Proposed to:
U.S. Department of Commerce – Economic Development Administration
U.S. Department of Commerce – National Institute of Standards and Technology
U.S. Department of Energy
U.S. Small Business Administration

Date: May 6, 2010

FOA: Fiscal Year 2010 Energy Efficient Building Systems Regional Innovation Cluster Initiative
# Greater Philadelphia Innovation Cluster for Energy Efficient Buildings

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GREATER PHILADELPHIA INNOVATION CLUSTER

The goals of the Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings are to improve energy efficiency and operability and reduce carbon emissions of new and existing buildings, and to stimulate private investment and quality job creation in the Greater Philadelphia region, the larger Mid Atlantic region, and beyond. GPIC will focus on full-spectrum retrofit of existing average size commercial and multi-family residential buildings.

Greater Philadelphia is an interconnected, well-defined and historically recognized region of 3,800 square miles comprising ten contiguous counties in Southeastern Pennsylvania and Southwestern New Jersey with the City of Philadelphia at its heart. The location for the DOE HUB/GPIC is the Clean Energy Campus at the Navy Yard in Philadelphia. The Navy Yard, which was closed by the federal government in 1996, represents one of the nation’s largest and most dynamic redevelopment opportunities. The 1,200 acre site currently houses more than 90 companies with more than 7,000 employees and is poised for continued investment and growth.

A cornerstone of the Navy Yard redevelopment effort is the Clean Energy Campus, aimed at making the Navy Yard a national center of excellence for energy research, education, and commercialization. The Clean Energy Campus currently houses the DOE Mid Atlantic Clean Energy Applications Center, the DOE Northern Mid Atlantic Solar Training Center, and the DOE Grid Smart Training Applications Resource (GridSTAR) Center.

Federal funding for the GPIC has been requested from four federal agencies. The largest request is the $122 million Energy Innovation HUB proposal to the Department of Energy (DOE) led by Penn State. The Philadelphia Industrial Development Corporation has requested $5 million from the Economic Development Administration, the Delaware Valley Industrial Resource Center has requested $1.5 million from the National Institute of Standards and Technology, and the Wharton Small Business Development Center has requested $1.3 million from the Small Business Administration. The Commonwealth of Pennsylvania has committed $30 million of new capital funding to support DOE HUB/GPIC facilities at the Navy Yard.

The DOE HUB component of the GPIC comprises a uniquely dynamic and diversified team of 11 prestigious universities including a historically black university, two DOE laboratories, five high profile global industry partners, economic development agencies, and community and technical colleges. DOE HUB activities are organized into five thrusts: 1) computational tools for integrated design, verification, and modeling; 2) components, sub-systems, controls, and diagnostics; 3) public policy, behavior, economics, and business; 4) education and workforce development; and 5) demonstration, deployment, and intellectual property (IP) management.

DOE HUB/GPIC headquarters facilities will include two buildings at the Navy Yard which will house HUB personnel. A historic building will undergo a full-spectrum retrofit and a new advanced integrated building sciences laboratory will be constructed. These facilities will function as living laboratories from design, through construction, commissioning and operation for developing tools and methods to transform the industry’s current fragmented serial process into system performance driven, integrated, parallel, team processes.

The GPIC is the culmination of more than a decade of dedicated team building efforts. All told, more than 90 organizations representing government, industry, education, workforce development, finance, labor, and philanthropic foundations have made commitments to help achieve the GPIC goals of national energy independence and regional economic development.
# GREATER PHILADELPHIA INNOVATION CLUSTER FOR ENERGY EFFICIENT BUILDINGS

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OVERARCHING NARRATIVE

INTRODUCTION

The goals of the Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings are to improve energy efficiency and operability and reduce carbon emissions of new and existing buildings, focusing on full spectrum retrofit of existing average-size commercial and multi-family residential buildings, and to stimulate private investment and quality job creation in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond.

Greater Philadelphia is an interconnected, well-defined and historically recognized region comprising ten contiguous counties situated in Southeastern Pennsylvania and Southwestern New Jersey with the City of Philadelphia at its heart and occupying in excess of 3,800 square miles. The location for the DOE HUB/GPIC is the Clean Energy Campus at the Navy Yard in Philadelphia. The Navy Yard, which was closed by the federal government in 1996, represents one of the nation’s largest and most dynamic redevelopment opportunities. The 1,200 acre site currently houses more than 90 companies with more than 7,000 employees and is poised for continued strategic investment and growth in the years ahead.

A cornerstone of the Navy Yard redevelopment effort is the Clean Energy Campus, aimed at making the Navy Yard a national center of excellence for energy research, education, and commercialization. The Clean Energy Campus currently houses the DOE Mid Atlantic Clean Energy Applications Center, the DOE Northern Mid Atlantic Solar Training Center, and the DOE Grid Smart Training Applications Resource (GridSTAR) Center.

The DOE HUB comprises a uniquely dynamic and diversified team of 11 prestigious academic institutions including a historically black university, two DOE laboratories, five high profile global industry partners, regional economic development agencies, and community colleges. DOE HUB activities are organized into five tasks, which are: 1) tools for integrated design, verification, and modeling; 2) components, diagnostics, sub-systems, and controls; 3) public policy, behavior, economics, and business; 4) education and workforce development; and 5) demonstration, knowledge management and deployment.

DOE HUB headquarters facilities will include two buildings at the Navy Yard which will house HUB personnel. A historic building will undergo a major retrofit and a new advanced integrated building sciences laboratory will be constructed. These facilities will function as living laboratories from design, through construction, commissioning and operation for developing tools and methods to transform the industry’s current fragmented serial process into system performance driven, integrated, parallel, team processes. The Commonwealth of Pennsylvania has committed $30 million of new capital funding to support these facilities.

The GPIC is the culmination of many years of dedicated team building efforts. More than 60 GPIC partners from government, industry, education and workforce development, banking and finance, labor, and philanthropic foundations have made commitments to the GPIC. The DOE HUB and the GPIC are tightly integrated. The EDA, NIST, and SBA co-applicants all are represented on the DOE HUB /GPIC Executive Board, and all serve as DOE HUB members.

The management of the DOE HUB /GPIC utilizes state-of –the-art communications and information technology and blends hierarchical control with decentralization, promoting day-to-day teamwork but also providing authoritative decision-making when needed. The heart of the
enterprise is the collaborative Operating Committee comprising the five DOE HUB task leaders (two from industry, two from academia, one from a regional economic development agency), the Navy Yard test bed facilities manager, and the Deputy Director. Ultimate decision making authority, however, rests with the DOE HUB /GPIC Director and the Executive Board.
A. IDENTIFICATION, DESCRIPTION, AND ANALYSIS OF REGION

This section identifies and describes the Greater Philadelphia Innovation Cluster (GPIC) including unique assets and advantages of the region, existing efforts to integrate research, development, and technology transfer and commercialization activities and to build public-private partnerships, and also identifies key obstacles that prevent further expansion of the cluster.

THE GREATER PHILADELPHIA REGION

The GPIC operates in Greater Philadelphia, an interconnected, well-defined and historically recognized region which encompasses ten contiguous counties situated in Southeastern Pennsylvania and Southwestern New Jersey. The Pennsylvania counties of Bucks, Chester, Delaware, Montgomery, and Philadelphia and the New Jersey counties of Burlington, Camden, Gloucester, Mercer, and Salem occupy in excess of 3,800 square miles.

The GPIC directly impacts one of the nation’s largest metropolitan areas. Based on data from the 2008 U.S. Census Bureau estimate, the GPIC contains the nation’s sixth largest city and the East Coast’s second-largest market in terms of employment. Philadelphia has a population exceeding 1,500,000 and the Greater Philadelphia region has a population exceeding 5,800,000. Of the region’s population, 69.9% is Caucasian, 20.4% is African-American, 4.6% is Asian, and 5.1% is Other. The region’s population is growing with 6,150,000 inhabitants expected to reside in Greater Philadelphia by 2035.

The GPIC draws on Greater Philadelphia’s substantial building stock to validate and deploy HUB discoveries. Energy efficiency initiatives to date have been primarily focused and successfully employed along the West Coast, and in particular California. However, little has been done to advance the East Coast energy efficient building design processes, methodologies and calibrated system modeling tools, and construction techniques. With a climate classified as a
Department of Energy Zone 4A and a highly varied building stock distributed across industry sectors and residential environments, Greater Philadelphia is an ideal test bed for research and deployment of technologies at the regional level that will have broad national impact.

The GPIC taps the technical expertise of the region’s citizens to grow and sustain a viable research and deployment HUB. The Greater Philadelphia region has 92 colleges and universities, a number of whom are GPIC core members and partners. According to the National Foundation for Educational Statistics, more than 361,000 full- and part-time students were enrolled in the region’s colleges and universities in the fall of 2006. Approximately 32% of the Greater Philadelphia region’s residents over the age of 25 hold a Bachelor’s degree or higher in comparison to only 27% nationwide. Tellingly, when compared to the top 25 metropolitan statistical areas (MSAs), the Greater Philadelphia region ranked 2nd only to Boston on the number of bachelor and first professional degrees awarded per capita.

The GPIC accesses a large and diversified labor force capable of advancing HUB discoveries, which will be multi-disciplinary and multi-sector by design. In 2007, 65% of the region’s population over age 16 was in the labor force, with 93.5% of those employed and 6.5% unemployed. Of those people working in the civilian labor force, 40% were employed in management, professional, or related occupations; 27% were working in sales and office occupations; 15% were employed in other services; and the remaining 18% were employed in construction or production related occupations. While Greater Philadelphia maintains a historically strong manufacturing base, knowledge-based industries have become prominent, with sectors such as education and health services, professional and business services, financial activities, and information technology making up over 44% of the region’s employment.

Headquartered in the very center of the region in Philadelphia County, the GPIC provides new and much needed quality job prospects. While the Greater Philadelphia region’s median annual household income of $60,515 was almost 20 percent higher than the national average according to the 2007 American Community Survey, the city of Philadelphia and many of the smaller jurisdictions in the region, including smaller cities, boroughs, and older first suburbs, have below average incomes. Of particular note, at the county-level, Philadelphia qualifies as “distressed” in each of the three categories reviewed by the Economic Development Administration, income, unemployment rate, and “special need.” According to a study by the Center for American Progress, “green investments generate not only significant numbers of well-paying jobs with benefits but also a relatively high proportion of lower, entry-level jobs that offer career ladders that can move low-paid workers into better employment positions over time.”

**Energy Efficient Buildings Sector**

The GPIC utilizes a growing network of Greater Philadelphia workers engaged in green business activities. Based on a 2010 Philadelphia Workforce Investment Board study using the definition of a green job in the Green Jobs Act of 2007, Southeastern Pennsylvania has greater than 88,000 green workers engaged in fields such as energy efficient building, construction, and retrofitting; renewable and sustainable energy; green property and facility management; deconstruction and material use recycling; and the assessment and monitoring services industry including energy auditing; hazardous material monitoring and evaluation, and environmental protection.
With close to 5,000 clean energy concerns located in Pennsylvania and New Jersey according to the Pew Charitable Trusts’ 2009 Clean Energy Economy, the GPIC assists the numerous businesses pursuing similar and or complementary endeavors. A sampling of the Greater Philadelphia region’s energy efficiency-related businesses compiled by the economic development marketing agency Select Greater Philadelphia includes:
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The inclusion of established and funded regional economic and workforce development partners within the GPIC’s executive management team, including the Ben Franklin Technology Partners of Southeastern Pennsylvania, the Delaware Valley Industrial Resource Center (DIVRC), the...
Philadelphia Industrial Development Corporation (PIDC), and the regional Small Business Development Centers and Workforce Investment Boards of Pennsylvania and New Jersey facilitates the transfer and adoption of GPIC discoveries and practices by businesses within the Greater Philadelphia region.

GPIC advances that fall outside established channels of industry adoption are supported by a robust Greater Philadelphia venture capital community. Based on the Pew study, over $500 million in venture capital spending was spent on new clean energy businesses in the states of New Jersey and Pennsylvania between 2006 and 2008. Of note, New Jersey and Pennsylvania rank 7 and 8 respectively in a state comparison of clean energy venture capital funding. The Greater Philadelphia region can boast a number of finance and venture capital firms that specialize in developing new clean energy businesses:

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**Differentiated Competitive Advantages**

Closed by the federal government in 1996, Philadelphia’s Navy Yard represents one of the nation’s largest and most dynamic redevelopment opportunities and offers the GPIC a number of distinct advantages. Thanks to successful public-private partnerships and a comprehensive, forward-thinking Master Plan the 1,200 acre site currently houses more than 90 companies with over 7,000 associated employees and is well poised for continued strategic investment and growth in the years ahead. One of the cornerstones of redevelopment to date has been to make The Navy Yard a national center of excellence for energy research, education, and commercialization focused specifically on clean and efficient energy production, storage, and management.

From a regional accessibility standpoint, the Navy Yard occupies more land than the central business and commercial district of Philadelphia and contains 282 existing buildings of which 233 are historic structures. Direct connections from The Navy Yard to the interstate highway system (both I-95 and I-76), the regional labor pool, the national rail network, and the Port of Philadelphia, in addition to close proximity to an international airport, ensure both excellent accessibility and high visibility of projects at this historic site.

The Navy Yard campus will function as a “living laboratory” for the GPIC, serving as a test bed for energy-efficient building system technology development and integration at the single building, building cluster and district energy levels. Equally important, the Navy Yard campus, which controls its own utilities including electric distribution grid, provides a unique opportunity for the testing of regulatory and public policy related issues in union with the GPIC’s technology development initiatives.
The Navy Yard provides for co-location of all GPIC co-applicant and strategic partner personnel. Co-location is an essential characteristic of successful innovation clusters, allowing for spherical integrated research and the development, demonstration and delivery of tools, technology, products and processes. Stage one of GPIC’s development will see key HUB personnel housed in a retrofitted, historically significant building. The retrofit design, delivery, commissioning and monitored operation of the facility will itself be utilized to develop tools and methods needed by the GPIC to transform the conventional building planning and construction process from a fragmented serial design and deliver process into system performance driven, integrated, parallel, team design and delivery processes that effect substantive changes with respect to energy efficiencies.

In stage two of GPIC’s development, the Commonwealth of Pennsylvania in conjunction with PIDC is committed to construct a new research laboratory and education facility in the Navy Yard to accommodate HUB personnel and the planned growth in GPIC-associated endeavors beyond the initial investment by federal funding agencies and GPIC founding members. The Governor of Pennsylvania has committed $30 million of new capital funding to support this new research and education facility at the Navy Yard in support of the GPIC.
As a core GPIC member, the PIDC controls the electric grid within the Navy Yard. There is a unique opportunity to apply and demonstrate Smart Grid and demand-response control technologies applicable to building system energy efficiencies. In addition, a number of businesses on site at the Navy Yard have already expressed an interest in exploring ways to advantage themselves of the cluster’s energy efficient building expertise. The Navy Yard campus provides GPIC’s experimental laboratory the ability to test and evaluate technology, architectural and engineering impacts, tradecraft and assessment tools and public policy implications, including electric and other utility rate tariff designs in an integrated fashion on an unprecedented scale.
INTEGRATION OF EFFORTS

The GPIC employs a unique, fully integrated approach to research, development, demonstration, and deployment (RDD&D) by actively engaging traditionally disparate stakeholders, academia, industry, and economic and workforce development partners, in all HUB activities, including design, management, operations, outreach, and educational training programs and adoption strategies. With 11 prestigious academic institutions including a historically black university, two DOE laboratories, five high profile global industry partners spanning the building and construction industries, four leading regional economic development agencies, and five community colleges (through the Collegiate Consortium for Workforce and Economic Development) as core members, and more than 60 partners drawn from stakeholder groups including government, industry, education and workforce development, banking and finance, labor, and philanthropic foundations, the GPIC is extremely broad and deep with respect to member, partner, and stakeholder engagement.

From a HUB design and management standpoint, stakeholders are represented by their most senior personnel on the GPIC Executive Board and the lead DOE applicant, Penn State, is committing their senior most research officer to be the GPIC Director. Cluster initiatives are facilitated by an onsite GPIC Operating Committee which is comprised of three members from lead academic institutions, two members from lead industry partners, one representative from the Greater Philadelphia regional economic development community, and one member from the real estate development community. The Director and the Operating Committee are advised by a broadly representative GPIC Advisory Committee that serves two primary functions, strategic review and assessment of HUB research and deployment activities and assistance with the diffusion of cluster discoveries and practices to the region and beyond.

At a more granular level, GPIC partners identified 5 critical tasks that need to be addressed to effect substantive change in the building industry:

- Task 1: Tools for Integrated Design, Verification, and Modeling
- Task 2: Advanced Components, Sub-Systems, Controls, and Diagnostics
- Task 3: Public Policy, Behavior, Economics, and Business
- Task 4: Education and Workforce Development
- Task 5: Demonstration, Knowledge Management and Deployment

Integration requires breaking down many traditional barriers that hinder collaboration including ingrained policies, procedures, methods and human behavior. In each of the selected tasks there is participation from across all stakeholder groups, creating a push-pull effect that allows for unique solutions to be developed and deployed that account for varied interests.

Finally, the GPIC accounts for one of the most complex aspects of academic-industry collaboration, innovation harvesting and intellectual property protection and management, by establishing an onsite, cross-stakeholder managed HUB Commercialization and Creativity Institute (C2I). The C2I facilitates the transfer of all GPIC/HUB discoveries; develops and modifies terms between bundles of technologies for marketing purposes as appropriate; assists in the resolution of disputes; and takes advantage of and fosters new cluster partnership opportunities as they arise. While a critical component of Task 5 (above), the C2I will be a direct report to the HUB Operating Committee and will be embedded in and contribute to yearly project reviews across all tasks.
DOE HUB Members

Penn State (lead)
Bayer Materials Science
Ben Franklin Technology Partners of SEPA
Carnegie Mellon University
Collegiate Consortium
Delaware Valley Industrial Resource Center
Drexel University
IBM Corporation
Lawrence Livermore National Laboratory
Morgan State University
New Jersey Institute of Technology
Philadelphia Industrial Development Corporation
PPG Industries
Princeton University
Purdue University
Rutgers University
Turner Construction
United Technologies Corporation
University of California
University of Pennsylvania
University of Pittsburgh
Virginia Tech
Wharton Small Business Development Center

GPIC Stakeholder Groups

Local STEM Community
Apprenticeship Programs
Secondary Schools
Career and Technical Institutes
One-Stop Career Centers
Workforce Investment Boards
Community Organizations
Local and State Agencies
Economic Development Agencies
Philanthropic Foundations
Venture Capitalists

Banks and Financial Institutions
Publicly and Privately Held Businesses
Industry Associations
Labor Organizations

GPIC Partners

Industry Partners
- Air Products and Chemicals
- ALSTOM Power
- Ametek
- Armstrong World Industries
- Boeing Company
- C.E. Rohlins, Inc.
- CertainTeed Corporation
- Constructive Specialties
- Deltic Services LP
- Dow Chemical Company
- DuPont Building Innovations
- Fluor
- HOK
- Horton Lees Brogden Lighting Design
- Johns Manville
- LaSalle
- Linn Partners
- Larson Design Group
- Linn Lighting and Electrical
- Lockheed Martin
- PECO
- Pfister Global Engineering
- PPL Interconnection
- Pittsburgh Corning
- PPG Industries
- Saint-Gobain
- Sauer Inc.
- Schneider Electric
- Siemens
- Turner Construction Group
- UPS Corporation
- Vivendi Energy
- Weir Murphy Fox, Inc.

Education and Workforce Partners
- Bucks County Workforce Investment Board
- Camden County Workforce Investment Board
- Chester County Workforce Investment Board
- Delaware County Workforce Investment Board
- Franklin Institute
- Gannett Institute
- Greater Philadelphia Regional Compact for STEM Education
- Liberty Science Center
- Montgomery County Workforce Investment Board
- Philadelphia County Workforce Investment Board
- Union County Workforce Investment Board
- Urban Education Partners
- Emerald Stage Ventures
- Minority Angel Investor Network
- Mid-Atlantic Angel Group

Community and Economic Development Partners
- Economic League of Greater Philadelphia
- Citizens for Pennsylvania's Future
- Select Greater Philadelphia
- University City Science Center

Government Partners
- Commonwealth of Pennsylvania
- Delaware Valley Regional Planning Commission
- City of Philadelphia
- Naval Surface Warfare Center
- Cardinal Division
- New Jersey Economic Development Authority

Labor Organizations
- National Roofing Contractors Association
- Penn-Jersey Chapter of NECA

Philanthropic Foundations
- Williams Penn Foundations

International Partners
- Lund University, Sweden
- Tampere University, Finland
Accessibility and Visibility
By leveraging the Greater Philadelphia region’s infrastructure, the GPIC offers a striking degree of accessibility and visibility to HUB endeavors. Located in the heart of the eastern seaboard, the Greater Philadelphia region is home to one of the nation’s most historic cities and is at the center of a large and thriving mega-market. Based on the most recent available data, in 2007 over 46 million people were reported to be living within 200 miles of Center City Philadelphia. In addition, the region is home to numerous national landmarks, arts and culture venues, professional sporting arenas, and a convention center. Greater Philadelphia attracts greater than 29 million domestic visitors per year according to the Greater Philadelphia Tourism Marketing Corporation. As a result, the region possesses an infrastructure capable of managing not only the needs of its citizenry but also the significant numbers of people that conduct business in and or visit Greater Philadelphia on a yearly basis.

The GPIC’s strategic location in Greater Philadelphia facilitates maximal adoption of HUB discoveries throughout the rest of the United States and offers ready access to global markets. Getting in and out of the Greater Philadelphia region is a breeze. The region can count eight airports located within a 90-minute drive of Philadelphia. The Philadelphia International Airport (PHL), which is located just a few miles from GPIC headquarters at the Navy Yard, provides a critical gateway for the region and is the 10th busiest airport in North America and the 11th busiest in the world. On the ground, the region is served by the Northeast Corridor lines of AMTRAK, the busiest passenger train route in the nation with more than 1,700 trains running daily. Philadelphia’s 30th Street Station is Amtrak’s busiest, and serves almost 4,000,000 passengers annually. In addition, the region boasts numerous arterial highways, including I-95, I-76, I-295, and the Pennsylvania and New Jersey Turnpikes.

From a commercial standpoint, the region can rely upon the aforementioned airports and highways as well commercial freight railroads and a major maritime facility. The Greater Philadelphia region is serviced by three Class 1 freight railroads: CSX Transportation, Canadian Pacific and the Norfolk Southern. The maritime Port of Philadelphia was the nation’s 10th busiest maritime freight gateway for international maritime trade by value of shipments in 2008, handling more than $43 billion of international freight. In the aggregate, the Port accounts for nearly 4 percent of the total U.S. waterborne freight tonnage.

Once in the region, Greater Philadelphians and visitors to the region can rely upon a comprehensive mass transit system. The Southeastern Pennsylvania Transportation Authority (SEPTA) serves the Philadelphia region and surrounds, offering bus, tram, commuter, light rail, and trolley services. In all, SEPTA operates over 450 miles of railroad lines and carries just under one million commuters every day, making it one of the nation’s largest commuter systems.1 The links between Southeastern Pennsylvania and Southwestern New Jersey, with more than 38,000 people each day commuting between New Jersey and Pennsylvania on the PATCO (Port Authority Transit Corporation) Hi-Speedline.

Existing Efforts
The GPIC leverages the members and activities of The Navy Yard Clean Energy Campus partners to diffuse HUB discoveries and practices. In 2005, The Navy Yard was designated a Keystone Innovation Zone (KIZ) as part of a funded incentive program of the Commonwealth of Pennsylvania designed to foster unique public-private partnerships and to support entrepreneurship in economically challenged geographic areas. The KIZ designation provided
the catalyst for a thorough assessment of the regional strengths in research and technology as drivers of economic development, and led to the formation of the Navy Yard Clean Energy Campus partnership, a growing group of public and private partners focused on creating economic opportunity by leveraging the complementary activities of education, research & development, and technology commercialization, specifically in the power and energy industry. The Navy Yard Clean Energy Campus was conceived as a unifying thrust for development of the Navy Yard real estate assets, physical infrastructure, and public and private tenant organizations’ capacity to serve as a unique national model for sustainable development and clean energy technology research, development, demonstration and deployment.

One of the GPIC’s core partners, the Ben Franklin Partners of Southeastern Pennsylvania (BFTP) has helped pioneer two innovative technology commercialization programs, the Nanotechnology Commercialization Group and the Energy Commercialization and Creativity Institute that will be emulated by the GPIC. The two programs combine the research expertise and innovative discoveries of Greater Philadelphia’s leading academic institutions, including core GPIC members such as Penn State, Penn, Drexel, with the economic development expertise of one of the region’s premier economic development agencies, BFTP. The members agree to jointly manage and market discoveries via a dedicated technology commercialization office that is funded in part by the Commonwealth of Pennsylvania. The programs have been highly successful in moving university discoveries, particularly those that involve multiple institutions, to market.

The GPIC’s core academic partners are significant contributors to the nation’s research and development enterprise, yielding a remarkable number of new inventions with commercial potential on an annual basis. The following table summarizes key research and development statistics for 9 of GPIC’s core academic members for the year 2008, the most recently available survey data from the Association of University Technology Managers:

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<th>Institution</th>
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<th>Disclosures</th>
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<th>Patent Applications</th>
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**OBSTACLES AHEAD**

As exciting as these achievements and opportunities are, a number of potential obstacles and barriers to further progress can be readily identified. The goals of the Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings is to improve energy efficiency and operability and reduce carbon emissions of new and existing buildings, focusing on full spectrum retrofit of existing average-size commercial and multi-family residential buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit
markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond. Perhaps the greatest obstacle to achievement of these GPIC goals are the challenges associated with the degree of change that is needed within the building and construction industry for the necessary improvement in building energy efficiency. These changes are not only technological; they are also organizational, psychological, sociological behavioral, economic, and legal.

The significant energy efficiency improvements that have been achieved over the past 30 years in transportation and industrial process have been carried out within vertically integrated industries such as automobile and aircraft manufacturing. This is not the case with building and construction sectors. What is needed is to convert this horizontal building design, development, construction, and operation industries into a virtual, vertically integrated sector. Several major barriers exist to achieving these goals which are embedded in the Tasks to be performed by the GPIC. Key barriers include:

- Lack of user friendly widely accessible tools for integrated design, optimization, and verification of energy efficient building systems
- Lack of for scalable system solutions and enabling component technologies, robust controls, and diagnostic platforms
- Public policies, patterns of human and organizational behavioral, and economic, business, and market models that inhibit investment in energy efficient buildings
- Lack of workers at levels, from secondary level through and associate, baccalaureate, and graduate degrees, with cross-disciplinary skill in energy efficient building systems
- Conflicting goals among government, industry, and academic partners
- Disagreement among partners over intellectual property management issues
- Potential labor-management conflicts in the building and construction industry
- A high degree of overall task complexity and requirements for task integration proves too difficult to effectively manage
- Shift in attention by government, industry, universities, or the general public away from energy efficiency issues
- Public and private financial resources available to support efforts to improve building energy efficiency proves to be inadequate
- Key leadership personnel are removed from the building energy efficiency enterprise due to retirement or other factors
- The current cooperative team spirit is replaced by competition due to factors beyond control of the partners

Many other barriers exist in addition to this sampling, many of which cannot be anticipated. The GPIC has developed a very strong team, management and operations plan, and integrated programmatic agenda to address such barriers as they arise. The GPIC is prepared to meet these and other challenges and to achieve the goals of improving energy efficiency and operability and reduced carbon emissions of new and existing buildings, and increased private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond.
B. OVERVIEW OF PROPOSED PROJECT

The Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings has been established to improve energy efficiency and operability and reduce carbon emissions of new and existing buildings, focusing on full spectrum retrofit of existing average-size commercial and multi-family residential buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond.

THE CO-APPLICANTS

The Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings is led by four co-applicants with a shared history in collaborative regional technology based economic development. The DOE co-applicant is the Pennsylvania State University (Penn State). The EDA co-applicant is the Philadelphia Industrial Development Corporation (PIDC). The NIST co-applicant is the Delaware Valley Industrial Resource Center (DVIRC), and the SBA co-applicant is the Wharton Small Business Development Center at the University of Pennsylvania. A copy of the signed binding agreement committing each of these organizations the roles and responsibilities specified in this section is appended to this proposal. A brief summary of the scopes of work to be pursued and the amount of funding requested by each of the co-applicants is provided below:

DOE Co-Applicant: Penn State

Penn State will pursue DOE Energy Innovation HUB funding to create quality jobs, save energy, and reduce carbon emissions by developing technologies and policies to stimulate private investment in the energy efficient retrofit of existing average size commercial and multi-family residential buildings in the Greater Philadelphia region and beyond. Penn State will provide overall leadership for the GPIC and the DOE HUB, comprised of 22 members in addition to Penn State. The goals of the GPIC are to improve energy efficiency and operability and reduce carbon emission of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond. DOE HUB activities are organized in five tasks, which are: 1) tools for integrated design, verification, and modeling; 2) advanced components, subsystems, controls, and diagnostics; 3) public policy, behavior, economics, and business; 4) education and workforce development; and 5) Demonstration, Knowledge Management and Deployment. The HUB will be located at the Navy Yard Clean Energy Campus in Philadelphia. The amount of DOE funding sought is $122 million.

EDA Co-Applicant: Philadelphia Industrial Development Corporation (PIDC)

The Philadelphia Industrial Development Corporation (PIDC) will pursue EDA funding to create jobs through the full spectrum energy efficiency retrofit of a 30,000 square foot building at the Navy Yard Clean Energy Campus to function as living laboratories for GPIC energy efficient building RDD&D activities and to provide a single location for the GPIC. PIDC will also serve as a DOE HUB member and will utilize first year DOE HUB funding to support this project. Using Commonwealth of Pennsylvania funds and private investment, PIDC will also develop at
least one new construction energy efficient building project and additional retrofit projects at the
Navy Yard Clean Energy Campus, all of which will be carried out as RDD&D projects of the
DOE HUB and will function as living laboratories before, during, and after commissioning. In
addition to personnel and facilities of the DOE Energy Innovation HUB, the Clean Energy
Campus will house other clean energy education, research, and technology commercialization
activities including the DOE Mid Atlantic Clean Energy Applications Center and the DOE
Northern Mid Atlantic Solar Training Center, and the DOE Grid Smart Training Applications
Resource (GridSTAR) Center. The amount of EDA funding sought is $5 million.

**NIST Co-Applicant: Delaware Valley Industrial Resource Center (DVIRC)**
The Delaware Valley Industrial Resource Center (DVIRC) will pursue NIST funding to create
quality jobs in the Greater Philadelphia region by engaging area small and medium size
enterprises (SMEs) in industry sectors that produce energy efficient building components and
subassemblies in GPIC RDD&D activities, and help integrate these firms into supply chains of
energy efficient building systems original equipment manufacturers (OEMs). Efforts will target
regional SMEs possessing manufacturing capacity that can address technology focus areas of the
Energy Innovation HUB such as advanced lighting, HVAC, building materials, controllers,
power management systems, and others. The DVIRC will assist these firms to participate in
HUB research, education and training, and technology development, demonstration, and
deployment activities to position them as preferred suppliers to OEMs in key building energy
efficiency sectors to strengthen the economy of the Greater Philadelphia region. The amount of
NIST funding sought is $1.5 million. DVIRC will also participate as a DOE HUB member and
will utilize DOE HUB funding to directly support HUB demonstration, deployment,
commercialization efforts by bringing together regional SMEs in the building design and retrofit
sector for collaborative energy efficient building systems work.

**SBA Co-Applicant: Wharton Small Business Development Center (SBDC)**
The Wharton Small Business Development Center (SBDC) will pursue SBA funding to create
quality jobs and enhance experiential educational opportunities for students by engaging teams
of undergraduate and graduate students and alumni to develop technology demonstration,
deployment, and commercialization strategies for GPIC technologies in partnership with new
and small business in the Greater Philadelphia region. In addition, the Wharton SBDC will
engage undergraduate and graduate students in business, law, and other fields, along with alumni
possessing relevant experience, to help prepare business and product development strategies to
accelerate commercialization of technologies developed by the Energy Innovation HUB. These
efforts will be carried out in close collaboration with technology licensing officers within the
HUB member institutions. The dual aims of this effort, which builds upon existing programs of
the Wharton SBDC, are to provide high quality educational experiences for students in business
administration and other fields, and to accelerate the commercialization of HUB-developed
technology. This effort will be closely coordinated with intellectual property management and
technology validation, prototyping, demonstration, and deployment activities of the HUB. The
amount of SBA funding sought is $1.2 million. The Wharton SBDC will also participate as a
DOE HUB member and will utilize DOE HUB funding to directly support HUB demonstration,
deployment, and commercialization efforts by engaging Wharton students and alums to help
develop RDD&D projects on behalf of complex multi-functional teams of firms within the
Greater Philadelphia region.
CONSORTIUM ORGANIZATIONAL AND MANAGEMENT CAPABILITIES

The goals of the Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings are to improve energy efficiency and operability and reduce carbon emissions of new and existing buildings, focusing on full spectrum retrofit of existing average-size commercial and multi-family residential buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond. The four co-applicants described above both individually and collectively possess a unique set of capabilities for achieving these goals, as described below.

Penn State and the DOE HUB Members

Penn State is a comprehensive public research university with more than $765 million of research expenditures in Fiscal Year 2009. Of this total, more than $103 million was industry sponsored research placing Penn State third among U.S. universities for industrial research funding. Energy is an area of particular education and research strength at Penn State. Last year Penn State was named the number one university worldwide in multidisciplinary alternative energy research according to the 2009 Elsevier Alternative Energy Research Leadership Study. To help maintain leadership in this area, the Penn State established the Institutes for Energy and the Environment in 2007 within the Office of the Vice President for Research to help coordinate energy education and research activities. In that same year Penn State also made a commitment to create 25 new faculty positions in energy over the five-year period from 2008 to 2013.

Technical leadership within Penn State for the GPIC comes from the Department of Architectural Engineering which is the oldest, continuously accredited program in the United States with more than 3,000 alumni working on building projects all over the world. The Department has championed the cause of energy efficiency in buildings through its unique integrated curriculum and research facilities that span across all building engineering disciplines. The Department has established a Center for High Performance Building Systems (CHiPBS) to serve as a focal point for engaging the building industry and its stakeholders in bringing about the paradigm shift necessary to deliver energy efficient buildings both now and in the future.

Penn State has assembled an uncommonly dynamic and diversified team of 22 globally prominent government, industry, and educational members to establish the DOE HUB component of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings. These DOE HUB members are shown by geographic location on the following page. To help ensure full integration of the GPIC and the DOE HUB, all GPIC co-applicants, (Penn State, PIDC, DVIRC, and the Wharton SBA) are also HUB members.

Key strengths of HUB members relevant to energy efficient buildings are summarized below:

- The Ray W. Herrick Laboratories (HERL) at Purdue University was created in the 1950s to support research into air conditioning and refrigeration compressors and evolved to consider all aspects of equipment and systems used to condition buildings, leading to over 300 graduate student theses that have contributed to advancement of science and
DOE HUB Members

1. Penn State (lead)
2. Bayer MaterialScience
3. Ben Franklin Technology Partners of SE PA
5. Collegiate Consortium
6. Delaware Valley Industrial Resource Center
7. Drexel University
8. IBM Corporation
9. Lawrence Livermore National Laboratory
10. Morgan State University
11. New Jersey Institute of Technology
12. Philadelphia Industrial Development Corporation
13. PPG Industries
14. Princeton University
15. Purdue University
16. Rutgers University
17. Turner Construction
18. United Technologies Corporation
19. University of Pennsylvania
20. University of Pittsburgh
21. Virginia Tech
22. Wharton Small Business Development Center
engineering related to HVAC&R technologies. Current research topics include high performance equipment, intelligent controls and diagnostics, indoor environments, and high performance building envelopes. One of the commonalities has been and continues to be the development, validation, and application of models useful for design, analysis and optimization, including modeling of components (compressors, flow control devices, heat exchangers, building envelopes), subsystems (packaged AC and heat pumps, chillers, air handling equipment, integrated envelope subsystems), indoor environments, and whole-building systems. HERL has focused on industry-relevant research and has maintained a close collaboration with industry.

- The Center for Energy at the University of Pittsburgh is a university-wide endeavor that leverages the energy-related expertise of more than 40 faculty members from multiple disciplines. The research focus areas of the Center for Energy are energy efficiency, delivery, and reliability, and advanced materials for energy-related applications. Within the area of increasing the energy efficiency of buildings, funded projects include thermal semiconductors for building insulation, thermoelectric and thermoacoustic waste heat recovery, nanostructured photoelectrodes for solar cells, dynamic life cycle assessment of building retrofits, combined PV and solar thermal systems, dynamic thermal models for high performance computation centers, aeroelastic energy harvesting, and optimal configuration and operation of hybrid cogeneration systems.

- PPG has a long history of developing and providing novel energy-efficient envelope components to the construction market. Over this time span, PPG has developed a relationship with architects and specifiers and has gained a deep understanding of what features are required of building products to ensure market adoption. This technical knowledge of both materials and manufacturing processes coupled with market savvy will enable rapid deployment and acceptance of products developed as a result of the DOE HUB. In the window market, PPG currently sells a variety of solar control glazings that reject solar heat gain while allowing a high degree of visible light. PPG also developed Intercept spacer technology for insulated window units. PPG sells value-added glass products into the photovoltaic market that enables higher energy power output due to ultra clarity and anti-reflective coatings. These materials may be utilized and developed for building integrated PV. In the roofing market, PPG sells Duranar® ULTRA-Cool coatings for structural and architectural metal roofing panels. These coatings are made with proprietary infrared-reflective pigments to keep buildings cooler while offering architects an expansive palette of environmentally progressive metal panel and roof colors.

- The Center for Building Performance and Diagnostics (CBPD) at Carnegie Mellon University is a National Science Foundation Industry-University Cooperative Research Center (IUCRC) that conducts research, development, and demonstrations in advanced building technologies and systems integration for high performance buildings, improved approaches to the building delivery process, and in workplace productivity in partnership with the Advanced Building Systems Integration Consortium (ABSIG). The ABSIC is comprised of globally active manufacturing and design corporations, US and foreign governmental agencies, and Carnegie Mellon University. The CBPD demonstrated firsthand the concepts of user comfort and satisfaction, organizational flexibility, technological adaptability, and energy and environmental effectiveness, with the construction of the Robert L. Preger Intelligent Workplace in 1997. The Intelligent
Workplace™ is a “living laboratory” for research and demonstration of advanced building systems and their integration for total building performance, as well as the home for the Center for Building Performance and Diagnostics.

- **The Center for Building Knowledge (CBK)** at the New Jersey Institute of Technology focuses on energy efficient and sustainable facilities, with a particular focus on the interface between energy efficiency innovations and their application to real world buildings. CBK is currently acting as the content coordinator for all of McGraw Hill Construction’s online education activities which focus primarily on introducing innovative building products and systems to architects across the country. CBK developed the energy efficiency design guide used by all design team working for the NJ Schools Development Authority. CBK is also providing technical assistance to an innovative, “near zero energy” multifamily housing demonstration project for the NJ Clean Energy Program. CBK is creating an online training program for the NJ Clean Energy Program that includes detailed documentation of the energy efficient retrofits of one residential and one commercial facility. CBK is also developing an online training program for Oak Ridge National Laboratory focused on the lab’s Weatherization Assistance Training software tool.

- **IBM Research** is the largest industrial research organization in the world, with eight labs in six countries. IBM Research has increased its focus on energy, including buildings, related research over the years. Emphasis is on standards-based smart grid and building-to-grid IT infrastructure; dynamic demand management, advanced analytics and simulation for improving building energy efficiency, thermal modeling, data center optimization, visualization, energy conversion and storage technologies such as batteries, advanced silicon photovoltaics, visual surveillance, cybersecurity, event-driven sensor-actuator integration and embedded systems. IBM is currently engaged with DOE/EERE in research focused on energy efficiency related to data center and telecommunication facilities. Research is focused on problems associated with power consumption of the cooling systems and the implications of locating IT equipment, implications of the chilled air flow control mechanisms, and implementation of innovative new technologies such as air side economizing, various air flow management solutions, and variable frequency drive fans. IBM is also engaged with the DOE in a smart grid regional demonstration across five states and 12 utilities in the Northwest.

- **Bayer MaterialScience (BMS)** is among the world’s largest polymer companies. BMS has more than 30 production sites around the globe and employed approximately 14,300 people at the end of 2009. In the U.S., BMS has world class manufacturing sites in Baytown, TX; New Martinsville, WV; and Newark, OH; not to mention state of the art research and development laboratories at its headquarters in Pittsburgh, PA. BMS is one of the largest and most innovative suppliers of raw materials for the construction industry with global sales exceeding $1.6 billion in 2009. Consistent with its overarching goals, BMS has invested heavily in developing technologies to support its EcoCommercial Building program. This program encourages collaboration and innovation among supply chain participants and other industry stakeholders to advance technology and increase adoption rates for energy efficient buildings. BMS has sponsored several lighthouse projects demonstrating highly efficient building design and technology integration concepts in different regions of the world.
• **Turner Construction Company** is both the largest general contracting company and the largest Green builder in the United States, as ranked by Engineering News Record (ENR) Magazine. Turner’s experience in green construction includes a wide variety of building types: commercial offices and high rises, research and development facilities, education facilities, government offices, and healthcare facilities. The largest builder of education facilities in the U.S., Turner put in place almost $1.6 Billion of new construction, fit-outs, and renovations in 2009. Turner is the largest procurer of Construction equipment and services nationally and maintains over 140 professionals to provide local supply chain management services. Turner has more LEED® accredited professionals (1,100) than any company in the industry, including a LEED® -accredited team of full-time preconstruction specialists located in the Philadelphia office that can utilize their own extensive experience and augment that experience with information and best practices from around the country.

• **Drexel University** faculty and researchers have been very active in energy research areas such as solar cells, biodiesel and hydrogen from biomass, power system and smart grid, life cycle analysis, and building energy efficiency and indoor environmental quality. Drexel hosts a wide variety of energy related research centers and research groups that are well-funded by federal and state agencies. Among other initiatives are: 1) The A. J. Drexel Nanotechnology Institute conducts research in areas such as nanostructured materials for energy storage and nano- and micro-scale devices for electronics; 2) The A. J. Drexel Plasma Institute conducts research in areas such as fuel conversion, hydrogen production, and combustion; 3) Center of Electric Power conducts research in areas such as smart grid system, solar photovoltaic system, and solar thermal system; 4) Center for Advancing Microbial Risk Assessment conducts research in indoor environmental quality and dose response assessment; and 5) the High Performance Building Research Group at Drexel University conducts research in building energy efficiency, indoor environmental quality, and alternative energy areas.

• **Lawrence Livermore National Laboratory** leverages its key expertise and capabilities in a broad energy program ranging from basic research to development of next generation energy technology. To cite several examples: LLNL is researching revolutionary nuclear reactor designs that produce almost no radioactive waste products based upon fusion laser energy, leveraging DOE’s multi-billion investment in the National Ignition Facility. The Laboratory is designing and development of advanced materials able to withstand the intense radiation conditions in nuclear energy plans thereby extending the life of current power generation resources. Applying those same materials science skills, LLNL is developing batteries and energy storage capabilities that will transform the transportation systems and enable the large scale integration of renewable energy. Through highly accurate predictions of atmospheric flows over complex terrain, we are improving the dispatch of wind farms and dramatically improving the design and lifetime of current wind turbines. LLNL’s carbon management activities are revolutionizing fossil fuel use, delivering zero carbon emissions, by developing technologies to gasify coal in-situ (underground) and simultaneously sequestrating carbon emissions.

• **Morgan State University**’s existing research on green roof technologies, electric grid integration, intelligent dashboard and visualization, sensor networks, life-cycle assessments of urban rowhouses, environmental controls research, and modeling and virtual prototyping are areas where research activity has direct applicability to energy
efficient building research. For the past five years, Morgan State has led major collaborative research projects in access of $20M, from DOD, NASA, and NSF. The first two have resulted in the funding of the DoD Knowledge Integration & Management Center of Excellence, and the NASA Chesapeake Information-Based Aeronautics Consortium. In early May, the University will sign a CRADA with the Army’s RDECOM. Research and technology spin-offs from these and other efforts are believed to have relevance to the proposed DOE HUB.

- The University of Pennsylvania’s TC Chan Center of Penn and Tsinghua University in China is a global leader in the building simulation studies and in the applied application of this research to energy management and policy development. The Institute for Global Environmental Leadership at the Wharton School brings together expertise from business, law, and elsewhere to bridge the gap between the academic and corporate worlds and to advance partnerships for change on energy innovation. The Penn Institute for Urban Research as invested in a research and publication agenda related to sustainable energy, including several edited volumes and a major international conference on post-oil cities. Pennergy is a major initiative by the Penn Engineering to gather expertise on both renewable energy and energy efficiency with significant research into materials and controls. In addition to research activities, the University launched a new degree this year, a post-professional Masters in Environmental Building Design as well as a new undergraduate minor in Environmental Studies.

- Virginia Tech’s research and development activities take place through, among other activities: 1) The Interdisciplinary Center for Applied Mathematics, which promotes interdisciplinary research and education in applied and computational mathematics at Virginia Tech. A major goal of ICAM is the enhancement of the historical links among mathematics, engineering and the sciences. ICAM was named a Commonwealth Center of Excellence in 1990, is home to the Center for Optimal Design & Control (CODAC) and was named a DOD Center of Research Excellence & Transition. 2) The Institute for Critical Technology and Applied Science (ICTAS) supports and promotes cutting edge Research at the intersection of engineering, science and medicine. 3) The Virginia Bioinformatics Institute (VBI) is a research institute dedicated to the study of the biological sciences, with collaborations in diverse disciplines such as mathematics, computer science, biology, plant pathology, biochemistry, systems biology, statistics, economics and synthetic biology. The Core Computational Facility (CCF) at VBI provides a secure, stable, and manageable infrastructure supporting data-intensive research.

- Ben Franklin Technology Partners of Southeastern Pennsylvania (BFTP), a nationally recognized leader in technology based economic development. BFTP functions as an innovation integrator and seed investor, linking public and private resources to create new systems to support technology development and commercialization, spawning new enterprises and growing existing ones. BFTP has a 27-year track record of successfully creating commercialization pathways, and catalyzing and developing cluster-based strategies and collaborations in the region. BFTP has invested over $37 million since 2001 and $130 million since 1982 in 1,600 companies. In the last six years, these investments have returned over $650 million in follow-on capital. BFTP’s statewide partnership was awarded the U.S. Department of Commerce Technology-Led Economic Development Award in 2008. As part of its regional energy strategy focused
at the Navy Yard, BFTP is engaging corporate partners for energy demonstration projects at the Navy Yard.

- The **University of Pittsburgh**’s Center for Energy leverages the energy-related expertise of more than 40 faculty members from chemical engineering, chemistry, physics, civil engineering, electrical engineering, industrial engineering, geology, mechanical engineering, and materials science. The research focus areas of the Center for Energy are energy efficiency, delivery, and reliability, and advanced materials for energy-related applications. Within the area of increasing the energy efficiency of buildings, funded projects include thermal semiconductors for building insulation, thermoelectric and thermoacoustic waste heat recovery, nanostructured photoelectrodes for solar cells, dynamic life cycle assessment of building retrofits, combined PV and solar thermal systems, dynamic thermal models for high performance computation centers, aeroelastic energy harvesting, and optimal configuration and operation of hybrid cogeneration systems. The Center for Energy also is complemented by and interacts with a number of other centers on the University of Pittsburgh’s campus, including the Center for Simulation and Modeling, the Nano-Scale Fabrication and Characterization Facility, and the Mascaro Center for Sustainable Innovation.

- **Rutgers University** has a strong array of interdisciplinary centers that focus on energy development and related issues. These include the: 1) Center for Green Building, focusing on developing and implementing innovative green building strategies; 2) Rutgers Center for Energy, Economic and Environmental Policy works to strengthen energy, economic and environmental public policy; 3) Rutgers Ecocomple is an Environmental and Alternative Energy Business Incubator and Research Center actively engaged in "Green Business" development by providing state-of-the-art facilities and assistance to entrepreneurs in business plan development, technology evaluation and commercialization; and 4) The Center for Ceramics Research (CCR) and the Fiber Optics (FO) building provides extensive infrastructural support for research, including materials preparation and characterization facilities, data acquisition and analysis, as well as technical and instrumentation support.

- **United Technologies Corporation (UTC)** will draw on its ongoing research strengths in the following areas: 1) *Methods and tools for design, delivery and operation*, including leveraging computational methods developed in other domains – multi-domain modeling (building subsystems components, building envelope models, and control design tools). Ability to develop optimum designs quickly, focusing initially on building retrofits but expanding scope to include campus and district scale. 2) *Development and demonstrations at scale*, via component/sub-system and controls technologies that enable system-level solutions to building energy efficiency, including dynamic thermal storage, independent humidity control, passive ventilation and air quality management techniques, advanced lighting and envelope configurations including integration of building integrated renewable CHP and district energy systems. 3) *Understanding of human factors*, including perception of comfort, indoor environmental quality versus productivity, culture, group dynamics and the decision making process. 4) *Techno-economic tools*, reflecting an understanding of the intersection of technology, policy, regulation, socio-economic factors and certification on energy consumption.
Philadelphia Industrial Development Corporation (PIDC)
Philadelphia Industrial Development Corporation (PIDC) is a private, not-for-profit Pennsylvania corporation, founded in 1958 by the City of Philadelphia and the Greater Philadelphia Chamber of Commerce to promote economic development throughout the city. PIDC's central strategy is to leverage financing and real estate resources to retain and to grow employment in Philadelphia. PIDC also coordinates tax incentive and work force development programs offered by the City and the Commonwealth. Clients range from the traditional base of commercial and industrial businesses to the developers of large, public purpose facilities to non-profits, in all neighborhoods of Philadelphia. A thirty-member Board of Directors appointed by the Mayor of Philadelphia and the President of the Greater Philadelphia Chamber of Commerce governs PIDC. The Staff includes 60 full-time employees and the annual budget is funded largely from service fees generated by PIDC’s business activities. PIDC also manages the Philadelphia Authority for Industrial Development (PAID) which is a conduit for tax exempt debt and other economic development transactions. Throughout its fifty year history, PIDC has closed a total of 5,350 individual transactions with combined project costs of $15 billion, which have contributed to retaining and creating over 442,000 jobs in Philadelphia.

Delaware Valley Industrial Resource Center
The Delaware Valley Industrial Resource Center (DVIRC) was established in 1988, and is part of Pennsylvania’s Industrial Resource Network, a program funded by the Department of Community and Economic Development (DCED). The Centers are private, not-for-profit economic development corporations supported by the Commonwealth and managed by private industry. DCED has also been instrumental in helping the IRC Network compete for, and win, federal MEP awards, which are part of The National Institute of Standards and Technology’s (NIST) Manufacturing Extension Partnership program. DVIRC receives approximately 1/3 of its funding from these organizations, and depends on its consulting and training services for additional revenue. It seeks to establish long-term relationships with customers, and success is measured on the value-added dollars achieved by its customers: in 2006 alone, its customers documented over $170 million in cost savings or productivity improvements.

The DVIRC aims to assist advanced manufacturers throughout the Philadelphia region grow business value. In order to develop the region’s “talent pool,” DVIRC established Applied Engineering Technology (AET) educational program. This initiative, formed in partnership with Pennsylvania’s academic, business and government leaders, has become a national model for Science, Technology, Engineering and Math (STEM) education. As a result, in 2007, funded by a grant from the National Governors Association, the Philadelphia Navy Yard – the venue for the proposed initiative – will become home to the area’s only STEM Center. The STEM Center represents only one aspect of DVIRC services to be housed in the Building 100 Innovation Center at the Navy Yard. DVIRC is also piloting new services at the Navy Yard that support revenue growth for small and medium-sized manufacturing enterprises (SMEs), including market research, market development and new product development. In these efforts, DVIRC is working closely with economic development and private enterprise partners, area universities, federal laboratories, and research institutions to drive economic growth through the development of commercially-viable technologies to SMEs.

Seeing the need for educational leadership in the region around the STEM Center concept, the DVIRC, organized the Greater Philadelphia Engineering Deans Economic Development Council. The Council is comprised of engineering deans from the tri-state regions eight
engineering schools. Most recently, DVIRC has begun to work with private capital firms in order to build solid relationships between the region’s manufacturers and the private capital community. In these efforts, DVIRC works closely with business, community, and academic leaders, as well as government agencies at the state and federal levels.

**Wharton Small Business Development Center**
The University of Pennsylvania is one of the nation’s leading research universities, and – founded by Benjamin Franklin – is one of the oldest as well. The University’s Wharton School is consistently ranked as one of the nation's top three business schools. The School enrolls more than 4,900 undergraduate, MBA, executive MBA, and doctoral students, with more than 9,000 additional annual participants in executive education programs. The Wharton SBDC is located at The Wharton School of the University of Pennsylvania and has been a driving force in the growth of over 20,000 small businesses in the past decade. The Wharton Small Business Development Center (WSBDC), a division of the Sol C. Snider Entrepreneurial Research Center of Wharton Entrepreneurial Programs, was founded in 1980 and is one of 18 SBDCs in the Commonwealth of Pennsylvania.

The WSBDC provides free consulting services to entrepreneurs as well as educational workshops for which a nominal fee is charged. The Wharton SBDC is strongly committed to helping small businesses in the Philadelphia area. All services are provided by WSBDC’s staff of highly qualified consultants. In addition to practical experience in operating small businesses themselves, the staff has more than 150 years of business experience and hold degrees in Business, Economics and Engineering. The Wharton SBDC also taps the expertise of industry experts, successful entrepreneurs, and other business professionals to deliver its educational programs. Each year, the Wharton Small Business Development Center provides the following services:

- Provides over 16,000 hours of consulting to 600 entrepreneurs and small businesses
- Offers over 70 educational programs attended by more than 1,500 entrepreneurs and small business owners
- Answers over 10,000 requests for information and assistance
- Helps clients obtain over $10,000,000 in start-up and expansion capital
Management Structure
The overall management structure of the GPIC is depicted on the organization chart below. As indicated, the GPIC/HUB management structure is designed to ensure integration by including senior representatives of all four Consortium co-applicants with DOE HUB members at the level of the Executive Committee which will oversee all activities of the GPIC.
ACTIVITIES TO BE UNDERTAKEN

Table 1 provides a year-by-year description of the tasks to be undertaken by the four co-applicants and specifies which activities will be funded by DOE, EDA, NIST, and SBA. These activities relate to and will leverage a number of existing federal awards. The Department of Architectural Engineering at Penn State has recently been awarded three DOE grants to establish the following centers at the Philadelphia Navy Yard, which will compliment the GPIC:

- In July 2009, the U.S. Department of Energy (DOE) awarded a $2 million five-year grant to the Penn State College of Engineering to establish the **Mid Atlantic Clean Energy Application Center** (CEAC) at the Navy Yard. The mission of the Mid Atlantic Clean Energy Applications Center is to promote the adoption of clean energy technology by industry and government in the six Mid Atlantic states through education and technical assistance.

- In September 2009 the DOE awarded a $3.5 million five-year grant to the Penn State College of Engineering to establish the **Northern Mid Atlantic Solar Training Center** at the Navy Yard. The mission of the Northern Mid Atlantic Solar Training Center is to assist development of the solar energy industry by ensuring a skilled workforce through development of solar education and training programs in Pennsylvania and New Jersey.

- In April 2010 the DOE awarded a $5 million five-year grant to the Penn State College of Engineering to establish the **Grid Smart Training Applications Resource (GridSTAR) Center** with a permanent site at the Navy Yard. The mission of the GridSTAR Center is to develop and deliver education and workforce training in smart grid integrated clean power production and management technologies in the Mid Atlantic region.

In addition, in April 2010 the City of Philadelphia received a $25 million award through the DOE Energy Efficiency and Conservation Block Grant program to establish a program entitled **Project Energy Smart: Transforming the High Performance Building Retrofit Market in Southeastern Pennsylvania.** A key component of this program is the Greenworks Revolving Loan Fund which will help finance building energy efficiency retrofits in the Greater Philadelphia region. The Greenworks Revolving Loan Fund will be administered by the Philadelphia Industrial Development Corporation (GPIC EDA co-applicant) and will be a key asset for deploying GPIC energy efficient building technologies and systems throughout the Greater Philadelphia region. Other federal awards to be leveraged by the GPIC include:

- The **NSF Center for Nanotechnology Applications and Career Knowledge (NACK Center)** at Penn State is responsible for assisting community and technical colleges across the U.S. to develop associate degree training programs in micro- and nanotechnology, with special emphasis on the Greater Philadelphia region. The skills developed through these programs are highly applicable to many clean energy production and energy efficiency industries.

- The **Naval Surface Warfare Center Carderock Division's Ship Systems Engineering Station (NSWCCD-SSES)** is located at the Navy Yard in Philadelphia. NSWCCD-SSES is responsible for support of electric power systems, machinery controls, climate control, and machinery condition assessment for all of the Navy's surface ships, aircraft carriers, submarines, submersibles, and large unmanned vehicles. NSWCCD-SSES is a partner in the GPIC and its technical expertise and engineering activities will directly complement the DOE HUB.
<table>
<thead>
<tr>
<th>Tasks</th>
<th>Sub-Tasks</th>
<th>Project Years 1-5</th>
<th>DOE Funds</th>
<th>Industry Funds</th>
<th>EDA Funds</th>
<th>NIST Funds</th>
<th>SBA Funds</th>
<th>Other Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1: Tools for Integrated Design, Verification, and Modeling</td>
<td>Integrated lifecycle project delivery process</td>
<td>X X X X X</td>
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<tr>
<td></td>
<td>Hierarchical modeling for building design</td>
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<td></td>
<td>Performance computational tools and applications</td>
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<td></td>
<td>Integrated delivery process infrastructure</td>
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<td>Tasks 2: Components, Sub-Systems, Controls, and Diagnostics</td>
<td>Integrated building systems with CHP and storage</td>
<td>X X X X X</td>
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<td></td>
<td>Façades, integrated HVAC, and lighting technologies</td>
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<td></td>
<td>Robust control systems</td>
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<td></td>
<td>Performance monitoring and diagnostic systems</td>
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<tr>
<td>Task 3: Public Policy, Behavior, Economics, and Business</td>
<td>Deploy expertise into GPIC-C2I projects</td>
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<td></td>
<td>Build practice/performance knowledge repository</td>
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<td></td>
<td>Explore energy management strategies for buildings</td>
<td>X X X X X</td>
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<td></td>
<td>Policy simulator for codes, incentives, and adoption</td>
<td>X X X X X</td>
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<td></td>
<td>Behavior in technology and policy deployment</td>
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<td>New business models for unlocking value in BEE</td>
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<tr>
<td>Task 4: Education and Workforce Development</td>
<td>Create GPIC education/training board</td>
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<td>Educational pathway/pipeline development</td>
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<td>Educator professional development (RETs)</td>
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<td>Associate through graduate degree programs</td>
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<td></td>
<td>Diverse student recruitment/marketing</td>
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<td></td>
<td>Outreach to underserved/underrepresented people</td>
<td>X X X X X</td>
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<td></td>
<td>Human capital development across HUB members</td>
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<td>Task 5: Demonstration, Deployment, and IP Management.</td>
<td>Demonstration and deployment via test beds</td>
<td>X X X X X</td>
<td>X X</td>
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<td>Commercialization and innovation management</td>
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<td></td>
<td>Outreach and communication</td>
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<td></td>
<td>Leverage regional DOE Centers, SBDCs and NIST MEPs</td>
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<td></td>
<td>Develop new partnerships and RDD&amp;D projects</td>
<td>X X X X X</td>
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<td></td>
<td>Outreach to underrepresented partners</td>
<td>X X X X X</td>
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USING BEST PRACTICES TO BUILD ON ASSETS AND OVERCOME BARRIERS

The GPIC will employ best practices developed over many years across its diverse members and partners, and will build on unique assets and overcome barriers to achieve its goals. The goals of the GPIC are to improve energy efficiency and operability and reduce carbon emissions of new and existing buildings, focusing on full spectrum retrofit of existing average-size commercial and multi-family residential buildings, and stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond. Several major barriers exist to achieving these goals which are embedded in the Tasks to be performed by the GPIC. Key barriers include:

- Lack of user friendly widely accessible tools for integrated design, optimization, and verification of energy efficient building systems
- Lack of for scalable system solutions and enabling component technologies, robust controls, and diagnostic platforms
- Public policies, patterns of human and organizational behavioral, and economic, business, and market models that inhibit investment in energy efficient buildings
- Lack of workers at levels, from secondary level through and associate, baccalaureate, and graduate degrees, with cross-disciplinary skill in energy efficient building systems

The Greater Philadelphia region possesses many assets for helping overcome these barriers to energy efficient buildings. With a 2007 population of more than 6 million people, the Greater Philadelphia region ranked as the fifth largest U.S. metropolitan area in the United States, and the second-largest market on the East Coast in terms of employment and average income. A key strength of the region is its diversity. More than 20 percent of the population is African American, 70 percent is White or Caucasian, and 10 percent Asian and other. Other key strengths include:

- Greater Philadelphia is within a 5-hour drive of one-quarter of the U.S. population.
- The Philadelphia International Airport is within a 2-hour flight of half the U.S. population and a ten-minute drive from the Navy Yard.
- Amtrak’s 30th Street Station serves nearly 4 million riders per year and offers high speed rail service to New York, Washington DC and Boston.
- The Delaware River Port Complex is the largest freshwater port in the world and is the only U.S. port served by 3 Class I railroads.
- Greater Philadelphia is served by 92 colleges and universities that fuel the talent pipeline for industry and government.

While these and other assets of the Greater Philadelphia are impressive, no region possesses all of the assets needed to effectively overcome the barriers listed above in a timely manner. For this reason, leaders within the region have assembled a dynamic and diversified team of globally prominent government, industry, and educational partners to establish the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings. This team brings together proven best practices across the range of strength areas needed to overcome barriers. Selected best practices and strengths of this team include:

- The Navy Yard location for the GPIC in Philadelphia is one of the most dynamic urban redevelopment sites in the nation with unique capabilities for RDD&D on energy efficient buildings, including dedicated GPIC test beds plus an additional 12 million square feet of new and retrofit space and an independent microgrid.
• A commitment from the Commonwealth of Pennsylvania for $30 million of new capital funding for RDD&D facilities to support the DOE HUB/GPIC at the Navy yard

• Strong participation from industry including companies of widely varying sizes and sectors, engaged at all levels including the HUB members and E-RIC partners and stakeholders levels, and across all activities.

• Higher education participation spanning academic disciplines spanning science and engineering, social and behavioral sciences, and professional fields, and types of institutions including prestigious private and public research-intensive universities, technical institutes, community and technical colleges, and others

• Existing DOE Centers including the Mid Atlantic Clean Energy Applications Center, the Northern Mid Atlantic Solar Resource and Training Center, and the Grid Smart Training Applications Resource (GridSTAR) Center, all at the Navy Yard

• Internally recognized state-of-the-art technology commercialization and intellectual property management strategies developed over 25 years by the Ben Franklin Technology Partners of Southeastern Pennsylvania located at the Navy Yard.

• A comprehensive education and workforce development approach aimed at developing, promoting, and delivering energy efficient building systems training from secondary level through and associate, baccalaureate, and graduate degrees led by the Science Education Program of the Princeton Plasma Physics Laboratory

• Well established existing relationships among partners including existing joint collaborative research programs, ongoing joint regional technology based economic development efforts at the Navy Yard, and collaborative education and workforce development programs involving educational institutions of all types

• Classification of building energy efficiency types and application to all length scales, from initial focus on test bed scale and small to medium size retrofit projects, extending down to single family homes and up to the largest commercial buildings

• Department of Defense participation through the Naval Surface Warfare Center Carderock Division Ship Systems Engineering Station (NSWCCD-SSES) partnership in the GPIC. NSWCCD-SSES is located at the Navy Yard and supports electric power, machinery, and other Navy ship systems
C. ANALYSIS OF GPIC FIT WITH FOA OBJECTIVES

The section summarizes how the both the overall GPIC proposal, and each individual Application within the proposal, contribute to the attainment of each of the following goals. The summaries that follow respond to each issue in the FOA, as quoted. Each response is keyed to a respective component proposal. Substantial additional information is available in the proposals themselves because of space limitations, and to avoid redundancy.

DEVELOP AND DEMONSTRATE SUSTAINABLE ENERGY SOLUTIONS

- **Overall Proposal:** A primary goal of the Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings is to improve energy efficiency and operability and reduce carbon emissions of new and existing buildings, focusing on full spectrum retrofit of existing average-size commercial and multi-family residential buildings.

- **DOE Proposal:** DOE HUB activities are organized in five tasks, which are: 1) tools for integrated design, verification, and modeling; 2) advanced components, subsystems, controls, and diagnostics; 3) public policy, behavior, economics, and business; 4) education and workforce development; and 5) demonstration, knowledge management and deployment. All of these tasks are aimed at developing strong solutions to achieve U.S. energy objectives.

- **EDA proposal:** Philadelphia Industrial Development Corporation (PIDC) will use EDA funding support the full spectrum energy efficiency retrofit of a 30,000 square foot building at the Navy Yard Clean Energy Campus to function as living laboratories for energy efficient building RDD&D activities and to provide a single GPIC location.

- **NIST/MEP Proposal:** The Delaware Valley Industrial Resource Center (DVIRC) will pursue NIST funding and will directly support HUB demonstration, deployment, commercialization efforts by bringing together regional SMEs in the building design and retrofit sector for collaborative energy efficient building systems work.

- **SBA proposal:** The Wharton Small Business Development Center (SBDC) will directly support HUB demonstration, deployment, and commercialization efforts by engaging Wharton students and alums to help develop RDD&D projects on behalf of complex multi-functional teams of firms within the Greater Philadelphia region.

CREATE AND RETAIN GOOD JOBS

- **Overall Proposal:** In addition to improving energy efficiency and operability and reduce carbon emissions of new and existing buildings, a second and equally important goal of the GPIC is to stimulate private investment in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond.

- **DOE Proposal:** All of the five tasks to be pursued by the DOE HUB will help create and retain good jobs, and Task 5, which focuses on demonstration, deployment, and intellectual property (IP) management and is led by the Ben Franklin Technology Partners of Southeastern Pennsylvania, is specifically aimed at this goal.

- **EDA proposal:** Using EDA, DOE, Commonwealth of Pennsylvania funds and private investment, PIDC will create jobs by developing multiple retrofit and new construction projects at the Navy Yard Clean Energy Campus as RDD&D living laboratory projects of the DOE HUB.

- **NIST/MEP Proposal:** DVIRC will create quality jobs in the Greater Philadelphia region...
by engaging area small and medium size enterprises (SMEs) in industry sectors that produce energy efficient building components and subassemblies in GPIC RDD&D activities, and help integrate these firms into supply chains of energy efficient building systems original equipment manufacturers (OEMs).

- **SBA proposal:** The Wharton SBA will help create quality jobs by engaging teams of undergraduate and graduate students and alumni to develop technology demonstration, deployment, and commercialization strategies for GPIC technologies in partnership with new and small business in the Greater Philadelphia region.

**ELIMINATE GAPS IN SUPPLY AND DEMAND FOR SKILLED WORKERS**

- **Overall Proposal:** Three primary types of skilled labor shortages in the energy efficiency services sector have been identified. These are program managers, engineers that specialize in energy efficiency; and trades people trained in building and constructing integrated energy-efficient buildings. The GPIC will work with all three groups but the primary concentration of the GPIC workforce development strategy will be on training trades people in building and constructing integrated energy-efficient buildings.

- **DOE Proposal:** Education and workforce development at all levels is crucial to the success of all five of the tasks to be pursued by the DOE HUB and Task 4, led by the Princeton Plasma Physics laboratory, is exclusively focused on education and workforce development.

- **EDA proposal:** PIDC serving as EDA co-applicant will support education and workforce development by developing multiple retrofit and new construction projects at the Navy Yard Clean Energy Campus as RDD&D living laboratory projects of the DOE HUB.

- **NIST/MEP Proposal:** DVIRC serving as NIST co-applicant will support education and workforce development by engaging area small and medium size enterprises (SMEs) in industry sectors that produce energy efficient building components and subassemblies in GPIC RDD&D activities and by bringing together regional SMEs in the building design and retrofit sector for collaborative energy efficient building systems work.

- **SBA proposal:** The Wharton SBA serving as SBA co-applicant will support education and workforce development by providing high quality educational experiences for students in business administration and other fields as they help accelerate the commercialization of HUB-developed technology.

**INCREASE REGIONAL GROSS DOMESTIC PRODUCT**

- **Overall Proposal:** The GPIC is intended to develop technologies and policies that will allow owners of commercial and multi-family residential buildings and other types of buildings to realize a three-year pay-back on energy efficiency retrofit investments. This private investment has the potential to significantly increase Gross Domestic Product in the Greater Philadelphia and the larger Mid Atlantic region and beyond over a five year period.

- **DOE Proposal:** All of the five tasks to be pursued by the DOE HUB will help crate and retain good jobs, and Task 5, which focuses on knowledge management and deployment and is led by the Ben Franklin Technology Partners of Southeastern Pennsylvania, is specifically aimed at this goal.

- **EDA proposal:** PIDC will help develop technologies and policies that will allow owners of commercial and multi-family residential buildings and other types of buildings to
realize a three-year pay-back on energy efficiency retrofit investments by developing multiple retrofit and new construction projects at the Navy Yard Clean Energy Campus as RDD&D living laboratory projects of the DOE HUB.

- **NIST/MEP Proposal:** DVIRC will help develop technologies and policies through which owners of commercial and multi-family residential buildings and other types of buildings will realize a three-year pay-back on energy efficiency retrofit investments by engaging area small and medium size enterprises (SMEs) in industry sectors that produce energy efficient building components and subassemblies in GPIC RDD&D activities and by bringing together regional SMEs in the building design and retrofit sector for collaborative energy efficient building systems work.

- **SBA proposal:** The Wharton SBA will help develop technologies and policies that will allow owners of commercial and multi-family residential buildings and other types of buildings to realize a three-year pay-back on energy efficiency retrofit investments by engaging teams of undergraduate and graduate students and alumni to develop technology demonstration, deployment, and commercialization strategies for GPIC technologies in partnership with new and small business in the Greater Philadelphia region.

**PROMOTE INNOVATION IN SCIENCE AND TECHNOLOGY**

- **Overall Proposal:** A primary goal of the Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings is to promote innovation in science and technology generally and in particular with respect to energy efficient building systems, designs and best practices.

- **DOE Proposal:** A dynamic and diversified team of research intensive universities, national laboratories, and leading industrial firms will promote innovation in science and technology generally and in particular with respect to energy efficient building systems, designs and best practices through two tasks. These are development of tools for integrated design, verification, and modeling, and development of components, subsystems, controls, and diagnostics.

- **EDA proposal:** Philadelphia Industrial Development Corporation (PIDC) will use EDA funding to help promote innovation in science and technology generally and in particular with respect to energy efficient building systems through the full spectrum energy efficiency retrofit of a 30,000 square foot building at the Navy Yard Clean Energy Campus to function as living laboratories for GPIC energy efficient building RDD&D activities and to provide a single location for the GPIC.

- **NIST/MEP Proposal:** The Delaware Valley Industrial Resource Center (DVIRC) will help promote innovation in science and technology generally and in particular with respect to energy efficient building systems, designs, and best practices by bringing together regional SMEs in the building design and retrofit sector for collaborative energy efficient building systems work.

- **SBA proposal:** The Wharton Small Business Development Center (SBDC) promote innovation in science and technology generally and in particular with respect to energy efficient building systems, design, and best practices by engaging Wharton students and alums to help develop RDD&D projects on behalf of complex multi-functional teams of firms within the Greater Philadelphia region.
ENHANCE UNITED STATES COMPETITIVENESS

- **Overall Proposal:** The GPIC is intended to develop technologies and policies that will allow owners of commercial and multi-family residential buildings and other types of buildings to realize a three-year pay-back on energy efficiency retrofit investments. A key outgrowth of this will be to make the Greater Philadelphia an international headquarters for energy efficient building systems, design, and best practices, which will directly enhance United States economic, technological and commercial competitiveness on the global stage.

- **DOE Proposal:** DOE HUB activities encompass five tasks which are: 1) tools for integrated design, verification, and modeling; 2) advanced components, subsystems, controls, and diagnostics; 3) public policy, behavior, economics, and business; 4) education and workforce development; and 5) Demonstration, Knowledge Management and Deployment. All five tasks will collectively help make the Greater Philadelphia an international headquarters for energy efficient building systems, design, and best practices, which will directly enhance United States economic, technological and commercial competitiveness on the global stage.

- **EDA Proposal:** PIDC will help make the Greater Philadelphia an international headquarters for energy efficient building systems, design, and best practices, which will directly enhance United States economic, technological and commercial competitiveness on the global stage, by developing multiple retrofit and new construction projects at the Navy Yard Clean Energy Campus as RDD&D living laboratory projects of the DOE HUB.

- **NIST/MEP Proposal:** DVIRC will help make the Greater Philadelphia an international headquarters for energy efficient building systems, design, and best practices, which will directly enhance United States economic, technological and commercial competitiveness on the global stage, by engaging area small and medium size enterprises (SMEs) in industry sectors that produce energy efficient building components and subassemblies in GPIC RDD&D activities and by bringing together regional SMEs in the building design and retrofit sector for collaborative energy efficient building systems work.

- **SBA Proposal:** The Wharton SBA will help make the Greater Philadelphia an international headquarters for energy efficient building systems, design, and best practices, which will directly enhance United States economic, technological and commercial competitiveness on the global stage, by engaging teams of undergraduate and graduate students and alumni to develop technology demonstration, deployment, and commercialization strategies for GPIC technologies in partnership with new and small business in the Greater Philadelphia region.
D. PROPOSED PROJECT PERFORMANCE TRACKING AND MEASUREMENT

This section describes the metrics and procedures by which the GOPIC will monitor performance and make decisions work priorities and funding reallocations. Table 2 presents the three- and five-year metrics by task and sub-task that will be used to monitor performance of the GPIC. Performance monitoring will be performed by the C2I which is the HUB’s innovation process management organization.

The C2I will be designed to meet the DOE’s goals of addressing market driven, cost effective, clean energy technology solutions through a systematic, integrated and accelerated approach to the development, demonstration, deployment and commercialization of innovative and transformational technologies. The C2I will utilize a unique organizational structure that encourages close collaborations between and among all of its stakeholders, including research institutions, industry, policy makers, market experts, economic development organizations, and capital providers. A function of the C2I will be to review proposals for DOE HUB opportunity research grant funding submitted by teams of DOE HUB members and GPIC partners and to make recommendations to the GPIC Executive Board on awarding of opportunity research grants.

HUB team experience and scientific research reveal that many good ideas are not vetted or even recognized because researchers are often focused on a single feature or result. To overcome this historical innovation and deployment gap, the C2I will develop an active engagement infrastructure for the innovation and deployment process.

The C2I will also have responsibility for ongoing review of internal GPIC progress on all tasks. Based on this ongoing review, the GPIC-C2I will make recommendations to the GPIC Executive Board concerning work priorities and reallocation of DOE HUB funding. In this regard, and in its capacity as a major interface with so many organizations involved in the GPIC, including co-applicants, partners, and stakeholders in the community at large, the Institute will serve as a catalyst for best practices in terms of:

- Researching best practices for specific topics as surfaced via searches of germane articles from juried professional journals; proceedings from professional associations; monographs; books; and other sources such as personal contacts with experts in given fields
- Integrating such researched best practices across GPIC activities
- Tracking best practices as they arise within the GPIC, and analyzing/summarizing/compiling them
- Disseminating information on best practices to co-applicants, partners, and stakeholders via both internal means (e.g., through RIC participation and program grants) as well as external means (e.g., through press releases, publications generated by the GPIC, presentations at professional conferences, and other means).
### Table 2
Three and Five Year GPIC Metrics by Tasks and Sub-Tasks

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Sub-Tasks</th>
<th>Three Year Metrics</th>
<th>Five Year Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Task 1: Tools for Integrated Design, Verification, and Modeling</strong></td>
<td>Integrated lifecycle project delivery process</td>
<td>Models in demonstration</td>
<td>Models fully deployed</td>
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<tr>
<td></td>
<td>Hierarchical modeling for building design</td>
<td>Representations in demonstration</td>
<td>Representations fully deployed</td>
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<tr>
<td></td>
<td>Performance computational tools and applications</td>
<td>Data base in demonstration</td>
<td>Data base fully deployed</td>
</tr>
<tr>
<td></td>
<td>Integrated delivery process</td>
<td>Design packages in demonstration</td>
<td>Design packages fully deployed</td>
</tr>
<tr>
<td><strong>Task 2: Components, Sub-Systems, Controls, and Diagnostics</strong></td>
<td>Integrated building systems with CHP and storage</td>
<td>Data base in demonstration</td>
<td>Data base fully deployed</td>
</tr>
<tr>
<td></td>
<td>Façades, integrated HVAC, and lighting technologies</td>
<td>Subsystems in demonstration</td>
<td>Subsystems fully deployed</td>
</tr>
<tr>
<td></td>
<td>Robust control systems</td>
<td>Technologies in demonstration</td>
<td>Technologies fully deployed</td>
</tr>
<tr>
<td></td>
<td>Performance monitoring and diagnostic systems</td>
<td>Systems in demonstration</td>
<td>Systems fully deployed</td>
</tr>
<tr>
<td><strong>Task 3: Public Policy, Behavior, Economics, and Business</strong></td>
<td>Deploy expertise into GPIC-C2I projects</td>
<td>Expertise deployed in GPIC-C2I projects</td>
<td>Expertise deployed in GPIC-C2I projects</td>
</tr>
<tr>
<td></td>
<td>Build practice/performance knowledge repository</td>
<td>Repository in demonstration</td>
<td>Repository fully deployed</td>
</tr>
<tr>
<td></td>
<td>Explore energy management strategies for buildings</td>
<td>Strategies in demonstration</td>
<td>Strategies fully deployed</td>
</tr>
<tr>
<td></td>
<td>Policy simulator for codes, incentives, and adoption</td>
<td>Simulator in demonstration</td>
<td>Simulator fully deployed</td>
</tr>
<tr>
<td></td>
<td>Behavior in technology and policy deployment</td>
<td>Behavior integrated in demonstrations</td>
<td>Behavior integrated into deployments</td>
</tr>
<tr>
<td></td>
<td>New business models for unlocking value in BEE</td>
<td>New business models developed</td>
<td>New business models fully deployed</td>
</tr>
<tr>
<td><strong>Task 4: Education and Workforce Development</strong></td>
<td>Create GPIC education/training board</td>
<td>Education/training board operating</td>
<td>Education/training board operating</td>
</tr>
<tr>
<td></td>
<td>Educational pathway/pipeline development</td>
<td>Pathway/pipeline in demonstration</td>
<td>Pathway/pipeline fully deployed</td>
</tr>
<tr>
<td></td>
<td>Educator professional development (RETs)</td>
<td>Professional programs in development</td>
<td>Professional programs fully deployed</td>
</tr>
<tr>
<td></td>
<td>Associate through graduate degree programs</td>
<td>Degree programs in development</td>
<td>Degree programs fully deployed</td>
</tr>
<tr>
<td></td>
<td>Diverse student recruitment/marketing</td>
<td>Recruitment programs fully underway</td>
<td>Recruitment programs fully underway</td>
</tr>
<tr>
<td></td>
<td>Outreach to underserved/underrepresented people</td>
<td>Outreach programs fully underway</td>
<td>Outreach programs fully underway</td>
</tr>
<tr>
<td></td>
<td>Human capital development across HUB members</td>
<td>Human development fully underway</td>
<td>Human development fully underway</td>
</tr>
<tr>
<td><strong>Task 5: Demonstration, Deployment, and IP Management.</strong></td>
<td>Demonstration and deployment via test beds</td>
<td>GPIC test beds under development</td>
<td>GPIC test beds fully operating</td>
</tr>
<tr>
<td></td>
<td>Commercialization and innovation management.</td>
<td>Commercialization and Creativity Institute operating</td>
<td>Commercialization and Creativity Institute operating</td>
</tr>
<tr>
<td></td>
<td>Outreach and communication to partners</td>
<td>IP commercialization underway</td>
<td>IP commercialization underway</td>
</tr>
<tr>
<td></td>
<td>Leverage DOE Centers, SBDCs and NIST MEPs</td>
<td>Industry outreach fully underway</td>
<td>Industry outreach fully underway</td>
</tr>
<tr>
<td></td>
<td>Develop new partnerships and RDD&amp;D projects</td>
<td>Joint RDD&amp;D projects developed</td>
<td>Joint RDD&amp;D projects fully underway</td>
</tr>
<tr>
<td></td>
<td>Outreach to underrepresented partners</td>
<td>Outreach efforts fully underway</td>
<td>Outreach efforts fully underway</td>
</tr>
</tbody>
</table>

1-36
E. GPIC PARTNER INVOLVEMENT PLAN

Dozens of public and private sector organizations have declared themselves partners and committed resources to the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings. These include companies of all sizes in many industrial sectors, a wide variety of community, economic, and workforce development organizations, organized labor, state and local governments, and educational institutions of all types, among others. These organizations are listed below. Letters of commitment from each of these organizations are appended to this proposal.

Industry Partners

Air Products and Chemicals
ALSTOM Power
Ametek
Armstrong World Industries
Boeing Company
C.B. Richard Ellis
CertainTeed Corporation
Construction Specialties
Deloitte Services LP
Dow Chemical Company
DuPont Building Innovations
Flad Architects
HOK
Horton Lees Brogden Lighting Design
Johns Manville
Lafarge
Lam Partners
Larson Design Group
Linc Lighting and Electrical
Lockheed Martin
PECO
Pfizer Global Engineering
PJM Interconnection
Pittsburgh Corning
Rose Companies
Saint-Gobain
Sauer, Inc
Schneider Electric
Thornton-Tomasetti Group
URS Corporation
Viridity Energy
Weber Murphy Fox, Inc.

Industry Associations

AIA Philadelphia
Alliance to Save Energy
Center for Environmental Innovation in Roofing
CEO Council of Growth
Chamber of Commerce Southern New Jersey
Cleantech Alliance Mid Atlantic
Delaware Valley Green Building Council
Greater Philadelphia Chamber of Commerce
National Electrical Manufacturers Association
New Jersey Technology Council
Sustainable Business Network of Greater Philadelphia
World Business Council for Sustainable Development
World Trade Center of Greater Philadelphia

Education and Workforce Partners
  Bucks County Workforce Investment Board
  Camden County Workforce Investment Board
  Chester County Workforce Investment Board
  Delaware County Workforce Investment Board
  Franklin Institute
  Garrison Institute
  Greater Philadelphia Regional Compact for STEM Education
  Liberty Science Center
  Montgomery County Workforce Investment Board
  Philadelphia County Workforce Investment Board

Banking and Finance Partners
  Emerald Stage2 Ventures
  Minority Angel Investor Network
  Mid-Atlantic Angel Group

Community and Economic Development Partners
  Economy League of Greater Philadelphia
  Citizens for Pennsylvania's Future (PennFuture)
  Select Greater Philadelphia
  University City Science Center

Government Partners
  Commonwealth of Pennsylvania
  Delaware Valley Regional Planning Commission
  City of Philadelphia
  Naval Surface Warfare Center Carderock Division
  New Jersey Economic Development Authority

Labor organizations
  National Roofing Contractors Association
  Penn-Del-Jersey Chapter of the National Electrical Contractors Association

International Partners
  Lund University, Sweden
  Tsinghua University, China

Philanthropic Foundations
  William Penn Foundation
Interactions among the GPIC partners, consortium members, and HUB members will take place via multiple settings, and in multiple activities, as described in the attached component proposals. For example, in the case of education and workforce development alone, activities will include two consortium members (Penn State and DVIRC), several HUB members (Bayer MaterialScience, Drexel University), and numerous partners (community and technical colleges, science museums, Workforce Investment Boards, and others). In addition, more than 30 private companies have made commitments as GPIC partners. The companies range from large multinational industrial firms to regional energy suppliers and small start-ups, and will have access to the full range of GPIC RDD&D activities.

Partners will be fully engaged in activities of the GPIC through meetings, workshops, conferences, and direct participation in GPIC projects and programs. All GPIC Executive Board meetings and Advisory Board meetings are open to GPIC partners. In addition, the GPIC Opportunity Research Fund managed by the GPIC Commercialization and Creativity Institute (GPIC-C2I) is specifically designed to promote partner engagement. The Opportunity Research Fund will provide co-funding for RDD&D projects proposed by teams of HUB members and GPIC partners that will help advance the goals of the GPIC. GPIC partners are encouraged to join with HUB members to develop joint proposals for co-funding through the GPIC Opportunity Research Fund.
F. STAKEHOLDER ANALYSIS

The goals of the Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings are to improve energy efficiency and operability and reduce carbon emissions of new and existing buildings, focusing on full spectrum retrofit of existing average-size commercial and multi-family residential buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond. This section lists the major stakeholder groups involved in the Greater Philadelphia Innovation Cluster (GPIC) and briefly analyzes their role in achieving the GPIC goals, and discusses prior relationships between Consortium members and GPIC partners and stakeholders.

STAKEHOLDER INVOLVEMENT IN THE GPIC

- **Stakeholder Group: Local STEM Community:** The Delaware Valley Industrial Resource Center (DVIRC) has been instrumental in engaging the Greater Philadelphia STEM community including secondary and post-secondary institutions in efforts to develop and promote the Applied Engineering Technology Career Pathway program. This work will be leveraged to mobilize this community to help develop programs and student pathways to support GPIC education and workforce development activities.

- **Stakeholder Group: Post-Secondary Institutions:** Science, technology, engineering, and mathematics (STEM) faculty and their departments at area post secondary institutions will help develop new programs and student pathways to support GPIC education and workforce development activities.

- **Stakeholder Group: Apprenticeship Programs:** Apprenticeship programs, particularly those of labor organizations such as the International Brotherhood of Electrical Workers and the national Electrical Contractors Association will be leveraged to help support GPIC education and workforce development activities, as these groups are already engaged with the DOE Northern Mid Atlantic Solar Training Center and the DOE GridStar Center at the Navy Yard.

- **Stakeholder Group: Secondary Schools:** Secondary schools are closely connected to the DVIRC led efforts to develop and promote the Applied Engineering Technology Career Pathway program in Greater Philadelphia. Key partners helping to ensure engagement by secondary schools and CTIs are the Math and Science partnership of Greater Philadelphia and the Philadelphia Math and Science Partnership.

- **Stakeholder Group: Career and Technical Institutes (CTIs):** CTIs can be a crucial pipeline supplying students for post-secondary STEM programs and careers in STEM occupations. Like secondary schools, CTIs are closely connected to the DVIRC led efforts to develop and promote the Applied Engineering Technology Career Pathway program in Greater Philadelphia.

- **Stakeholder Group: One-Stop Career Centers:** Individuals seeking education, training, and employment at one-stop career centers, including low-income individuals and members of underrepresented groups, will learn of the GPIC and be encouraged to enroll in educational components of all GPIC initiatives.

- **Stakeholder Group: Workforce Investment Boards:** Workforce Investment Boards (WIBs) will be crucial partners in GPIC efforts to develop and deploy education and workforce development programs in energy efficient building systems, especially at the certificate and associate degree technician and incumbent worker levels. WIBs will also
play key roles in recruiting underserved students and workers to GPIC education and workforce development programs.

- **Stakeholder Group: Community Organizations**: Community based organizations such as minority business development organization, community development organization, clergy association, Community Action Agencies, and other neighborhood based civic associations are key stakeholders in the GPIC and will be engaged in education and workforce development efforts.

- **Stakeholder Group: Local and State Agencies**: State and local economic development agencies and sustainable energy agencies are key stakeholders in the GPIC. As one example, the Commonwealth of Pennsylvania sponsors the Pennsylvania Center for High Performance Building Systems, a foundational program for the GPIC. The Commonwealth of Pennsylvania has also committed $30 million to support GPIC test bed facilities at the Navy Yard.

- **Stakeholder Group: Economic Development Agencies**: Economic development organizations are embedded stakeholders in the GPIC. These include the DVIRC, which is both a GPIC Consortium member and a HUB member, and the Ben Franklin Technology Partners of Southeastern Pennsylvania which is a HUB member and task leader for demonstration, deployment, and commercialization activities.

- **Stakeholder Group: Philanthropic Foundations**: Philanthropic Foundations are critical stakeholders particularly with regard to sustainability plans for the GPIC. Relationships with philanthropic foundations will be cultivated assiduously by the GPIC, a number of which are giving increased priority to energy efficiency issues in their investment plans. The Penn State Office of Corporate and Foundation Relations will assist with these efforts.

- **Stakeholder Group: Venture Capitalists**: Participation by the venture capital community is essential to the success of GPIC demonstration, deployment, and commercialization strategies. The Ben Franklin Technology Partners of Southeastern Pennsylvania has extensive ties to this community and will connect the GPIC to this source of investment financing as part of its leadership role in demonstration, deployment, and commercialization activities.

- **Stakeholder Group: Banks and Financial Institutions**: Like the venture capital community, participation by banks and financial institutions is essential to the success of GPIC demonstration, deployment, and commercialization strategies. The Ben Franklin Technology Partners of Southeastern Pennsylvania will connect the GPIC to this source of investment financing as part of its leadership role in these areas.

- **Stakeholder Group: Publicly and Privately Held Businesses**: Publicly and privately held businesses are embedded participants in the GPIC at every level, including HUB members, GPIC partners, and GPIC stakeholders. Business at all levels will be fully engaged in activities of the GPIC through meetings, workshops, conferences, and direct participation in GPIC projects and programs. All GPIC Executive Board meetings and Advisory Board meetings are open to GPIC partners and stakeholders. GPIC stakeholder businesses are encouraged to work with teams of partners and HUB members to develop joint proposals for co-funding through the GPIC Opportunity Research Fund.

- **Stakeholder Group: Industry Associations**: Industry associations, including broad based organizations like chambers of commerce and trade associations focused on sustainable energy or the construction sectors, are a key to the ability of the GPIC to
reach a large number of publicly and privately held companies. Industry associations will be fully engaged in activities of the GPIC through meetings, workshops, conferences, and direct participation in GPIC projects and programs.

- **Stakeholder Group: Labor Organizations**: Labor organizations such as the International Brotherhood of Electrical Workers and the National Electrical Contractors Association will be keys to the success of GPIC education and workforce development activities and other activities. The GPIC will leverage the existing engagement of these groups with the DOE Northern Mid Atlantic Solar Training Center and the DOE GridStar Center at the Navy Yard.

**PARTNER AND STAKEHOLDER INVOLVEMENT**

GPIC Consortium members, partners, and stakeholders have a rich history of collaboration on which the GPIC is built. Foremost among these are the relationships established over the past decade among the partners in the Clean Energy Campus development effort at the Navy Yard. A key aim of this effort has been to make the Navy Yard and the region a national headquarters for energy research, education, and commercialization focused on clean energy and energy efficiency. The centerpieces of this strategy are the combined education, research and commercialization strengths of government, industry, and universities in the southeastern Pennsylvania region relating to power production and management. These include:

- Ben Franklin Technology Partners of Southeastern Pennsylvania
- Delaware Valley Industrial Resource Center
- NAVSEA Warfare Center Carderock Division Philadelphia Component
- Philadelphia Department of Commerce
- Philadelphia Industrial Development Corporation
- Penn State
- Drexel University
- Collegiate Consortium for Workforce and Economic Development

These and other GPIC members, partners, and stakeholders have already collaborated on a number of major joint clean energy initiatives, and a number of them (BFTP/SEPA, DVIRC, Drexel University, and Penn State) already share space in the Building 100 Innovation Center at the Navy Yard. In addition, numerous other examples of existing collaboration across GPIC members, partners, and stakeholders can be cited. A few examples are:

- With NIST Technology Innovation Program (TIP) support, United Technologies Corporation partnered with Carnegie Mellon University to assist the architectural charrette process by providing simulation results with fidelity appropriate to the design stage.
- Under a Department of Defense program UTC is partnered with Penn State to produce tools for architects to use for designing safe and secure buildings and HVAC systems.
- Under another DOD contract, UTC, is partnering with Penn State to develop a methodology and a software tool that support a energy master planner by enabling generation, optimization, and selection of the best holistic energy system architectures that meet the demands of ultra low energy Army installations.
- IBM is working with Penn State on architecture innovations for future exascale computing, moving computers from petascale to exascale level. In addition, in 2009, IBM created an industry alliance called the Green Sigma™ Coalition with companies
specializing in metering, monitoring, automation, data communications and software to provide smart solutions for energy, water, waste and greenhouse gas management. Charter members of the Green Sigma™ Coalition are Johnson Controls, Honeywell Building Solutions, ABB, Easton, ESS, Cisco, Siemens Building Technologies Division, Schneider Electric and SAP.

- Faculty associated with the University of Pittsburgh Center for Energy have a long history of collaboration with faculty from Carnegie Mellon University. Faculty from both institutions have worked together on seed grants funded through the Mascaro Center for Sustainable Innovation since 2004, and have collaborated to sponsor the international Engineering Sustainability conferences held in Pittsburgh in 2007 and 2009. Furthermore, there are agreements in place between the institutions that allow students from each to take classes at the others without financial or academic penalty.

- There are also established collaborations between the University of Pittsburgh and Bayer MaterialScience. Researchers from each institution have collaborated on advanced materials for hydroelectric, aeroelastic wind harvesting, and smart insulation to increase the energy efficiency of commercial and residential buildings.

- PPG has a history of collaborating with Carnegie Mellon University (CMU), the University of Pittsburgh, and Penn State. Recently, PPG has interacted with Pitt to explore new battery technologies. PPG is currently working with CMU to optimize its glass manufacturing processes for greater energy efficiency via mathematical modeling.

- Turner Construction Company has forged several partnerships with DOE HUB members. During the past 15 years Turner has built a succession of educational facilities for Penn State. Turner regularly recruits Penn State graduates as part of its new hire program, and its staff works with the Architectural Engineering Department at Penn State to provide educational support and a builder’s perspective to the University’s academic programs.

- Turner also has an important relationship with Princeton University, where Turner’s latest project is the construction of a vast 265,000 square foot chemistry building that incorporates green building elements such as sunscreens to optimize ambient day-lighting of interior spaces and sensors with dimmable electric lighting.

- Turner also has a relationship with Drexel University, where we are building the University’s new Integrated Science Building, which immediately follows our construction of the new Recreation Center that is seeking 3 Green Globes.

- Morgan State University (MSU) was a partner with Penn State and other institutions for 10 years in one of the Engineering Coalitions Programs (ECSEL), funded by NSF. Several MSU undergraduates have received graduate degrees from Penn State, Purdue, Carnegie Mellon, New Jersey Institute of Technology, and Virginia Tech. Morgan has a longstanding relationship with IBM and the Turner Construction Company.

- PPG has a history of collaborating with Carnegie Mellon University, the University of Pittsburgh, and Penn State University. Recently, PPG has interacted with Pitt to explore new battery technologies, and PPG is currently working with CMU to optimize its glass manufacturing processes for greater energy efficiency via mathematical modeling.

- Purdue University collaborates with United Technologies Corporation (UTC) in the area of energy efficiency buildings. Purdue has partnered with UTC Carrier on several recent proposals to the DOE to develop advanced heat pumps and air conditioners in response to solicitations from ARPA-E and ARRA funding. UTC Carrier also has a history of
directly sponsoring research projects at Purdue related to improving the efficiency of air conditioning and heat pumping products.

- Virginia Tech and UTC have frequently collaborated, including joint work developing the computer design tools for constructing reduced-order design models of whole building systems for simulation, design, control, optimization and sensitivity analysis. This work has focused on the development of computer design tools for application to DOD building retrofits.

- Ben Franklin Technology Partners of Southeastern Pennsylvania (BFTP/SEP) is a catalyst for many collaborations among DOE HUB members and GPIC partners through its Energy Commercialization and Creativity Institute (ECI), Nanotechnology Institute (NTI), Bridge Business Center, which focuses on bio-energy development and advanced alternative energy related manufacturing, Pennsylvania Advanced Textile Research and Innovation Center, and other initiatives.

ENGAGING THE REGIONAL BUSINESS COMMUNITY

Active participation by businesses in the Greater Philadelphia region is critical to the success of the GPIC, and focused efforts will be undertaken to engage the regional business community. These efforts will be led by the Ben Franklin Technology Partners of Southeastern Pennsylvania in partnership with the DVIRC, the Wharton SBDC, Penn State, and others. Activities will include broad based marketing and communications via meetings and presentations to individual companies and groups of companies through industry associations, as well as more focused outreach efforts.

Information about the GPIC will be highlighted through web sites, newsletters, and press releases in order to engage the broad business community in the Greater Philadelphia region, and beyond. DVIRC will engage area small and medium size enterprises (SMEs) in industry sectors that produce energy efficient building components and subassemblies in GPIC RDD&D activities and will bring together regional SMEs in the building design and retrofit sector for collaborative energy efficient building systems work. The Wharton SBDC will engage Wharton students and alums to help develop RDD&D projects on behalf of complex multi-functional teams of firms within the Greater Philadelphia region.

Outreach activities will include ongoing workshops, seminars, meetings and conferences, presentations at regular meetings of area business and industry associations, press releases and news articles in local media, and many other activities. It is expected that hundreds of regional firms will be engaged with the GPIC, spanning global industrial firms, small and medium size enterprises (SMEs) and new innovative start-up firms across the full spectrum of industry sectors concerned with energy efficient buildings. Extensive and ongoing participation by regional industry is crucial to the success of the GPIC.
G. COMMUNICATIONS PLAN

This section describes activities to ensure robust communications between and among Co-Applicants, DOE HUB members, GPIC partners and stakeholders, and the broader community, as well procedures for collection, analysis, and dissemination of performance data.

GPIC COMMUNICATIONS

A number of strategies, techniques, and technologies will be employed to ensure communication among GPIC co-applicants, partners, and stakeholder groups. The GPIC Operating Committee, Advisory Committee, and Executive Board, which are described in more detail in the Management and Operations section of the DOE proposal, will be key vehicles for ensuring communication among GPIC co-applicants, partners, and stakeholder groups. The GPIC Operating Committee will be responsible for jointly managing the day-to-day operations of the GPIC and the DOE HUB. All members of the Operating Committee will reside in the Greater Philadelphia area and will work at the Navy Yard. Members will meet weekly as a committee of the whole and more frequently in dyads and triads and other configurations as needed. In addition to overall day-to-day management, the Operating Committee is responsible for ensuring continuous and dynamic engagement and integration of GPIC and DOE HUBs members, partners, and stakeholders across all tasks and activities.

The GPIC Advisory Committee will provide guidance to the GPIC Director, Deputy Director, and the Operating Committee in the management of the GPIC. A key role of the Advisory Committee will be to ensure that the Operating Committee maintains continuous and dynamic engagement and integration of GPIC and DOE HUBs members, partners, and stakeholders across all tasks and activities. The Advisory Committee will be comprised of senior officials possessing experience spanning government, industry, and educational sectors, and particular knowledge in areas such as building energy efficiency, joint government-industry-university research, technology transfer and commercialization, and organization development and management. The GPIC Advisory Committee will meet quarterly. The GPIC Executive Board will provide primary oversight to the GPIC Director in management of the GPIC. The Executive Board will meet quarterly to review progress of the GPIC and to approve or disapprove recommendations for allocation and/or reallocation of funds.

The GPIC will invest in the Cisco TelePresence system as a primary medium for ensuring communication among co-applicants, partners, and stakeholder groups. This video conferencing system provides easy involvement and access in live, face-to-face communication, providing for collaboration among co-applicants, E-RIC partners, and members of stakeholder groups from distant locations. This is important: while some members of these groups that are located in the Greater Philadelphia region will be able to easily attend meetings at the Navy Yard location, or elsewhere in the region, others – e.g., faculty from Purdue University or Virginia Tech – may not easily be able to attend due to difficult logistics, the cost of travel to meetings, or scheduling conflicts. Continuous interchange across all co-applicants, HUB members, GPIC partners, and members of stakeholder groups is critical to success.

A GPIC website will also be a key communications tool, featuring continuous updates on all activities, links to other relevant sites and best practices in related fields such as retrofitting, developing new energy sources, creating green jobs, financing of new energy technologies and businesses, and more. This easily-navigable, attractive site will be open to access by all internet users.
users in terms of such broad program elements. The web site will also include an interactive energy asset map, which will show GPIC related energy resources, including companies, research and buildings in the region. The energy asset map will allow for the identification of opportunities and collaboration in the region. There will be password-protected availability for those directly involved in the program, including representatives of co-applicants, HUB members and selected constituent organizations. This area within the web site will be used for ongoing online collaboration, sharing of proprietary or project-specific information, internal communications, and other features to facilitate communications and the efficient, effective meeting of project goals.

The GPIC will also establish a cadre of spokespeople who will be available for speaking engagements, interviews, or presenting seminars on GPIC-related topics. The GPIC will publicize its history, activities, strengths, challenges, successes, and other features both in general media and in specialized journals such as the *International Journal of Renewable Energy Technology*, *Renewable Energy*, and the *Journal of Energy Resources Technology*. Information on the structure, implementation, and results of the GPIC will also be presented in regional and national meetings of professional societies such as the American Institute of Architects, Association of Energy Engineers, and the IEEE Power and Energy Society.

**PERFORMANCE DATA**

Performance data will be collected by the GPIC Director from GPIC co-applicants and HUB members and partners for reporting to the GPIC Commercialization and Creativity Institute (C2I) which will utilize its unique innovation evaluation methods and criteria to assess performance and make recommendations to the Executive Board for work priorities and reallocation of DOE and other GPIC funds. The results of these assessments will be available to all GPIC co-applicants and HUB members, partners, and stakeholder groups since all Executive Board meetings will be open to these participants. The results of these assessments will also be provided to the federal sponsors of the GPIC. Performance data and results of GPIC-C2I assessments will be maintained by the GPIC Director.

Finally, the GPIC will employ a scientific information system (SIS) developed and operated by Morgan State University to collect, catalogue, and store information on the many RDD&D projects and activities to be undertaken across the GPIC. The SIS was developed at Morgan State in collaboration with Johns Hopkins University through research supported by the NSF Engineering Research Center (ERC) on Computer Integrated Surgical Systems Technology (CISST). Four key subsystems will be developed, integrated, and operated to establish a SIS for GPIC RDD&D on energy efficient buildings which are: 1) the static object-oriented model; 2) scientific poster pattern methodology; 3) the communication and collaboration process; and 4) a SIS website. The SIS will provide the GPIC with a state-of-the-art method for understanding and communicating both internally and externally the array of RDD&D activities underway, and will also contribute to the body of knowledge on the management of scientific information.
**H. RISK MANAGEMENT**

This section discusses potential risks to the success of the GPIC and strategies for mitigating such risks, and identifies GPIC strengths, weaknesses, opportunities, and threats (SWOT) and steps to capitalize on strengths and opportunities, address weaknesses and threats, and continuously reassess SWOT. Table 3 displays the major external, management, and RDD&D program risk factors confronting the GPIC and their affect on activities, budget, and schedules. Table 4 classifies each of these same factors based on their consequence to the GPIC and their likelihood and then based on these two classification the impact potential was determined.

As indicated, the single risk with both high likelihood and serious potential consequences for the GPIC is for RDD&D project activities to require excessive resources. To minimize this risk, the GPIC Commercialization and Creativity Institute will review all RDD&D activities and report to the Executive Board with recommendations for reprioritization and reallocation of resources as appropriate. Other risks of moderate likelihood and potential impact pertain to technological change, collaboration among GPIC participants, and market acceptance of GPIC results. These risks will be addressed through continuous communication and monitoring of activities across co-applicants, HUB members, and GPIC partners and stakeholder groups.

Table 5 provides an analysis of GPIC strengths, weaknesses, opportunities, and threats (SWOT). The SWOT analysis will guide the management and operation of the GPIC. The GPIC Executive Board, the Director, the Deputy Director, the Operating Committee, and the Advisory Committee, as well as all participants, will continuously explore approaches to capitalize on strengths and opportunities, and address weaknesses and threats. GPIC strengths, weaknesses, opportunities, and threats will be formally reassessed as a regular agenda item of the quarterly meetings of both the GPIC Executive Board and the Advisory Committee.

<table>
<thead>
<tr>
<th>External Risk Factors</th>
<th>Activities</th>
<th>Budget</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Political focus shifts away from energy</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New technologies surfacing</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Management Risk Factors</th>
<th>Activities</th>
<th>Budget</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consortium and HUB organization fails to fulfill expectations</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The HUB members, co-applicants and GPIC partners will not cooperate</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>GPIC management requires excessive unanticipated resources</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Change in the leadership of the organization</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exits of HUB member(s)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RDD&amp;D Program Risk Factors</th>
<th>Activities</th>
<th>Budget</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDD&amp;D project activities require excessive resources</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Changes in the key personal will cause delays in projects</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Change in HUB member’s focus will cause delays in projects</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>RDD&amp;D projects prove to be not feasible/practical/economical/</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Consumer acceptance is lower or more difficult than expected</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Scope creep of RDD&amp;D projects cause excessive consumption of resources</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Cost increase due to inflation, changes in economic circumstances</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>RDD&amp;D projects encounter unexpected result/barriers</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Promised cost match or other financial resource decrease/ disappear</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
### Table 4
**Classification of Risk Factors**

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Likelihood</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Political focus shifts away from energy</td>
<td>Low</td>
<td>Minor</td>
</tr>
<tr>
<td>New technologies surfacing</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Management Risk Factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consortium and HUB organization fails to fulfill expectations</td>
<td>Medium</td>
<td>Moderate</td>
</tr>
<tr>
<td>The HUB members, co-applicants and GPIC partners will not cooperate</td>
<td>Medium</td>
<td>Moderate</td>
</tr>
<tr>
<td>GPIC management requires excessive unanticipated resources</td>
<td>Medium</td>
<td>Moderate</td>
</tr>
<tr>
<td>Change in the leadership of the organization</td>
<td>Low</td>
<td>Minor</td>
</tr>
<tr>
<td>Exits of HUB member(s)</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>RDD&amp;D Program Risk Factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RDD&amp;D project activities require excessive unanticipated resources</td>
<td>High</td>
<td>Serious</td>
</tr>
<tr>
<td>Changes in the key personal will cause delays in projects</td>
<td>Low</td>
<td>Minor</td>
</tr>
<tr>
<td>Change in HUB member’s focus will cause delays in projects</td>
<td>Low</td>
<td>Minor</td>
</tr>
<tr>
<td>RDD&amp;D projects prove to be not feasible/practical/economical/</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Consumer acceptance is lower or more difficult than expected</td>
<td>Medium</td>
<td>Moderate</td>
</tr>
<tr>
<td>Scope creep of RDD&amp;D projects cause excessive consumption of resources</td>
<td>High</td>
<td>Serious</td>
</tr>
<tr>
<td>Cost increase due to inflation, changes in economic circumferences</td>
<td>Low</td>
<td>Minor</td>
</tr>
<tr>
<td>RDD&amp;D projects encounter unexpected result/barriers</td>
<td>Medium</td>
<td>Moderate</td>
</tr>
<tr>
<td>Promised cost match or other financial resource decrease/disappear</td>
<td>Low</td>
<td>Minor</td>
</tr>
</tbody>
</table>

### Table 5
**Analysis of GPIC Strengths, Weaknesses, Opportunities, and Threats**

<table>
<thead>
<tr>
<th>Task 1: Tools for Integrated Design, Verification, and Modeling</th>
<th>Strengths</th>
<th>Weaknesses</th>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strong participants with national and international experience.</td>
<td>Uncertainty in equipment performance, and the models used.</td>
<td>The RIC will develop fast, accurate sensitivity analysis tools</td>
<td>Unforeseen software or hardware problems that arise</td>
</tr>
<tr>
<td>Tasks 2: Components, Sub-Systems, Controls, and Diagnostics</td>
<td>Living Laboratory with replaceable, modular elements and instrumentation</td>
<td>Fragmentation of the design, commissioning, and operating processes.</td>
<td>Existing platforms will be used for the short-term retrofit demonstrations.</td>
<td>Complex dynamic systems involving large number of components.</td>
</tr>
<tr>
<td>Task 3: Public Policy, Behavior, Economics, and Business</td>
<td>Policy makers and researchers engaged together from the outset</td>
<td>Disparate codes, laws, and practices in the region and nationwide.</td>
<td>Creating knowledge repository that will inform all program activities</td>
<td>Resistance to change due to risk aversion, status quo bias, or political/social climate</td>
</tr>
<tr>
<td>Task 4: Education and Workforce Development</td>
<td>Involvement of a broad array of participants</td>
<td>Resistance to new curriculum and training modules</td>
<td>Orientation toward comprehensive, effective education</td>
<td>Potential participant attrition due to socioeconomic barriers</td>
</tr>
<tr>
<td>Task 5: Demonstration, Deployment, and IP Management.</td>
<td>Nimble, effective process for the movement from ideas to rollout.</td>
<td>Limitations on access to capital, STEM workers, and other requirements.</td>
<td>Strong likelihood for development of new businesses and job creation</td>
<td>Potential limitation of non-governmental funding for new initiatives/technologies</td>
</tr>
</tbody>
</table>
I. STRATEGY FOR THE DEVELOPMENT OF A SKILLED WORKFORCE

A strong and effective strategy for education and workforce development is essential to the economic development and energy efficiency goals of the GPIC. The education and workforce development activities of the GPIC are designed to assure that new innovative energy efficiency technologies and systems developed and demonstrated at the Navy Yard are supported by a robust human capital infrastructure for deployment throughout the Greater Philadelphia region and beyond. The workforce development efforts also include outreach to diversify the workforce and include recruitment and training for members of communities who are underrepresented in the building trades to assure their participation in this important economic development effort.

The Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings has been established to improve energy efficiency and operability and reduce carbon emissions of new and existing buildings, focusing on full spectrum retrofit of existing average-size commercial and multi-family residential buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond.

The GPIC has the potential to create many thousands of quality, family sustaining jobs in the Greater Philadelphia and the larger Mid Atlantic region and beyond over a five year period. The GPIC is intended to develop technologies and policies that will allow owners of commercial and multi-family residential buildings and other types of buildings to realize a three-year pay-back on energy efficiency retrofit investments. If this is achieved, owners of commercial and multi-family residential buildings in the Greater Philadelphia region will be incentivized to invest in energy efficiency retrofit improvements, stimulating construction employment in the Greater Philadelphia energy efficiency retrofit sector. If this is extrapolated to the Mid Atlantic region and beyond, the potential economic impact of GPIC could be quite significant.

RECRUITING, TRAINING, PLACING, AND RETAINING SKILLED WORKERS

A March 2010 report from the Lawrence Berkeley Laboratory entitled, Energy Efficiency Services Sector: Workforce Education and Training Needs, identifies three primary shortages in the energy efficiency services sector: trained and experienced program managers; engineers that specialize in energy efficiency; and trades people trained in building and constructing integrated energy-efficient buildings. The GPIC will work with all three groups but the primary concentration of the GPIC workforce development strategy will be on job training and job creation for trade’s people. Trades people are projected to constitute 65-75% of the workforce in the energy efficiency services sector and will undergo significant growth.

Currently, overall national workforce composition and generalized skill set deficits pose a threat to the ultimate success of the GPIC and the energy efficiency services sector. Three main factors have been identified that make identification, recruitment, training and placement of energy efficient building retrofit personnel especially difficult: the country’s 76 million baby boomers are beginning to enter retirement; our nation’s education system is losing more than one million high school students per year to dropout; and educators and workers at every level, lack specific integrated systems knowledge for energy efficient building retrofit. These three conditions indicate that adequate training in energy efficient building systems is currently unlikely without rapid and significant changes to our education and training systems.
According to the National Commission on Energy Policy, between 120,000 and 160,000 (30-40 percent) of electric power workers will retire or leave the industry for other reasons by 2013, and 60,000 will be skilled craft workers and another 11,000 will be engineers.iii The Association of Energy Engineers (AEE), in their 2009 report, *Green Jobs: Survey of the Energy Industry*, found that 41% of the energy professionals who were surveyed plan to retire in the next ten years.iv It is estimated that more than 10,000 people, on average, will retire each day over the next two decades. This mass exodus will cause significant shortages in the entire United States workforce and industries will be increasingly challenged to meet hiring requirements in a highly competitive environment.

At the same time older workers are retiring, about 30 percent of U.S. students do not graduate on time with a regular high school diploma. More than 1.2 million students drop out annually and those who do graduate often lack math, science and technical skills critical to meeting energy efficient building workforce demands. In recent studies, the United States ranked near the bottom of developed countries in math and science competencies. Obviously, additional information and training, as well as retraining, will be required to effectively disseminate and instill knowledge regarding new smart grid systems, technologies and system needs. Significant focus must be given to educating the educators before expecting adequate filtration to students in K-12 programs, new and incumbent workers in technical programs and channels of higher education.

Finally, a scarcity of integrated energy efficient building systems related skills presents another significant workforce development challenge and these deficiencies exist from grade school students to post-doctorate educators. The 2009 Association of Energy Engineers (AEE), survey cited above showed that 70% of energy professionals indicate a need for national and state training for "green jobs" to address job shortages that are impairing growth in green industries, such as energy efficient buildings and construction, renewables, electric power, smart grid, energy efficient vehicles and biofuels development.

In response to these three major workforce development realities, the creation of integrated worker identification, recruitment and training programs, funding streams for training and placement strategies will be critical to providing a competitive edge for utility and manufacturing partners to attract and retain highly qualified workers. Career ladders must be built that lead from the least educated and least skilled workers to the most educated and most skilled workers. The unifying message from educational providers and hiring companies must become more direct: Integrated energy efficient building systems training provides valuable skills that lead to a variety of high-paying job opportunities.

Dealing with an industry in such a dramatic state of flux requires training providers to capture cutting-edge information and developments by throwing wide nets for research while networking with industry and thought leaders. The training providers must then thoroughly learn and internalize the information being produced, and respond rapidly with appropriate curriculum. Finally, intensely shortened feedback loops must be created that immediately integrate emerging theories and best practices. In addition to innovative technologies and new information, many existing workforce training will require repackaging and realigning with subject matter that meets current and future workforce development needs in energy efficient building systems.
THE ENERGY EFFICIENT BUILDINGS LABOR MARKET

A 2009 U.S. Department of Labor report indicates that increased demand occupations in this sector require skills involving installation, maintenance, inspection, technology and manufacturing with many of these positions revolving around energy efficiency-related facility and existing infrastructure upgrades. The report specifically lists electrician, technician, technologist, consultant and engineering positions with competencies that are directly applicable to energy efficient building systems such as: energy; instrumentation, controls and electrical systems; electronics; geographic and geospatial information systems; manufacturing and production; computer software; mechatronics; Microsystems; nanotechnologies; remote sensing systems; and robotics.

Since many job descriptions for energy efficient building systems fall into the designation of “green jobs” which include energy efficiency and renewable energy, workforce demand projections for the more specific area of energy efficient building systems are difficult to isolate. The 2009 Association of Energy Engineers (AEE) report, Green Jobs: Survey of the Energy Industry cited above lists more 400 job titles that capture “typical energy, sustainable, green, environmental, and industry jobs based on the actual survey responses of AEE members and participants in AEE programs.”

According to a June 2009 report by the Pew Charitable Trusts, Pennsylvania ranks second among the 50 states in clean energy jobs, third in conservation and pollution mitigation jobs, and ninth in training and support jobs. New Jersey ranks seventh in energy conservation jobs. As such, there is a strong base on which to build the job training and placement elements of the GPIC. This same study states that “more than 68,200 businesses across all 50 states and the District of Columbia accounted for about 770,000 jobs that achieve the double bottom line of economic growth and environmental sustainability.” The report also notes that, while these are relatively modest numbers, they reflect a growth rate in green jobs of 9.1% 1998 from 2007), compared to only 3.7% for total jobs.

Researchers have identified six industries that feature occupations that may benefit in the green economy. These industries are building retrofitting, mass transit, energy-efficient automobiles, wind power, solar panels, and cellulosic biofuels. Occupations within each of these industries have also been identified. Table 6 lists the 12 occupations within the energy efficient building retrofitting industry along with employment at the national and Greater Philadelphia regional level, projected employment change from 2008-2018, and training levels required. Table 6 clearly indicates robust employment growth in these occupations independent of the GPIC, and suggests that education and training programs will be needed to meet the increased demand for new workers in these occupations in the Greater Philadelphia region that will result from the GPIC.
COLLABORATIVE WORKFORCE DEVELOPMENT

Education and workforce development and clean energy business organizations and organized labor will work together in the Greater Philadelphia region to develop and deliver training programs in energy efficient building systems technology and recruit students, including incumbent and displaced workers, into these programs. Some of these organizations include:

- The **Collegiate Consortium for Workforce and Economic Development** is a non-profit organization that is a partnership of Drexel University and five area community colleges: Community College of Philadelphia, Delaware County Community College, Bucks County Community College, Camden County College and Montgomery County Community College. The Consortium provides a comprehensive, coordinated approach to developing a highly skilled workforce for the region.

- The **Sustainable Business Network (SBN) of Greater Philadelphia** is a business organization that brings together local leaders who share a common passion to grow successful businesses that are socially and environmentally responsible. SBN works with businesses from startups to older companies who want to create or maintain organizations that respect their employees, value the community and protect the earth. Over 500 local businesses are members of SBN.

- **Educational Data Systems**, Inc. (EDSI) is an ISO 9001:2000 Certified workforce development company with significant and successful experience providing comprehensive business and jobseeker services in a dual customer role. EDSI has been in the workforce development and consulting business, assisting individuals with the transition from unemployment to employment and from under-employment to self-sufficiency.

- **Delaware Valley Industrial Resource Center (DVIRC)** has been instrumental in promoting the Region’s Applied Engineering Technology Career Pathway’s program in collaboration with the Collegiate Consortium for Workforce and Economic Development. This program has been expanded through a grant from the United States Department of

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### Table 6
Energy Efficient Building Retrofit Occupations:

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<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Electricians</td>
<td>633,010</td>
<td>13,300</td>
<td>+12%</td>
<td>Long-term OJT</td>
</tr>
<tr>
<td>HVAC mechanics/installers</td>
<td>261,610</td>
<td>6,750</td>
<td>+28%</td>
<td>Long-term OJT</td>
</tr>
<tr>
<td>Carpenters</td>
<td>899,920</td>
<td>17,830</td>
<td>+13%</td>
<td>Long-term OJT</td>
</tr>
<tr>
<td>Operating Engineers</td>
<td>398,910</td>
<td>5,490</td>
<td>+12%</td>
<td>Moderate-term OJT</td>
</tr>
<tr>
<td>Roofers</td>
<td>120,200</td>
<td>2,070</td>
<td>+4%</td>
<td>Moderate OJT</td>
</tr>
<tr>
<td>Insulation Workers</td>
<td>58,540</td>
<td>680</td>
<td>+17%</td>
<td>Moderate OJT</td>
</tr>
<tr>
<td>Carpenter Helpers</td>
<td>81,260</td>
<td>1,090</td>
<td>+23%</td>
<td>Short-term OJT</td>
</tr>
<tr>
<td>Truck Drivers, heavy</td>
<td>1,672,580</td>
<td>26,040</td>
<td>+13%</td>
<td>Moderate-term OJT</td>
</tr>
<tr>
<td>Construction Managers</td>
<td>220,550</td>
<td>3,770</td>
<td>+17%</td>
<td>Bachelor’s degree</td>
</tr>
<tr>
<td>Construction Inspectors</td>
<td>96,000</td>
<td>2,860</td>
<td>+17%</td>
<td>Work experience</td>
</tr>
<tr>
<td>Electrician Helpers</td>
<td>104,850</td>
<td>1,280</td>
<td>+25%</td>
<td>Short-term on-the-job</td>
</tr>
<tr>
<td>Truck Drivers, light</td>
<td>908,960</td>
<td>19,030</td>
<td>+4%</td>
<td>Short-term on-the-job</td>
</tr>
</tbody>
</table>
Labor Employment and Training Administration (ETA) to support marketing, industry advisory activities and program design support.

- **Princeton Plasma Physics Laboratory** is a DOE national laboratory with a mission to advance the coupled fields of fusion energy and plasma physics. PPPL staff and collaborators together are developing the scientific understanding and key innovations needed to realize fusion as an energy source for the world. For more than 20 years, PPPL has created a portfolio of science education programs around energy technology.

- All local unions such as the chapters of the **International Brotherhood of Electrical Workers**, the **Laborers and Operating Engineers**, and others that are likely to be engaged in energy efficiency retrofitting projects throughout the region will be involved in project design and development, and recruitment of participants.

Given the diverse skill set required for the proposed initiative, existing degree and certificate programs cannot simply be modified. The Collegiate Consortium is ideally positioned to lead the development and implementation of a new training program, curriculum and career ladder by adapting already established degree and certification programs in the related fields of Waste Water Treatment, Construction Technology, Applied Engineering Technology, Green Technology, and LEED & Green Advantage certification. Ultimately, these new tools can serve as a national model, especially in communities with older infrastructure and a need to retrofit older buildings.

The training model will be developed in collaboration with industry, government, and faculty experts from the fields of construction, architecture, engineering, conservation retrofitting, and related fields. To ensure that the program meets the skill and competency demands of industry, organized labor and local employers will play a leading role in program development. Unions will provide a staff liaison to coordinate the dialogue between the apprenticeship coordinators and the community college curriculum experts to ensure the program is widely endorsed by unions.

The Sustainable Business Network will help to secure input from industry partners (e.g., alternative energy firms), who can provide ongoing expertise in the pre-screening tools and development of program curriculum. SBN will continue to recruit active participation by other green employers. Individuals enrolling in the Green Construction Technician segment of the program will participate in up to 280 classroom hours over a 12 week period. The first training “module” will provide up to 160 hours of course time and will include an introduction to the construction workplace environment, applied math and measurement techniques, construction administration, OSHA, technical reading skills and construction and green technology. Another 16 hours of course time will be dedicated to blueprint reading.

Upon completion of training module I, participants will have the option to start module II, which will cover core skills for green construction technicians, such as methods and materials of construction and an introduction to green landscaping. This training module will demand 114 hours of course time. Work readiness skills (interviewing, job search) will be integrated into the second module. Individuals interested in becoming a Green Construction Team Leader can complete additional coursework to develop the competencies to organize teams at construction sites, communicate the site requirements from the project plan, interpret blueprint specifications, and respond to new community demands that emerge during the project implementation.
The third tier of this training model will prepare participants to gain employment as Green Construction Supervisors (141 hours). Upon completion of the third tier of the program, participants will have the necessary competencies to manage a project site and community relations, as well as to oversee the work plan, staffing, assets, and budget. Upon completion of the program, graduates will receive industry-validated certificates of competency. An articulation model will also be developed into already existing degree granting programs for those trainees who wish to pursue an Associate’s degree and then a Bachelor’s degree in Civil Engineering, Construction Management, or other related technical fields in fully articulated programs.

Training programs will be offered to multiple cohorts that have seven distinct start dates over the first 18 months, enabling the project team to track ongoing performance based on completion and placement rates for each cohort. Collegiate Consortium faculty and industry experts will provide the training in college classroom and laboratory settings, and when possible, in community settings such as union halls, one-stop Career Centers or neighborhood agencies. Efforts will be made to collaborate with employer partners to incorporate visits to worksites across the region.

RECRUITING AND SERVING DISADVANTAGED WORKERS

Education and workforce development efforts in energy efficient buildings systems must include outreach to diversify the workforce and include recruitment and training for members of communities who are underrepresented in the building trades to assure their participation in this important economic development effort. A three-tiered, targeted recruitment approach will be used to ensure that participants are a good match for the program and will gain successful employment upon graduation. At the first tier, the recruitment team will partner with the State Unemployment Insurance offices to distribute customized program marketing materials to workers who have been recently laid-off from occupations with a skill set that overlaps with those required in the program, such as construction and maintenance workers.

For the second tier, the recruitment team will orient staff from all 13 one-stop centers in the Greater Philadelphia region on the program, helping to define entry requirements so that the staff can correctly identify and refer dislocated workers coming into the centers. To facilitate recruitment in specifically-targeted communities that have concentrations of unemployed, low-income, minority residents, we will also work closely with Delaware County CareerLink in Chester, PA, Workforce New Jersey, with an emphasis on Camden, NJ, and the Philadelphia Workforce Development Corporation (PWDC).

The recruitment team will collaborate with the unions to publicize the program, through customized marketing materials and other means, to union members in related fields who are unemployed. Each of these targeted populations will be invited to sign-up for invitation-only informational sessions on the program. The information sessions will provide a group orientation to the program’s requirements and job prospects and individual pre-screening of interested candidates. These sessions will be managed by EDSI, and will take place in either the local one-stop centers or at the partner colleges, during a range of times to ensure accessibility. As part of the screening process, EDSI will gather work histories and use pre-screening tools validated by SBN employer partners.

At the third tier, attendees who appear to be a strong match for the program will be invited to sign-up for a full assessment managed by the college partners using the WorkKeys assessment
system and possibly others such as the Bennett Mechanical Comprehension Test, which evaluates a candidate’s ability to apply physical and mechanical principles in practical situations. Post assessment recommendations will be made on which track the candidate might want to pursue (Green Construction Technician, Team Leader, or Supervisor) and the appropriate entry point for the program. All enrolled candidates will be assigned an EDSI Case Manager. EDSI’s role in both recruitment and case management will create a feedback loop that will allow EDSI to track the number of people who proceed from an information session through to enrollment, allowing for adjustments to the recruitment and assessment strategies appropriately.

Following completion in the program educational program (above), each program participant will follow a customized placement strategy that will connect them with union and non-union employers. EDSI Job Developers will be responsible for connecting participants to non-union employers who will have been identified and cultivated through SBN’s Emerging Industries Project and Green Business Council or listed in one-stop career center job listings. EDSI staff will coordinate with one-stop staff to either refer participants for job matching services or to contact employers directly. EDSI staff will then conduct a task analysis to match participant strengths and skills with employer needs, and schedule or help participants to schedule interviews.

Throughout the placement process, EDSI will continue to assist workers in developing solutions to any transportation, childcare, financial or personal issues. EDSI will follow-up with the participants after any interviews and job offers to help them with next steps. EDSI will track participants’ success in gaining and retaining employment and report outcomes to the management team.

Once a trainee secures employment, EDSI staff will continue its case management, contacting participants at least weekly during the first month, followed by bimonthly contact until 180 days of employment to ensure retention. Referrals for supportive services (including to UWSEPA agencies) and funding will be offered to address needs for child care, emergency housing, health care, legal assistance, financial consulting, personal protective equipment, tools and/or transportation. EDSI staff will communicate with employers and workers monthly to determine their satisfaction with the job placement new hire, and will feed this information back to the Collegiate Consortium and the project management team. Job verification will be conducted with the employer at three- and six-months following placement. A Retention Status Report will transmit this information to the project management team.

To ensure successful graduation from the programs, each participant will be connected to an EDSI case manager upon enrollment who will track participants’ progress, counsel the participant, help to address any challenges that emerge, and guarantee that each participant has a plan in place to overcome barriers they may face such as those related to transportation and childcare. The case managers will also capitalize on the broad range of supportive services that are offered through regional human service agencies, thereby addressing any additional issues faced by participants that might impede participation or program completion.
J. INCLUSION PLAN

The Greater Philadelphia region is a highly diverse community in terms of ethnicity, age, household income, and the type of household units occupied. Census data shows that the proportion of the population that is African-American (20.4%) is significantly higher than is the national average of approximately 14%. Individuals over age 60 make up 27.7% of the Greater Philadelphia population, versus 16.8% nationally. Several large communities within the Greater Philadelphia region have very large percentages of minority and low-income residents. In Philadelphia itself (population 1,448,000), the median household income in 2008 was $37,090, vs. the state average of $50,702, and approximately 56% of residents are African-American or Latino. In Chester, Pennsylvania (population 37,000), the median income was $25,703, and 81% are African-American or Hispanic. The city of Camden, New Jersey (population 79,000), one of the nation’s poorest cities, has a median income of $23,421, and approximately 92% are African-American or Latino.

Clearly, there are several large communities in the Greater Philadelphia region with very high concentrations of minority populations and very low family incomes. The GPIC represents an opportunity for a high degree of inclusion of low-income underrepresented residents in a major regional technology based economic development initiative. The GPIC members, partners, and stakeholders will undertake focused efforts to ensure that low-income and underrepresented individuals from these communities and others throughout the region benefit from the economic opportunities that are expected to result. This section describes the commitment and track record of the GPIC, Co-Applicants, members, partners and stakeholder groups to the inclusion of underrepresented groups in programs and activities, as well as plans and strategies for ensuring that underrepresented groups participate fully in the activities of the GPIC.

TRACK RECORD OF CO-APPLICANTS

Each GPIC co-applicant and HUB member brings unique experience and capabilities to the challenge of ensuring that disadvantaged and underrepresented individuals participate in GPIC activities. Some of these are highlighted below:

- **Penn State** is highly committed to inclusion of underrepresented groups in all of its activities, and operates a number of programs aimed at to broadening participation by underrepresented students, especially in STEM disciplines. Penn State’s Vice Provost for Educational Equity has primary responsibility for Penn State’s many activities to advance and broaden educational and career opportunities for underrepresented groups. These activities include Affirmative Action Office/Diversity Education Services; College Multicultural Programs; FastStart, a mentoring program for first-year African-American, Latino/Hispanic, and other underrepresented students; the Office of Graduate Educational Equity Programs, McNair Scholars Program, the Paul Robeson Cultural Center, Student Minority Advisory and Recruitment Team, Women in Engineering Program, and much more.

- **Philadelphia Industrial Development Corporation** has several programs to expand and diversity financing sources, in order to better address the needs of the City’s changing economy. For example, the *Welcome Fund* provides flexible, low-cost debt funded by federally approved immigrant investors; the *Emerging Business Program* offers working capital loans to minority and women-owned businesses; the *Non-Profit Bond Pool* is a
cost effective, tax-exempt funding source for small institutions; and the New Market Tax Credits provides US Treasury Department subsidies for urban redevelopment.

- Through Diversity Councils, IBM ensures that its workforce represents an environment that visibly encourages and values the contributions and differences of employees from various backgrounds. In addition, IBM researchers participate in major diversity conferences each year, including BEYA (Black Engineer of the Year Awards), NSBE (National Society of Black Engineers), AISES (American Indian Science & Engineering Society), Richard Tapia (Minority Graduate Engineers), Grace Hopper & Anita Borg Institute (Women in Computing), and SWE (Society of Women Engineers).

- The University of Pittsburgh School of Engineering has a dedicated office responsible for diversity issues in engineering. A specific recruitment and diversity strategy is developing strong relationships with undergraduate students through Pitt’s EXCEL program. Faculty associated with the Center for Energy have also participated in research and education programs in the area of energy efficiency that involve underrepresented groups through collaboration with the Kingsley Association, located in a low-income, largely minority neighborhood.

- Bayer MaterialScience LLC (BMS) has been an active supporter of the GEM student fellowship program through co-sponsorship of summer internships programs. In these programs, minority and women engineers and scientists have gained valuable hands-on industry experience working in BMS facilities on a variety of key projects such as sustainable chemistry, manufacturing design, market and product development, etc. Since 2005, 10 GEM interns worked at BMS facilities. One joined the organization as a permanent employee. Most are still in graduate school working toward their advanced degrees. Surveys find the program is largely successful and mutually beneficial to both the organization and the student. For the proposed initiative, BMS intends to provide several internships dedicated to building technologies.

- At Rutgers University, a special focus on underrepresented minority and disabled Students was established within the research and education programs to identify capable students at the undergraduate and graduate level pursuing degrees in science or engineering. These students receive tuition support, mentoring support and opportunities to spend their summers conducting research with principal investigators at Rutgers. A specific example of these efforts includes the Rutgers Center for Green Building which is working with the Women’s Housing and Economic Development Corporation to evaluate a large affordable green housing complex in the South Bronx, NY, in America’s poorest county.

- New Jersey Institute of Technology ranks number one in New Jersey in awarding engineering degrees to African-American and Hispanic Students. The University is also in the Top100 Undergraduate Degree Producers who focus on diversity, according to an annual survey conducted by Diverse Issues in Higher Education. The Engineering Opportunity Program was established in 1968 and has grown to over 550 currently enrolled. The university has consistently displayed strong commitment to and support for EOP, and provides adequate resources to assure the Program’s success.

- Carnegie Mellon’s “Celebration of Diversity (COD)” weekends are designed as two and a half days of activities for students interested in diversity issues and who want to learn how to engage in a diverse academic and social community. The Summer Internship for Diversity (SID) is a six-week long training program that introduces architecture
upperclassmen to research and graduate studies at Carnegie Mellon University. Instructional topics include urban design, and approaches to building performance requirements. Urban Design Regional Employment Action for Minorities (UDREAM) provides recent graduates of architecture, landscape architecture, urban design and urban planning programs the opportunity to deepen their knowledge of urban design in a summer and fall immersion experience. UDream participants receive free tuition, housing, and transportation to and from Pittsburgh, plus a $1,000/month stipend.

- **PPG’s** Minority Leadership Council (MLC) focuses on minority recruiting, minority networking, and minority career development. The MLC works with PPG’s recruiting staff in the identification of well qualified minority candidates by actively participating in college recruitment and career job fairs hosted by organizations such as the National Society of Black Engineers, the Society of Women Engineers, the Society of Hispanic Engineering Professionals, the National Organization of Black Chemical Engineers, and The Consortium just to name a few. New hires are also placed in a mentoring program, matching minority employees with mentors who can help the employee gain an understanding of PPG’s organizational culture, obtain skills and knowledge that could develop them in their career, and encourages them to use their imagination and initiative.

- **Morgan State University** is one of the leading institutions nationally in the number of applications received from African-American high school graduates. While Morgan is a historically black institution, it has served students of all racial and ethnic backgrounds. Its mission today is to enroll a student body that is diverse in its socioeconomic and academic status and to provide the full-range of experiences and services that permits it to successfully serve students with a wide variety of goals and needs. The University awards more bachelor's degrees to African-American students than any campus in Maryland. *In many fields, but particularly in engineering and the sciences*, Morgan accounts for large percentages of degrees received by African-Americans from Maryland institutions. An above-average percentage of Morgan graduates enter graduate and professional school. Historically, the University has ranked among the top public campuses nationally in the number of black graduates receiving doctorates.

- **Lawrence Livermore National laboratory** (LLNL) has worked closely with underrepresented groups addressing both research and educational activities. Many of these activities involve energy research and development and are included in three LLNL programs. These are the LLNL American Indian Program under the Office of Strategic Diversity Programs, the Historically Black Colleges and Universities (HBCUs) Science and Engineering Alliance (SEA), which is a consortium between the Laboratory and four HBCUs (Alabama A&M University, Jackson State University, Prairie View A&M University, and Southern University), and the recently established relationship with the National Hispanic University (NHU).

- **Drexel University**’s Alliance for Minority Participation has many programs and goals, including promoting the success of students pursuing degrees in science, technology, engineering and mathematics disciplines. The Alliance is a partner in the Louis Stokes Alliance for Minority Participation, which represents a diverse partnership of Historically Black Colleges and Universities, both public and private two- and four-year research and non-research institutions.

- **Purdue University**’s Summer Research Opportunities Program (SROP) provides research mentoring for potential graduate students from social and economic
backgrounds underrepresented in science and engineering. The Summer Undergraduate Research Fellowship (SURF) and Discovery Park Undergraduate Research Internship (DURI) successfully recruit a higher percentage of female students than the Purdue student population and sponsor a variety of campus research projects related to biomass, bioenergy, and green buildings. Mentoring and scholarship programs such as Food, Environment, Engineering, and Life Sciences (FEELS) prepare first-generation students from underrepresented backgrounds for success in areas of study central to high performance buildings. Recruiting mechanisms are extensive and include avenues such as the Indiana Louis Stokes Alliance for Minority Participation (LSAMP), a Minority Engineering Program, the first Women in Engineering Program in the nation, and Historically Black Institutions (HBI) Visitation Program.

- **Virginia Tech** has a strong record of attracting and retaining underrepresented groups at all levels, and approximately 40% of ICAM’s graduate students have been women. The University has one ICAM faculty member (Dr. Lizette Zietsman), who will be in charge of recruitment of graduate students and postdocs from underrepresented groups, and also act as mentor to these participants in all aspects of the Virginia Tech projects associated with the proposed initiative.

- **Ben Franklin Technology Partners of Southeastern Pennsylvania** (BFTP/SEP) works closely with many organizations and institutions that focus on minority, women and disadvantaged populations. These include the African American Chamber of Commerce of PA, NJ & DE; Asian American Chamber of Commerce in Greater Philadelphia; Enterprise Center; Forum of Executive Women; Greater Philadelphia Hispanic Chamber of Commerce; Minority Angel Investor Network; National Society of Black Engineers of Greater Philadelphia; Network for Teaching Entrepreneurship (NFTE); WIN (formerly Women’s Investment Network); and Women Impacting Public Policy (WIPP), among others.

**BRIDGES TO INCLUDE THE DISADVANTAGED AND UNDERREPRESENTED**

As described above, co-applicants and partners have a strong track record of seeking out members of minority groups, involving them in meaningful activities, and helping them to meet their educational, training, and career goals. The GPIC is highly committed to inclusion of underrepresented individuals and organizations at all levels of activity. The DOE HUB includes among its members a historically black institution, Morgan State University, which will lay robust roles in the RDD&D activities of the GPIC and also in the management of the GPIC through development and operation of an innovative Scientific Information System developed by Morgan State in collaboration with Johns Hopkins University through research supported by the NSF Engineering Research Center (ERC) on Computer Integrated Surgical Systems Technology (CISST). The GPIC also includes a number of minority serving institutions as members including the Community College of Philadelphia and Camden Community College, which are members of the Collegiate Consortium for Workforce and Economic Development.

Beyond participation as members in the management and RDD&D activities of the HUB, underrepresented groups will be proactively recruited to participate in GPIC activities. GPIC education and workforce development efforts include a dedicated activity focused on outreach to disadvantaged and underrepresented individuals. To facilitate recruitment in communities that have concentrations of unemployed, low-income, minority residents, the these efforts will be closely coordinated with Delaware County CareerLink in Chester, Pennsylvania, Workforce
New Jersey, with an emphasis on Camden, and the Philadelphia Workforce Development Corporation (PWDC). These efforts will be led by the Science Education Program of the Princeton Plasma Physics Laboratory (PPPL) in partnership with DVIRC, the Collegiate Consortium for Workforce and Economic Development, Penn State, and others. The aim is to ensure that GPIC education and workforce development activities create training and career ladders for disadvantaged and underrepresented students and workers for careers in the burgeoning field of energy efficient building systems.

In addition, GPIC demonstration, deployment, and commercialization activities will also have a dedicated effort to include underrepresented partners. HUB/GPIC members and partners will actively seek minorities and females for internship and business development opportunities. An outreach and communication program will be established with key organizations serving minorities and women including: the African American Chamber of Commerce of PA, NJ & DE, the Asian American Chamber of Commerce in Greater Philadelphia, the Enterprise Center, the Forum of Executive Women, the Greater Philadelphia Hispanic Chamber of Commerce, the Minority Angel Investor Network, the National Society of Black Engineers of Greater Philadelphia, the Network for Teaching Entrepreneurship (NFTE), WIN (formerly Women’s Investment Network), and Women Impacting Public Policy (WIPP). A university based intern program will also be developed to support GPIC demonstration, deployment, and commercialization activities and provide a rich learning experience in the technology innovation management field. These efforts will be led by the Ben Franklin Technology Partners of Southeastern Pennsylvania, which has a long record of working with minority and female owned companies and investors.
K. SUSTAINABILITY AND CARBON REDUCTION

This section describes the sustainability for the GPIC Consortium and for the GPIC as a whole and also describes the ways that the GPIC Consortium will reduce its own carbon footprint as well as carbon emission throughout the Greater Philadelphia region and beyond.

SUSTAINABILITY

The GPIC for Energy Efficient Buildings is proposed as part of a going concern, which is the Clean Energy Campus at the Navy Yard. This history dates to the closure of the Navy Yard in Philadelphia by the federal government in 1996 and the emergence of the Clean Energy Campus concept as a centerpiece of the Navy Yard redevelopment effort. The aim of the Clean Energy Campus is to make the Navy Yard a national center of excellence for energy research, education, and commercialization. The core elements of this effort are the combined education, research and commercialization strengths of government, industry, and universities in the southeastern Pennsylvania region and beyond relating to power production and management. These have primarily included but are not limited to:

- Ben Franklin Technology Partners of Southeastern Pennsylvania
- Delaware Valley Industrial Resource Center
- NAVSEA Warfare Center Carderock Division Philadelphia Component
- Philadelphia Department of Commerce
- Philadelphia Industrial Development Corporation
- Penn State
- Drexel University
- Collegiate Consortium for Workforce and Economic Development

As a result of these ongoing efforts, the Clean Energy Campus currently houses the DOE Mid Atlantic Clean Energy Applications Center, the DOE Northern Mid Atlantic Solar Training Center, and the DOE Grid Smart Training Applications Resource (GridSTAR) Center. Thus, the GPIC for Energy Efficient Buildings will be one element, albeit the major element to date, of the ongoing development of the Clean Energy Campus at the Navy Yard.

The GPIC at the Navy Yard will involve significant non-DOE HUB resources both during the five-year period of DOE HUB funding period and beyond. In addition to $7.7 million of non-DOE federal funding requested from EDA, NIST, and SBA to support activities during the five-year award period, DOE HUB members and GPIC partners have committed more than $50 million of co-funding to support the DOE HUB/GPIC. This includes $30 million of new capital funding committed by the Commonwealth of Pennsylvania to support DOE HUB/GPIC test bed facilities at the Navy Yard.

Beyond the initial public and private funding for the GPIC described above, DOE HUB members and GPIC partners will work together aggressively to pursue funding support from other federal agencies including the Department of Education, the Department of Labor, and the NSF, as well as philanthropic foundations, private industry, and others both during and after the GPIC award period. The broad-based collaborative effort that has guided the development of the Clean Energy Campus at the Navy Yard to date will guide the operation of the GPIC for Energy Efficient Buildings through the award period and will sustain these efforts beyond the GPIC award period and for decades to come.
REDUCING GREENHOUSE GAS EMISSIONS

The GPIC will adopt a proactive and multi-faceted approach to sustainability and carbon footprint reduction. This will entail putting sustainability/carbon footprint reduction at the forefront of day-to-day operations, and its retrofitting and demonstration activities. The key elements of this strategy include the following:

- **Reducing greenhouse gas (GHG) emissions**: The GPIC will seek to reduce all greenhouse gas emissions in addition to carbon dioxide. This is particularly important as other gases such as methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF6) have a much higher global warming potential than carbon dioxide. Our approach will involve exploring all opportunities to limit the generation of these gases at all stages of the building process. The technical potential of a 50% reduction in today’s commercial building energy use would result in an 8% to 10% reduction in GHG (CO2e) emissions.

- **Minimization and elimination of waste streams**: Minimizing all waste streams will not only enhance sustainability but contribute significantly to carbon footprint reduction within the GPIC and across the region. The importance of this aspect of sustainability is that it conserves resources at the outset and minimizes or eliminates the energy used to generate these resources that would otherwise be wasted. An example of a waste stream to be tackled is reducing paper consumption and hence reducing paper waste. This will be achieved through consortium agreements/protocols on resource conservation, as well as the following:
  - Use of PIDC’s control of all aspects of the Philadelphia Navy Yard to introduce policies, incentives and other measures to control waste across the whole campus;
  - Education and awareness programs to sensitize the businesses and others that use the Navy Yard, as well as the wider Greater Philadelphia region;
  - Proactive measures to promote recycling and waste stream recovery.

- **Adoption of sustainable business processes**: There are tremendous opportunities within businesses to adopt sustainable business processes. This is certainly possible within those organizations that constitute the GPIC. Some of these involve the use of efficient and cost-effective procurement methods; streamlining of business processes to remove non-value adding activities; and increased use of information and communication technologies to increase efficiency, reduce waste, minimize travel, and reduce costs. We plan to promote the adoption of these practices within the HUB’s member organizations and are committed to adopting these in the operation of the HUB itself;

- **Minimization of travel**: A big contributor to carbon emissions is travel – by air, road or other vehicles that are fossil fuel dependent. Given the large number of members in the GPIC, there is the potential for travel and its associated financial and environmental cost to be high. In addition to limiting travel to only those that are strictly necessary for the delivery of the energy efficient building agenda, we will minimize travel through two key strategies:
  - A requirement for all HUB members to locate key research personnel at the Navy Yard. This will significantly reduce the need for travel;
  - Extensive and effective use of tele- and video-conferencing systems to facilitate interaction between HUB members and others not located at the Navy Yard.

- **Use of renewable and clean energy systems**: There is considerable scope to deploy renewable energy systems (solar, CHP, ETC.) at the Navy Yard. This will be at the level
of both the demonstration/testbed facilities as well as the whole Navy Yard campus. We will seek to leverage the opportunity provided by the existing DOE-funded centers at the Navy Yard – the Mid-Atlantic Clean Energy Application Center, and the Mid-Atlantic Solar Regional Training and Resource Center – in achieving this;

- **Reduction in energy usage within the Greater Philadelphia region:** The approach here will involve a spectrum of initiatives – from simple things such as ensuring that energy usage is minimized by turning off lights and appliances that are not needed to more sophisticated approaches that involve embedded sensors and other control strategies that are not dependent on human fallibility. The GPIC will adopt these strategies in its retrofitted facility and then extend them across the whole Navy Yard and the region;

- **Undertaking lifecycle assessment of building materials, components, sub-assemblies and design provisions:** An understanding of the lifecycle implications of the use of certain building materials, components, and sub-assemblies is vital for establishing their environmental impact. Materials that have a lower initial cost may have higher lifecycle costs and/or more adverse environmental impact. We will undertake lifecycle assessment (LCA) of materials and components to ensure that guidance is available on their long-term impact. The same is true of design provisions that minimize the flexibility of building usage or increase long-term operating costs and environmental impact. This LCA approach will be adopted in the development of the retrofitted and new buildings at the Navy Yard.

- **Monitoring energy usage:** Integral to any sustainability/carbon footprint reduction strategy is the ability to measure the key energy usage parameters and to monitor these over a period of time. We plan to do this within the retrofitted building and across the entire Philadelphia Navy Yard campus. The data collected from this exercise will inform some of the policy and other initiatives to be adopted and disseminated across the Greater Philadelphia region.

In addition to the above, organization-specific strategies will also be adopted by HUB members. Elements of good practice will be shared between members and across the region.
L. KEY PERSONNEL

The DOE HUB comprises an uncommonly dynamic and diversified team of eleven prestigious academic institutions including a historically black university, two DOE laboratories, five high profile global industry partners, regional economic development agencies, and community colleges. The DOE HUB and the GPIC are tightly integrated. The EDA, NIST, and SBA co-applicants all serve as DOE HUB members. More than 100 individuals across the HUB members, which include all co-applicants, are participating as key project personnel. These key personnel are listed below with organizational affiliation, and a brief biosketch for each participant is included in Appendix 7 of the DOE HUB proposal.

PI – Foley, Henry C., Penn State
Akers, Mary Ann, Morgan State
Akinci, Burcu J., CMU
Alur, Rajeev, Penn
Amaba, Ben, IBM
Andrews, Clinton, Rutgers
Anumba, Chimay, Penn State
August, David, Princeton
Azizan Aziz, CMU
Bahnfleth, Williams P., Penn State
Bailey, Trevor, UTC
Bales, Erv, NJIT
Barton, William, Turner
Bilec, Melissa, Pitt
Birch, Eugenie, Penn
Birmie, Dunbar, Rutgers
Blumsack, Seth A., Penn State
Borggaard, Jeff, Virginia Tech
Both, Arend-Jan, Rutgers
Braun, James, Purdue
Brennan-Tonetta, Margaret, Rutgers
Bronner, Lee Roy, Morgan State
Brownson, Jeffrey, Penn State
Burkardt, John Vetter, Virginia Tech
Burns, John Allen, Virginia Tech
Caton, James M., IBM
Chen, Qingyan, Purdue
Clark, William, Pitt
Cliff, Eugene Matthew, Virginia Tech
Cohen, Adam, Princeton
Cole, Daniel, Pitt
D'Amora, Bruce D., IBM
Dickens, Corey, Morgan State
Echols, Stuart, Penn State
Evans, Deane, NJIT
Felder, Frank, Rutgers

Finn, Alan, UTC
Fisher, Amit, IBM
Frase, Katharine G., IBM
Freihaut, James, Penn State
Gambino, James, BFTP
Garrett, James H., CMU
Girifalco, Anthony, DVIRC
Grady, John, PIDC
Green, Anthony, BFTP
Grosh, John, LLNL
Gugercin, Serkan, Virginia Tech
Gurian, Patrick, Drexel
Hallacher, Paul, Penn State
Hamann, Hendrik F., IBM
Harasin, Steve, Bayer
Hartkopf, Volker, CMU
Hayes, John, Bayer
Henshaw, William, LLNL
Herdman, Terry L., Virginia Tech
Horton, Travis, Purdue
Houldin, Joseph J., DVIRC
Houser, Kevin W., Penn State
Hu, Jianghai, Purdue
Hughes, Mark Alan, Penn
Hunter, James, Morgan State
Iliescu, Traian, Virginia Tech
Isom, Joshua, UTC
Jadbabaie, Ali, Penn
Jafari, Mohsen, Rutgers
Jha, Niraj, Princeton
Jiao, Yu, PPG
Jurberry, David, Bayer
Kalagnanam, Jayant, IBM
Karava, Panagiota, Purdue
Kimber, Mark, Pitt
Klein, Levente J., IBM

2-6
Kleit, Andrew N., Penn State
Klinger, Jeffrey, Turner
Krogh, Bruce H., CMU
Kenreuther, Howard, Penn
Kuntz, Michael, Turner
Lam, Khee Poh, CMU
Landis, Amy Elaine, Pitt
Lee, Seong, Morgan State
Lee, Stephen R., CMU
Lee, Young M., IBM
Lenchner, Jonathan, IBM
Liaukus, Christine, NJIT
Loftness, Vivian, CMU
Malkawi, Ali, Penn
Mangharam, Rahul, Penn
Marathe, Madhav V., Virginia Tech
Mashkif, Nir, IBM
Masin, Michael, IBM
Mazurek, Monica, Rutgers
Memari, Ali M., Penn State
Messner, John I., Penn State
Michel-Kerjan, Erwann, Penn
Miller, Barry W., DVIRC
Mistrick, Richard, Penn State
Napade, Milind R., IBM
Narayanan, Satish, UTC
Nyarko, Kofil, Morgan State
Oggianu, Stella Maris, UTC
Oliva, Ralph, Penn State
O’Neill, Zheng D., UTC
Orland, Brian, Penn State
Orts, Eric, Penn
Pappas, George J., Penn
Pekarek, Steven, Purdue
Radcliffe, Thomas, UTC
Ransom, Avis, Morgan State
Rashid, Ali, PPG
Ritter, Frank, Penn State
Romano, Paul, NJIT
Saeedifard, Maryam, Purdue
Schaefer, Laura A., Pitt
Sexton, James C., IBM
Shwom, Rachael, Rutgers
Sisson, William, UTC
Sliwinski, Martin, Penn State
Smith, Gregory, Turner
Snowdon, Jane L., IBM
Srebric, Jelena, Penn State
Sturm, James, Princeton
Sunderland, Nicolas, Bayer
Tong, Charles L., LLNL
Treado, Stephen, Penn State
Tzempelikos, Athanasios, Purdue
Verma, Naveen, Princeton
Vipperman, Jeffrey S., Pitt
Wachtler, Susan, Penn
Wagner, Sigurd, Princeton
Wagner, Timothy, UTC
Walker, Craig, UTC
Waring, Micheal, Drexel
Watkins, Damian, Morgan State
Weiland, Lisa Mauck, Pitt
Welsh, Joseph, Collegiate Consortium
Wen, Jen, Drexel
Willis, Daniel E., Penn State
Witman, Mark, Bayer
Wu, Dinghao, Penn State
Yen, John, Penn State
Zietsman, Lizette, Virginia Tech
Zwicker, Andrew, Princeton

1 American Rails: http://www.american-rails.com/southeastern-pennsylvania-transportation-authority.html
5 U.S. Department of Labor, Employment and Training Administration, Office of Workforce Investment, Division of Workforce System Support, National Center for O*NET Development, Greening of the World of Work: Implications for O*NET®-SOC and New and Emerging Occupations, February 12, 2009.


x US Dept. of Labor, Employment Projections, Occupation Employment by Industry, Table 1.9, 2008-2018.
MEMORANDUM OF UNDERSTANDING: GREATER PHILADELPHIA REGIONAL INNOVATION CLUSTER FOR ENERGY EFFICIENT BUILDING

This Memorandum of Understanding (MOU) is entered into as of the 19th day of April, 2010 ("Effective Date") by and among The Pennsylvania State University, (University), The Philadelphia Industrial Development Corporation (PIDC), Delaware Valley Industrial Resource Center (DVIRC), and The Pennsylvania Small Business Development Center (Pennsylvania SBDC), each for the purpose of this agreement referred to individually as a "Co-Applicant" or "Consortium Member" or collectively as "Consortium Members".

WHEREAS, the Consortium Members, by virtue of signing this MOU, agree to serve as Co-Applicants in the formation and establishment of a consortium whose purpose is to support the development and growth of a regional energy innovation cluster described herein, to foster the development; expansion and commercialization of innovative energy efficient building systems; and promote non-federal investments in business development, public infrastructure, workforce development and education.

WHEREAS, Consortium Members acknowledge that University will serve as the principal "DOE Co-Applicant" and "Consortium Lead" who will prepare and submit a formal proposal based on an integrated multidisciplinary research, development, demonstration, and deployment program comprised of university, industry, government, and non-profit participants to the U.S. Department of Energy (DOE) in response to a Joint Federal Funding Opportunity, dated February 8, 2010 in support of "Energy Efficient Building Systems Regional Innovation Cluster Initiative".

NOW, THEREFORE, the purpose of this MOU is to establish the overall process and obligations of each Consortium Member in support of this DOE initiative.

INTRODUCTION

The Consortium Members identified herein agree to participate in and support the "Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings" (hereinafter referred to as "Consortium") in response to the DOE joint Federal funding opportunity. The geographic focus of the Greater Philadelphia Regional Innovation Cluster is on the City of Philadelphia and the four Pennsylvania counties (Bucks, Chester, Delaware, and Montgomery) and four New Jersey counties (Burlington, Camden, Gloucester, and Mercer) surrounding it. The Cluster Initiative is headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia. The Navy Yard is a 1,200 acre regional economic development site located on the Delaware River in South Philadelphia. The Navy Yard was closed in 1996 by the federal government, and its redevelopment represents one of the nation's largest and most dynamic urban redevelopment opportunities. A key aim of the redevelopment effort is to make the Navy Yard and Greater Philadelphia a national hub for clean energy research, education, and commercialization, and to deploy clean energy technologies to the larger Mid Atlantic
region and beyond. The Co-Applicants in the Consortium initiative have uniquely positioned the region to become a national leader in energy efficient buildings research, education and training, and technology development, demonstration and deployment. Each of the Co-Applicants named herein agrees to prepare a formal proposal to be submitted to the appropriate Federal funding agency in support of this Consortium as follows:

**DOE Co-Applicant: The Pennsylvania State University**

University, as Consortium Lead, will pursue DOE Energy Innovation HUB funding to develop technologies and policies to accelerate the retrofit of existing commercial and residential buildings of averaging approximately 10,000-20,000 square feet in size. The goals of the effort are to improve energy efficiency and operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond. The effort will focus on five (5) tasks: Task 1: Tools for Integrated Design, Verification, and Modeling, Task 2: System Solutions, Enabling Components, Robust Controls and Diagnostics, Task 3: Economic, Policy, and Behavioral Factors, Task 4: Education and Workforce Development, Task 5: Demonstration, Deployment, and IP Management.

Consortium Lead will assemble a team of leading researchers from academia, industry and government sources to work in these seven thrust areas. The HUB will be located at the Philadelphia Navy Yard Clean Energy Campus and will be easily accessible and highly interactive to all Consortium Members.

**EDA Co-Applicant: Philadelphia Industrial Development Corporation**

PIDC, acting through the Philadelphia Authority for Industrial Development (PAID), will pursue EDA funding to support the energy efficient retrofit of a 25,000 SF building at The Navy Yard Clean Energy Campus. PIDC manages all planning, development and operations on behalf of PAID at The Navy Yard. The Navy Yard retrofit project will be preceded by and leverage a HUB energy efficiency retrofit project at Purdue University in West Lafayette, Indiana, which will explore integrated building design, construction, operations and control for energy efficiency. The EDA sponsored Navy Yard retrofit project will apply knowledge generated through the Purdue research effort. Both the Purdue and the Navy Yard retrofits will be carried out as research projects of the DOE HUB and will function as living laboratories before, during, and after commissioning. The retrofitted building at the Navy Yard Clean Energy Campus will be configured for flexible use, and will initially house elements of the Energy Innovation HUB as well as other clean energy education, research, and technology commercialization activities including the DOE Clean Energy Applications Center and the DOE Northern Mid Atlantic Solar Training Center.
NIST Co-Applicant: Delaware Valley Industrial Resource Center

The DVIRC will pursue NIST funding to assist building energy efficiency related small and medium size manufacturing enterprises (SMEs) in the Consortium region with the intent of improving global competitiveness, develop new products, and create quality jobs in the region. The DVIRC will identify SMEs in the Consortium region that are or can be integrated into the supply chains of original equipment manufacturers (OEMs) in the building energy efficiency sector, and assist these firms to participate in activities of the Energy Innovation HUB. Efforts will target regional SMEs possessing manufacturing capacity that can address technology thrust areas of the Energy Innovation HUB such as advanced lighting, HVAC systems, construction materials, power management, and others. The DVIRC will assist these firms to participate in HUB research, education and training, and technology development, demonstration, and deployment activities to position them as direct contributors to and beneficiaries of the research as well as preferred suppliers to OEMs in key building energy efficiency sectors. Finally DVIRC will support the establishment of a regional STEM Center within the HUB.

SBA Co-Applicant: Pennsylvania Small Business Development Center

The Pennsylvania SBDCs will pursue SBA funding to provide commercialization advice, education, and business development services to small and emerging businesses addressing building energy efficiency in the Consortium region. Led by the SBDC at the Wharton School at the University of Pennsylvania, the Pennsylvania SBDCs will support small businesses in the region by.

1. **Promotion of awareness and understanding of new energy efficient building technologies and environmental responsibility to small business owners throughout the region through education, information and outreach.**

2. **Commercialization, Acceleration, Program for Clean and Energy Efficient Building, Technologies developed by and with the Energy Innovation, HUB and throughout the region.**

3. **Supporting Small Business Owners to Evaluate and Implement Clean and Energy Efficient Buildings Technologies.**

These programs will draw on the expertise and experience of the Wharton and Temple SBDCs and PA SBDCs E-MAP (Environment Management Assistance Program). The addition of the Commercialization Acceleration Program for Clean and Energy Efficient Building Technologies run by the Wharton SBDC will expand existing programs that currently provide experiential education to over 250 graduate and undergraduate students at the University of Pennsylvania. These efforts will be carried out in close collaboration with resident technology licensing officers within the HUB member institutions and will use HUB facilities – showcasing HUB facilities and technologies to small business owners in the region and facilitating the commercialization of these
technologies by small business. This effort will be closely coordinated with the intellectual property management and technology validation, prototyping, demonstration, and deployment activities of the HUB.

ADVISORY COMMITTEES: DOE ENERGY INNOVATION HUB

To facilitate a greater level of interaction and collaboration amongst the Consortium Members each of the Co-Applicants will appoint a representative to serve on all appropriate advisory and management committees of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings and of the DOE Energy Innovation HUB for the duration of their existence. For the Pennsylvania SBDC, this individual will be the director of the Wharton SBDC. This individual will be responsible for attending regular meetings of the HUB directorate and to participate in HUB directorate decision making and to serve as an information bridge between HUB activities and opportunities for application of HUB research results and technology developments within the Consortium region consistent with their respective funding obligations. It is through this vehicle that the Consortium likewise will inform HUB members of their respective activities in support of HUB efforts.

FUNDING: CO-Applicant

This MOU is not intended to, and shall not be used to obligate any Consortium Member to commit its funds to any of the efforts set forth in this MOU. Specific work statements and details of support budget to be furnished by each of the Co-Applicants will be developed separately apart from this MOU in specific formats to be submitted to the appropriate funding agencies. Each of the Co-Applicants agrees to prepare the above request for funding in a timely manner and will coordinate submission efforts with Consortium Lead. Each of the Co-Applicants acknowledges that it will remain a Consortium Member for the duration of the funding opportunity and that each will receive separate awards from the respective funding agencies under any joint funding opportunity.

INTELLECTUAL PROPERTY

No rights of any kind whatsoever in any invention, copyright, trade secret or other form of intellectual property are granted or transferred under this MOU. All intellectual property exchanged pursuant to this MOU, shall be governed by the terms of a separate agreement.

CONFIDENTIALITY

Confidential, proprietary, or business sensitive information ("Proprietary Information") may be disclosed between Consortium Members for the purpose and activities of this MOU. Therefore the Consortium Members agree as follows:
1. A Consortium Member may, but shall not be obligated to, disclose Proprietary Information (Discloser) to any of the other Consortium Members (Recipient), in writing, electronically, or orally, during the term of this MOU. All written disclosures or Proprietary Information shall include appropriate markings of confidentiality. All non-written disclosures of Proprietary Information shall be summarized in writing with appropriate markings of confidentiality and furnished to the other party within thirty (30) days after disclosure. Recipient shall receive and use the Proprietary Information for the sole purpose of review, evaluation, and possible proposal preparation related to this MOU, and for no other purpose. Recipient agrees not to disclose the Proprietary Information to any third party or parties without the prior written consent of the Discloser, except that Pennsylvania SBDC may disclose Proprietary Information to its subcontractor SBDC entities, including WSBDC.

2. Upon expiration or termination of this MOU, Recipient shall promptly return to the Discloser or destroy the Proprietary Information and all copies thereof, including but not limited to prototypes, written documentation, drawings, photographs, and models, subject to the Recipient retaining one copy of the Proprietary Information for archival purposes only.

3. Recipient shall use reasonable efforts to preserve the confidentiality of the Proprietary Information as it would if Recipient owned the Proprietary Information and shall use not less than a reasonable care with respect to such Proprietary Information. Recipient shall oblige its wholly-owned subsidiaries with access to any portion of the Proprietary Information to protect the proprietary nature of the Proprietary Information. Recipient shall be responsible for any breach of confidentiality under this MOA by such wholly-owned subsidiaries.

4. Recipient shall have no obligation to refrain from disclosing or using proprietary information which:

a. is generally available to the public at the time of this MOU;

b. becomes part of the public domain or publicly known or available, by publication or otherwise, not through any unauthorized act or omission of Recipient;

c. is lawfully disclosed to the Recipient by third parties without breaching any obligation of non-use or confidentiality;

d. has been independently developed by persons in Recipients employ or otherwise who have no contact with Proprietary Information, as proven with written records; or

e. is required to be disclosed by law, rule, regulation, subpoena, civil investigation, demand or similar legal process.
5. The period of time during which the Consortium members may exchange Proprietary Information under this MOU shall be the earlier of (i) five (5) years from the Effective Date of this Agreement; or (ii) expiration or termination of this MOU. All obligations of Recipient with respect to the use and disclosure of the Proprietary Information shall terminate five (5) years from the date of disclosure.

6. In the event that a Consortium Member is to be in receipt of “Protected Data”, so identified as originating under the HUB activities, the Discloser must identify all such proprietary information as “Protected Data” prior to disclosing all such proprietary information and Recipient shall treat all such Protected Data as highly sensitive Proprietary Information. Recipient has the right to decline receipt of any such Protected Data. Recipient shall not be responsible to any Disclosure for the confidentiality of any information if such information is not clearly marked as confidential.

7. Notwithstanding the foregoing, the Consortium Members each acknowledge and understand that PIDC, as agent for the Philadelphia Authority for Industrial Development and as an economic development agency which works with the City of Philadelphia (City) on certain economic development projects in the City, (1) has the right and may be required to inform City officials and state officials of the discussions PIDC has with the Consortium member and may give certain Proprietary Information to City or state officials; and (2) may be subject to laws which require public disclosure of documentation, including but not limited to e-mails and notes of meetings and discussions. In such event that there is a request for Proprietary Information under such public disclosure laws, PIDC will inform the other Consortium Members of such request so that the Consortium members can consider further action as deemed necessary to protect such information.

8. Consortium member’s sole and exclusive remedy for PIDC’s actual or threatened breach of this section is limited to obtaining injunctive relief. It is specifically understood and agreed that neither PIDC nor any of its officials, officers, directors or employees shall have any liability, personal, pecuniary or otherwise, with respect to this Agreement, nor shall the property of PIDC or any of its officials, officers, directors or employees be subject to attachment, levy, execution or other judicial process, and there shall be no recourse against any assets or personal liability of PIDC or any of its officials, officers, directors or employees.
RELATIONSHIP OF THE PARTIES

This MOU is not intended to directly or indirectly constitute, create or give effect to, or otherwise imply a joint venture, corporation, partnership, or any form of formal business entity, other than the collaborative relationship set forth herein. Each party to this MOU will act as an independent contractor. No party to this MOU is intended to have, or is granted by another party, any authority or control over the other party, nor shall a party have the power to bind another party.

COMMUNICATIONS

Press releases, media announcements, and advertising by the Consortium Members to this MOU or activities hereunder, shall be mutually approved in writing by the Consortium Members prior to release. A Consortium Member’s name shall not be used by another Consortium Member without the express written consent of the Consortium Member.

DISCLAIMER

IN NO EVENT WILL ANY CONSORTIUM MEMBER BE LIABLE FOR ANY SPECIAL, INDIRECT, CONSEQUENTIAL, PUNITIVE, EXEMPLARY OR INCIDENTAL DAMAGE, ARISING IN ANY WAY OUT OF THIS AGREEMENT, EVEN IF THAT CONSORTIUM MEMBER HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

GOVERNING LAW

This MOU shall be construed and performance thereof shall be determined according to the laws of the Commonwealth of Pennsylvania, excluding its conflict of law provisions.

MODIFICATION

This agreement may only be modified by a written amendment that is executed by an authorized representative of each Consortium Member.

DISPUTE RESOLUTION

If a dispute arises between or among the Consortium Members concerning any right or duty under this MOU, then the affected Consortium Members will confer, as soon as practical, in an attempt to resolve the dispute in good faith. If the Consortium Members are unable to resolve the dispute amicably, then the affected Consortium Members will submit to resolve such dispute in either the Courts of the Common Pleas of Philadelphia County, Pennsylvania, or in the United States District Court for the Eastern District of Pennsylvania, to whose jurisdiction for such purposes the Consortium Members each hereby irrevocably consents and submits.
NOTICES

Any notice or other required communication must be in writing, addressed to the Consortium Member’s respective address listed on the signature page, and delivered by certified mail, overnight courier service or by e-mail.

TERM OF AGREEMENT

This Agreement will commence on the Effective Date and shall automatically terminate upon the date of the happening or occurrence of anyone of the following events whichever shall occur:

a) DOE decision not to pursue funding or notice of cancellation of the DOE funding opportunity.
b) The receipt by Consortium Lead of a written notice from DOE that it will not award this Consortium team an award.
c) The receipt of written notice from DOE that it has made an award for this initiative to another party.
d) Mutual written agreement of the Consortium members to terminate this Agreement.
e) The expiration of a five (5) year period commencing from that date that DOE has made an award to Consortium Lead.

Consortium members agree to review the MOU on an annual basis; and all modifications, including an extension of the term of this Agreement shall be in writing and signed by all Consortium members. Confidentiality provisions of this Agreement shall survive termination in accordance with the terms stated above.

ENTIRE AGREEMENT

This MOU constitutes the entire agreement of the parties pertaining to matters contemplated hereunder, and supersedes any and all prior agreements and communications on such matters, of any form whatsoever. No Consortium Member may assign any rights or obligations under this MOU without the prior written consent of the other Consortium Members.

IN WITNESS WHEREOF, the Consortium Members have executed this MOU to be effective on the herein above indicated:
THE PENNSYLVANIA STATE UNIVERSITY

By: [Signature]
Typed name: Thomas F. Massaro
Title: Associate Director IRO & OSP
Date: April 20, 2010
Address: 119 Technology Center Bldg.
University Park, PA 16802-7000

e-mail: TFM2@psu.edu

PHILADELPHIA INDUSTRIAL DEVELOPMENT CORPORATION

By: [Signature]
Typed Name: John S. Grady, Jr.
Title: Executive Vice President
Date: April 20, 2010
Address: 2600 Centre Square West
1500 Market Street
Philadelphia, PA 19102

e-mail: johng@pidd-pa.org

DELAWARE VALLEY INDUSTRIAL RESOURCE CENTER

By: [Signature]
Typed name: Joseph J. Houlelin
Title: CEO
Date: April 20, 2010
Address: 2905 Southampton Road  
Philadelphia, PA 19154  

E-mail: jhouldin@dvirc.org

PENNSYLVANIA SMALL BUSINESS DEVELOPMENT CENTER

By: (see attached)

Typed name: Christian Conroy

Title: Director

Date: 

Address: 

E-mail: 
Address: 

e-mail: 

PENNSYLVANIA SMALL BUSINESS DEVELOPMENT CENTER

By: [Signature]

Typed name: Christian Comroy

Title: Director

Date: 4-23-10

Address: 3819 Chestnut Street, Suite 325
        Philadelphia, PA 19104

e-mail: ccomroy@wharton.upenn.edu
GPIC PARTNER LETTERS OF COMMITMENT

Government Partners
Commonwealth of Pennsylvania
Delaware Valley Regional Planning Commission
City of Philadelphia
Naval Surface Warfare Center Carderock Division
New Jersey Economic Development Authority

Industry Partners
Air Products and Chemicals
ALSTOM Power
Ametek
Armstrong World Industries
Boeing Company
C.B. Richard Ellis
CertainTeed Corporation
Construction Specialties
Deloitte Services LP
Dow Chemical Company
DuPont Building Innovations
Flad Architects
HOK
Horton Lees Brogden Lighting Design
Johns Manville
Lafarge
Lam Partners
Larson Design Group
Linc Lighting and Electrical
Lockheed Martin
PECO
Pfizer Global Engineering
PJM Interconnection
Pittsburgh Corning
Rose Companies
Saint-Gobain
Sauer, Inc
Schneider Electric
Siemens
Thornton-Tomasetti Group
URS Corporation
Viridity Energy
Weber Murphy Fox, Inc.

Industry Associations
AIA Philadelphia
Alliance to Save Energy
ASHRAE
Center for Environmental Innovation in Roofing
CEO Council of Growth
Chamber of Commerce Southern New Jersey
Cleantech Alliance Mid Atlantic
Delaware Valley Green Building Council
Greater Philadelphia Chamber of Commerce
National Electrical Manufacturers Association
New Jersey Technology Council
Sustainable Business Network of Greater Philadelphia
World Business Council for Sustainable Development
World Trade Center of Greater Philadelphia

Education and Workforce Partners
Bucks County Workforce Investment Board
Camden County Workforce Investment Board
Chester County Workforce Investment Board
Delaware County Workforce Investment Board
Franklin Institute
Garrison Institute
Greater Philadelphia Regional Compact for STEM Education
Liberty Science Center
Montgomery County Workforce Investment Board
Philadelphia County Workforce Investment Board

Banking and Finance Partners
Emerald Stage2 Ventures
Minority Angel Investor Network
Mid-Atlantic Angel Group

Community and Economic Development Partners
Economy League of Greater Philadelphia
Citizens for Pennsylvania's Future
Select Greater Philadelphia
University City Science Center

Labor organizations
National Roofing Contractors Association
Penn-Del-Jersey Chapter of NECA

Philanthropic Foundations
William Penn Foundations

International Partners
Lund University, Sweden
Tsinghua University, China
April 30, 2010

The Honorable Steven Chu
Secretary
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585

Dear Dr. Chu:

I am writing on behalf of the Commonwealth of Pennsylvania to express my very strong commitment to the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings at the Navy Yard in Philadelphia. This proposal responds to the Joint FOA issued by seven federal agencies entitled Fiscal Year 2010 Energy Efficient Building Systems Regional Innovation Cluster (E-RIC) Initiative. The goals of the Greater Philadelphia Regional Innovation Cluster are to improve energy efficiency and operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond.

An extremely dynamic and diversified team of globally prominent government, industry, and educational organizations has been assembled to carry out the DOE Hub component of this effort. In addition to the DOE Hub members, hundreds of public and private sector organizations have become partners and have committed resources to support the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings. These include companies of all sizes in many industrial sectors, a wide variety of community, economic, and workforce development organizations, organized labor, state and local governments, and educational institutions of all types, among others.

The Commonwealth of Pennsylvania is highly committed to this initiative. In fact, the Commonwealth has authorized $30 million for capital facilities at the Navy Yard in Philadelphia to support the work of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings.

Sincerely,

Edward G. Rendell
Governor
April 20, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

The Delaware Valley Regional Planning Commission (DVRPC) is pleased to provide this letter of support to the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings (E-RIC). This application for funding under the Energy Efficient Building Systems Regional Innovation Cluster Initiative is led by Penn State, and is joined by the Wharton Small Business Development Center at the University of Pennsylvania, the Philadelphia Industrial Development Corporation, and the Delaware Valley Industrial Resource Center.

DVRPC serves as the federally-designated Metropolitan Planning Organization (MPO) for the nine counties of Greater Philadelphia, including Bucks County, Chester County, Delaware County, Montgomery County, and the City of Philadelphia in Pennsylvania, and Burlington County, Camden County, Gloucester County, and Mercer County in New Jersey. Together our region comprises nine of the ten counties of the proposed E-RIC.

One key distinguishing feature of E-RIC that makes it particularly attractive to DVRPC is that it addresses the challenge of retrofitting buildings for energy efficiency in a regional manner. The region’s long range plan Connections: The Regional Plan for a Sustainable Future, unanimously approved in July 2009 by the DVRPC Board, recognizes energy efficiency as a hallmark of successful regions, and sets “building an energy efficient economy” as one of four highlighted regional goals.

This proposed project is designed to meet the twin goals of immediate job creation and a profound long-term transformation of the regional energy efficiency marketplace.

DVRPC strongly supports this outstanding regional effort.

Sincerely,

Barry Seymour
Executive Director
April 22, 2009

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

The City of Philadelphia is excited to support, and be a leading partner in, the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings to be headquartered at the Clean Energy Campus at The Navy Yard in Philadelphia.

The goals of this initiative are completely consistent with Greenworks Philadelphia, a multi-dimensional strategy adopted by the City of Philadelphia that considers sustainability through five lenses—Energy, Environment, Equity, Economy and Engagement. These same lenses form the framework for the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, which seeks to develop and implement solutions for energy efficient building retrofits that improve energy efficiency, operability and reduce carbon emissions of existing buildings. The effort will also stimulate private investment and create quality jobs in the local, regional and even national building energy efficiency retrofit markets.

The City is particularly pleased that this initiative will be based at The Navy Yard, becoming a key component of its Clean Energy Campus. The Navy Yard represents an ideal location to draw on regional and national collaboration; to develop, test and deploy workable strategies for building renovations and workforce solutions; and to stimulate the broad market acceptance of the new technologies, public policies, regulations and financial products that will radically transform our built environment into a leading example of energy efficiency and carbon reduction.

Lastly, the proposed Regional Innovation Cluster dovetails perfectly with DOE’s recent $25 million award to the City of Philadelphia to expand its Greenworks Loan Program, providing additional financial resources to support the energy efficient retro-fit of existing buildings in Philadelphia and the surrounding southeastern Pennsylvania region.

The City of Philadelphia is extremely pleased to be a partner in this undertaking as we continue to make Philadelphia the greenest city in America.

Sincerely,

Michael A. Nutter
Mayor
April 23, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings

Dear Dr. Foley:

On behalf of the Mayor’s Office of Sustainability, it is with great enthusiasm that I offer my support and commit to participating as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings are to improve energy efficiency and reduce carbon emissions of existing buildings, while stimulating private investment and quality job creation in growing a strong energy efficiency retrofit market in the Greater Philadelphia region and beyond. These are goals that are shared by and reflected in our Greenworks Philadelphia sustainability plan. Through Greenworks, we aim to reduce citywide building energy consumption by 10% and retrofit 15% of our housing stock by the Year 2015. In the process, we hope to transform the retrofit market to make it both significantly larger and more self sustaining over time, while aggressively transitioning Philadelphia and the region towards a clean energy economy.

To this end, the City of Philadelphia was recently awarded $25 million in funding through the Department of Energy’s competitive Retrofit Ramp-Up program. Our project blends outside capital with federal resources and establishes powerful new links between retrofit programs and private capital pools, small business growth, workforce development, and the emergence of an energy efficiency technology sector - demonstrating an alignment in strategy between initiatives.

A Regional Innovation Cluster at the Navy Yard would further develop the deep partnerships and commitments our region has forged to support energy efficiency. I am pleased to support this innovative and exciting endeavor.

Sincerely,

Katherine Gajewski, Director  
Mayor’s Office of Sustainability
April 23, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley,

The New Jersey Economic Development Authority (EDA) is pleased to support the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Philadelphia Navy Yard.

EDA is a state financing and development agency that works to strengthen New Jersey’s economy by managing the State’s various business incentive programs to attract and retain domestic and international business, including clean energy incentives. We are happy to support the Regional Innovation Cluster and its efforts to redevelop the region of Southern New Jersey, Philadelphia, and its surrounding counties as a national hub for clean energy research, education, and commercialization.

As New Jersey’s “bank for business” with a focus on innovative ways to grow jobs, we support the Regional Innovation Cluster’s goals of improving energy efficiency and reducing carbon emissions in existing buildings in our region. We look forward to participating in the Cluster’s policy research and work in coordination with their development activities.

Only by working together in partnership can we achieve the energy efficiencies and reduction of carbon emissions required to sustain a healthy environment while supporting the creation of jobs and economic vitality. We look forward to working with the Cluster on achieving these stated goals.

Sincerely,

Caren S. Franzini
Chief Executive Officer
April 22, 2010

Henry C. Foley  
Vice-President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, Pa. 16802

Dear Dr. Foley:

Air Products strongly supports the proposal, centered at the Clean Energy Campus at the Philadelphia Navy Yard, being led by Penn State University in response to the joint FOA: Energy Efficient Buildings Regional Innovation Cluster Initiative.

Air Products recognizes the timeliness and importance of a program to develop a replicable and sustainable model to improve energy efficiency, operability, reduce carbon emissions of existing buildings and stimulate investment and job creation by developing energy efficient retrofit markets. We are convinced these plans will prove successful in the Greater Philadelphia Region, the larger Mid Atlantic Region and will ultimately enhance the economic, technological, and commercial competitiveness of the United States on a global scale.

Air Products is pleased to be accorded the opportunity to participate as a partner in this effort and looks forward to providing leadership and participation in the activities of the Regional Innovation Center, which include technology and policy research, development, demonstration and deployment, workforce development, and other activities. We also understand that the Regional Innovation Cluster will generate additional opportunities for organizations similar to Air Products to propose and participate in additional co-funded projects which further the stated goals of the Funding Opportunity.

A reliance on the status quo does not support the goal of significantly improving energy efficiency in buildings. We believe your proposal describes a program that can make the necessary changes to technologies and policies, behavior and workforce development necessary to accomplish the goals of the funding opportunity.

We look forward to working with you and your team should this project be selected.

Sincerely,

Drew Kompanek  
Mgr. Business Development,  
Government Contracting
Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802  

Dear Dr. Foley:

Alstom is pleased to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

We believe that the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings is a great regional initiative, whose aims to improve energy efficiency and reduce carbon emissions of existing and new buildings is of the highest standards and benefits to the region, to our nation, and ultimately to society as a whole.

We look forward in participating in an initiative whose expected deliverables are more private investments, and more “green” jobs.

Alstom is a large multinational deeply committed to improving the environment. By deploying several key innovative power technologies, Alstom has established its leadership in clean Urban Power™ and smart generation as demonstrated by our own headquarters. An active worldwide player involved with several Smart Campus and Eco-Building initiatives, Alstom is honored to be invited to propose its various engineering competencies and technologies, as well as its subject expertise and passion, in making the Cluster a successful initiative.

We are delighted in being presented the opportunity to contribute and participate in co-funded projects that will improve energy efficiency in both new and retrofit buildings, and will result in energy savings, environmental protection, and quality job creation.

_______________________  
JD Savelli  
Managing Director North America  
Alstom Power – Energy Management Business
April 22, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley:

We are happy to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

Armstrong heartily endorses the goals of the Greater Philadelphia Regional Innovation Cluster to improve the energy efficiency and operability of existing buildings. As a building industry leader who obtained the first LEED-EB Platinum rating for Existing Buildings outside of California for our own corporate headquarters here in Pennsylvania, we look forward to sharing our experience and learnings with others in the consortium.

Our company is focused on a wide range of energy-related innovations spanning products, processes and programs. Our Flooring and Building Products operations look forward to participating in the Cluster in a number of ways. One of the most intriguing areas for potential collaboration is in regional demonstrations of new ways to power buildings. Armstrong’s leadership in this area, along with other members of a not-for-profit group we helped found called the EMerge Alliance, may be able to deliver even better efficiencies from new DC-based technologies like LED lighting and on-site renewable energy used in new and retrofit buildings.

We understand that the Regional Innovation Cluster will provide ongoing opportunities for companies like ours to propose and participate in co-funded projects, and we look forward not only to contributing to these efforts, but also inviting participation from leaders in related industries.

Achieving true, step-level change in energy efficiency in buildings will demand broad, interdependent thinking and actions - in technology, policy, processes, business strategies, research, and training. However, the potential rewards for business, universities and the community alike are priceless. We are proud to be a partner in this effort, and urge positive consideration of this proposal.

Sincerely,

Stephen E. Becker  
General Manager  
Worldwide New Product Innovation  
Armstrong Building Products

Jeffrey S. Ross, Ph.D.  
General Manager  
Quality, Innovation & New Product Development  
Armstrong Floor Products
April 28, 2010
AGSS-M014-0026

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Subject: Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings

Dear Dr. Foley:

We are delighted to provide this letter, confirming our intent to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings are to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region and beyond. The Boeing Company, through its BDS Energy Solutions organization, located in St. Louis, Missouri is proud to offer the benefits and services of Integrated Modeling & Simulation; System Integration, Interoperability and Security; and Renewable Energy Technologies for the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings. We understand that the Regional Innovation Cluster will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals, and we look forward to contributing to the Cluster through such co-funded projects.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous.

While this commitment to participate is contractually non-binding, and subject to all necessary permissions, negotiation of firm terms/ conditions and price, Boeing looks forward to finalizing an agreement with mutually agreeable terms from the Greater Philadelphia Regional Innovation Cluster.

Sincerely,

Diane L. Stone
The Boeing Company
BDS Energy Solutions - Contract & Pricing
Office: 314-232-8261
Email: diane.l.stone@boeing.com
April 28, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

We are delighted to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings are to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region, and beyond.

We have the full resources of CB Richard Ellis, the world’s largest commercial real estate services firm, including possible access to a vast portfolio of commercial properties and institutional owners who are committed to play a role in the development and implementation of new energy efficient practices and programs in the built environment. We are particularly interested in the areas of measurement, real time metering, controls, LED lighting advances, and integrated building management systems. Additionally, we have spent a great deal of time addressing ways to gain engagement and cooperation from the occupants of these buildings who typically have little or no economic interest in the outcome.

We understand that the Regional Innovation Cluster will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals, and we look forward to contributing to the Cluster through such co-funded projects.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business
models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. We are extremely pleased to be a partner in this undertaking.

Sincerely,

[Signature]

Jack R. Norris

Cc: Tanna Pugh, PSU, Director, Industrial Research Office
    David L. Pogue, LEED AP,
    CBRE National Director of Sustainability
April 28, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Subject: Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings  
CertainTeed Saint-Gobain Letter of Commitment

Dear Dr. Foley:

CertainTeed Corporation, a subsidiary of Saint-Gobain Corporation is pleased to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Philadelphia Navy Yard.

The goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings are to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region, and beyond.

CertainTeed and Saint-Gobain High Performance Materials businesses have a major emphasis in developing and commercializing advanced products for habitat and energy efficiency. These products include building envelope materials (roofing, siding, gypsum, ceilings, fence, pipe, foundations and insulation materials), roof integrated photovoltaics (RIPV), solar reflective roofing products, glass and polymer products for PV, and ceramics for products such as collectors, and distributed energy SOFC and microturbines.

As a partner to the E-RIC, CertainTeed and Saint-Gobain would be interested in providing in-kind R&D for collaborative projects in the above areas. The in-kind support could include: Researcher labor at the Navy Yard or at our Research Centers in Blue Bell, PA, and Northboro, MA, developmental and commercial products, material testing and characterization, materials, equipment and tooling.

We understand that the Regional Innovation Cluster will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals, and we look forward to contributing to the Cluster through such co-funded projects. Our commitment is made contingent on the availability of appropriate collaborative projects and on the negotiation of equitable provisions, including patent and technical data rights.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. We are excited to be a partner in this undertaking.

Sincerely,

Husnu Kalkanoglu  
Vice President of Research & Development  
CertainTeed Corporation  
Roofing Group
Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

April 23, 2010
Dear Dr. Foley:

We are pleased to provide you with this letter of support to participate as a partner in the proposed Greater Philadelphia Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia. The goals of the GPIC are to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region, and beyond. These goals closely align with our own interests and vision to continue creating products that make buildings better.

Founded in 1948, Construction Specialties, Inc. is an international manufacturer of specialty architectural products. With ten product lines and sales of more than $350 million, C/S has grown to include more than 27 sales and manufacturing locations in 19 countries. We have long prided ourselves on being innovators in the building products industry. We embrace clean manufacturing principles and strive to create products that lower the impact of new and existing buildings on the environment and their occupants. Throughout these endeavors we often find it essential to collaborate with higher education institutions, government agencies, professional organizations and the like to supplement our R&D capabilities. Construction Specialties would be open to sharing our knowledge of the built environment, manufacturing techniques, marketing expertise and existing R&D capabilities to benefit E-RIC projects of interest. We will also commit to attending workshops, participating in or organizing workforce development activities, matching funds needed to work on approved projects of interest to C/S and supporting the program in any other way that arises.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development. The potential benefit in terms of energy savings, technology development, environmental protection, and quality job creation are enormous. We are extremely proud to be a partner in this undertaking and offer our continued support.

Paul R. Moulton
VP Marketing
Construction Specialties, Inc.
April 27, 2010

Dr. Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Subject: Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings

Dear Dr. Foley:

Deloitte & Touche is pleased to submit its letter of support to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster (RIC) for Energy Efficient Buildings, located at the Clean Energy Campus at the Naval Yard in Philadelphia, Pennsylvania.

The objectives of the RIC are to stimulate improvements in energy efficiency and reduce carbon emissions of existing buildings as well as create a platform for new private investment and job growth. Energy efficiency is one of the most cost effective means to reduce our carbon emissions through demand reduction. We are most excited about the opportunities this program will create for the Greater Philadelphia region and look forward to providing input to one of our nation’s most daunting issues. Our understanding is the activities of the RIC will provide a foundation to deploy the latest in technology, building and retrofit techniques, workforce training and deployment, standards development and other supportive activities.

We understand the RIC will provide opportunities for organizations like ours to support with our knowledge, network and solutions to help the RIC in Philadelphia become a model for the country. We would like to thank you again for the opportunity to partner in this mission.

Sincerely,

James J. Balaschak
Principal
Energy & Resources

Cc: T.L. Weiner, Deloitte LLP
The Dow Chemical Company
Midland, Michigan 48674
USA

200 LARKIN CENTER
April 29, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

The Dow Chemical Company is writing to express support and our commitment to collaborate with the Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the GPIC are well aligned with the expertise and activities of our organization. The Dow Chemical Company is a leader in the development and commercialization of innovative products that improve energy efficiency, operability and carbon emissions in the built environment.

The Dow Chemical Company is a $45 billion dollar company founded on innovation and research. In 2009, Dow invested $1.5 billion in research supporting 7000 researchers and 500 projects. As an element of Dow’s Advanced Materials Division’s Building and Construction Business, the Dow Building Solutions business unit manufactures and markets an extensive line of insulation, weather barriers and adhesives. More recently, we intend to launch a new line of Building Integrated Photovoltaic Shingles (POWERHOUSE™). Dow would intend to collaborate with the PSU Consortium in the following roles:

- Potential collaboration in specific areas of building product research including energy efficiency projects under the Dow/PSU Master Agreement
- Early look at new and innovative technologies
- Offer commercialization strategies and unique business models to speed the successful launch of new, innovative technologies to the marketplace
- Access to venture capital

We are confident that the GPIC Consortium is uniquely poised to spur substantial growth in new technology, business and employment opportunities. It will also provide a new pool of skilled workers and professionals linked in partnership with the nation’s first E-RIC focused on energy efficient buildings. We are pleased to pledge our support and desire to collaborate in this bold initiative. Please contact Greg Bergtold at 989.636.6371 or email to gsbergtold@dow.com if you have any questions or if we can be of assistance.

Sincerely,

William E. Jackson Ph.D.
The Dow Chemical Company
Global R&D Director
Dow Building and Construction
200 Larkin Center
Midland, MI 48674 USA
Phone: (989) 638-0088
Fax: (989) 638-9683
E-mail: WEJackson@dow.com
True innovation is required to meet the needs of future green building and the goal to enable net zero energy building. DuPont is committed to developing, integrating and deploying innovative technology based solutions to the marketplace that focus on increasing the performance of building systems, help to reduce operating costs and create more sustainable structures.

Our primary focus is on enabling net zero energy buildings through delivery of products that improve the energy performance of the building, generate electricity within a building and store energy within a building. Our building innovations business has been investing for many years to deliver energy-efficient products to builders and contractors in the residential and commercial markets. A few examples of our innovation in this space are below.

- Tyvek® HomeWrap® is part of the DuPont Building Innovations business. Tyvek® HomeWrap® protects the R-value of the insulation, which prevents heat loss and helps reduce energy use. We have also developed a new Tyvek® AtticWrap™ and ThermaWrap™ which, when used together, can reduce home energy use by up to 15 percent with a five-year payback.
- Energain® is a wall board material that absorbs heat when available and releases it when required
- Photovoltaic Solutions - DuPont supplies eight key materials to the photovoltaic market, the broadest offering in the industry.

Building Science expertise resides in our Building Innovations organization, with focus on fundamental technologies, application/integration of innovative technologies with the building, building and energy code competence and blended (in person and web-based) training and education of our channel partners and end customers on innovative products and proper installation. We have certified installer networks for our residential and commercial offerings.

DuPont Building Innovations understands both the residential and commercial construction value chains and is positioned to provide expertise in key areas such as market development, voice of the customer and market outreach in an effort to more rapidly deploy technology in the marketplace.

Operating in more than 70 countries, DuPont offers a wide range of innovative products and services on a global basis.

We believe that our expertise in building technology, our access to the market and our global reach can be beneficial to the development of innovative products, integrated systems and services to help enable net zero energy buildings.
April 27, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

Flad Architects is very pleased to provide this letter of commitment and support and to participate as an industry partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia. The issues of renewable energy production and energy use are defining ones for the current generation of young adults, and we believe that the team that Penn State leads is well positioned to address the wise use of our global resources.

The goals of the Cluster - to improve energy efficiency, operability, and reduce carbon emissions of existing buildings and to stimulate private investment and quality job creation in the building industry - are ones that Flad Architects shares. Our firm was ranked 48th out of the Top 100 Green Design firms in ENR’s 2009 national survey, and our focus on science-based facilities puts us among the top planning and design firms for one of the most technically demanding markets in our industry. We have won numerous design awards including Lab of the Year High Honors in 2008, and have been a leader in developing energy-efficient building solutions, most recently with a LEED NC 2.2 Gold certified laboratory for Johnson & Johnson in Springhouse, Pennsylvania.

We believe that Flad’s expertise in lab planning and architectural design is a natural fit for the Cluster and its mission to undertake research and development studies that lead to demonstration projects and real-world deployment. We understand that the Regional Innovation Cluster will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the state of our existing building stock and newly constructed facilities, and we look forward to contributing to the Cluster through collaborative RD&D projects.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education, and the workforce. The potential rewards in terms of energy savings, environmental protection, energy independence, and quality job creation are enormous, and we are excited to join you as a partner in this undertaking.

Sincerely,

William Bula, AIA, LEED AP
Principal and CEO

Jerry Polly, PE
Principal and
Science & Technology Practice Leader
April 28, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

We are delighted to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

HOK is a global leader in the practice of architecture, design and sustainability. We are also an industry leader in integrated design solutions that are transforming how the built environment is designed, analyzed and constructed. Our commitment to improved energy efficiency, operability and reduced carbon emissions parallel GPIC’s goals as demonstrated by our recently awarded LEED Platinum Certification for the King Abdullah University of Science & Technology (KAUST) in Saudi Arabia. The KAUST project has the unique distinction of being the world’s largest platinum certified project and larger than all the other platinum certified projects together.

Industry surveys consistently rank HOK among the leading firms in numerous building types, specialties and regions, and the firm has earned many awards and honors for its projects, people and practice. HOK is a global leader in sustainable design and for the second consecutive year in a row, ranks as the greenest design firm on the planet, according to the July 6, 2009, issue of Engineering News-Record (ENR) magazine. HOK is number one as the firm engaged in the most sustainable work.

HOK’s success is rooted in our culture of collaboration and our commitment to improve our built environment and planet. Our collaborations with groups like the Biomimicry Guild have developed innovative building solutions, informed by nature, that improve both our project’s energy profile and carbon footprint.

We see our partnership with GPIC as an extension of work we are already doing with organizations like United Technologies in integrated building solutions. The value we will bring to the Hub is our experience, market expertise and knowledge of the needs of our clientele. Our partnership will help create, test and implement new technologies and processes along with our clients whom we see as potential participants in GPIC’s co-funded opportunities.

Sincerely,

James Berge, AIA, LEEP AP
Principal
26 April 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Re: Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings
E-RIC Partner Letter of Commitment

Dear Dr. Foley:

Horton Lees Brogden Lighting Design (HLB) is pleased to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings. We support the goals of the GPIC for Energy Efficient Buildings to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit which will have impacts beyond the Philadelphia area.

HLB Lighting Design designs quality lighting systems to complement both interior and exterior areas while at the same time providing an integrated system that utilizes daylight and environmentally favorable products. We are advocates for advanced control technologies and can aid in establishing criteria for utilizing smart technology with high quality lighting systems that enable load shedding, task tuning, lumen maintenance and occupancy/photocell controls to enhance performance in indoor and outdoor environments.

The Regional Innovation Cluster will provide ongoing opportunities for organizations to propose and participate in co-funded projects to advance the stated goals, and we look forward to contributing to the Cluster through such co-funded projects. We believe that we can be a part of the design of lighting and daylighting related systems through meetings and workshops as this endeavor is worked and collaborated on. We look forward to discussing specific services once more detail on the project is understood.

Attaining the goal of greatly improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. How this relates to the both the natural and electrical lighted world is very exciting to us. The potential rewards in terms of energy savings are great and possible quality job creation is another interesting aspect. We are pleased to be a partner in this proposal.

Sincerely,

Lee E Brandt, LC, LEED AP
Associate Principal
HLB Lighting Design
Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley,

We are pleased to offer this letter of commitment to participate as a partner in the proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings. Johns Manville strongly supports the goals of this proposed initiative to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region, and beyond.

Johns Manville is part of the Berkshire Hathaway family and a global leader in the manufacture of a wide range of building and construction materials including commercial roofing systems, fiberglass insulation, fiberglass for plastics reinforcement, and filtration media. We are committed to the development and commercialization of new products that will enable improvements in energy efficiency and carbon footprint reduction of both existing and new commercial and residential buildings. We desire to collaborate with other industrial, academic, and government agencies to collectively develop the knowledge required to practically and economically achieve substantial improvements in energy efficiency of buildings. We commit to providing technical resources and expertise to participate in various projects, activities, and exchanges. These resources would also participate and assist in the organization of meetings, workshops, seminars, and educational activities to foster communication and interaction between partners. In addition, we are willing to supply a variety of building materials for the purposes of testing and modeling as well as offer the use of our extensive testing facilities and analytical tools. Johns Manville has a history of collaboration with the Penn State University Materials Science Department and have funded numerous graduate and post-doctorate research projects over the past 15 years. We are interested in continuing to sponsor such research projects that support the goals of the Innovation Cluster.

We understand that the GPIC will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals, and we look forward to contributing to the Cluster through such co-funded projects.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. We are extremely pleased to be a partner in this undertaking.

Sincerely,

John B. Smith, P.E.
Johns Manville
Global Platform Leader
Environmental Construction
john.smith@jm.com
303-978-2686
Greater Philadelphia Innovation Cluster for Energy Efficient Buildings  
E-RIC Letter of Interest

May 3, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802  

Dear Dr. Foley:

We are pleased to offer our support for the proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings are to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region, and beyond.

Lafarge North America Inc., a Lafarge Group company, is the largest diversified supplier of construction materials in the United States and Canada with top-ranking positions in all of its businesses: Cement, Aggregates & Concrete and Gypsum. With the world’s leading building materials research facility, the Lafarge Group places innovation at the heart of its priorities, working for sustainable construction and architectural creativity.

Lafarge has already demonstrated it’s commitment to energy efficient builds as co-chair of the World Business Council for Sustainable Development, Energy Efficiency in Buildings project. Although we are not able to make a financial commitment at this time, we understand that the GPIC will give an opportunity to advance the vision and we are interested in participating in workshops / meetings to this end.

Sincerely;

Kevin Cail  
Director, Sustainability and Commercial Innovation

Lafarge North America Inc.  
12950 Worldgate Drive, Suite 500, Herndon, VA  20170  
Office: (703) 480-3600  Fax: (703) 480-3899  
Web: www.lafargenorthamerica.com
23 April 2010

Henry C. Foley, Ph.D
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

Lam Partners is pleased to submit this letter of commitment to become a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, to be located at the Clean Energy Campus at the Navy Yard in Philadelphia.

Lam Partners is a premier architectural lighting design firm, working on projects across the nation and internationally. We specialize in designing electric and daylighting systems for major institutional, governmental and commercial projects that aggressively lower lighting energy use, while providing high-quality environments for work, study and recreation.

We’re inspired by the goals of Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings to develop technology and techniques for the improvement of energy efficiency and reduction of carbon emissions of existing buildings. The Regional Innovation Cluster will provide opportunities for organizations like ours to propose and participate in projects, and we are excited by the possibility of being able to contribute to the Cluster through these projects. Our contribution will be our “real world” understanding of what it means to provide high-quality lighting, and our recognition of what technical solutions and procedures would be practical and effective.

The goal of significantly increased energy efficiency in both new and retrofit buildings demands not only new technologies, but new design and construction practices. But the rewards in energy savings, environmental protection, and job creation will be great. We look forward to beginning this partnership with you.

Sincerely,

Glenn Heinmiller, IALD, LEED AP, LC
May 3, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Re: Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings
E-RIC Partner Letter of Commitment

We are proud to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia. The goals of the GPIC for Energy Efficient Buildings are to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region, and beyond.

The Linc Group represents many aspects of the technical service and energy retrofit industry for the existing building market. Our business units consist of trade-specific skill sets for the commercial/industrial markets through Linc Lighting & Electrical and Linc Service (HVAC), as well as general building engineering and maintenance staffing through our Linc Facility Services business. Additionally, we are committed to bring energy efficiency to the residential market with our Green Homes America operation.

The Linc Group (TLG) is committed to creating quality jobs for skilled technicians, and our participation in the E-RIC supports this mission. TLG will be interested in participating with leadership resources to ensure that the energy efficiency technologies that are being developed can be successfully installed in the field and maintained throughout the life of the building; thus realizing the energy savings potential. We plan to be an active participant at workforce development, educational activities, and other events that can develop a highly trained workforce.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. We are extremely pleased to be a partner with you in this undertaking.

Sincerely,

Andrew Beggs, P.E.
Vice President/General Manager
The Linc Group / Linc Lighting & Electrical

A Linc Group Company

152 Technology Drive · Irvine, California 92618 · (877) 546-2463 · (949) 888-2340 · Fax (949) 888-2350
LINCLIGHTINGELECTRICAL.COM · LICENSE NUMBER 479677
April 23, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley:

On behalf of PECO, I am pleased to provide this letter of support for the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings (E-RIC), headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

PECO strongly supports the goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings:

- improving the energy efficiency and operability of existing buildings
- reducing the carbon footprint of existing buildings; and
- stimulating private investment and creating jobs in the energy efficient building retrofit market

PECO, project sponsors, and the regional partners supporting this application are working collaboratively on a broad range of measures to make the Philadelphia region a global leader in energy efficiency and advanced energy technologies. The Regional Innovation Cluster proposal will advance this goal, while promoting technology and policy research, development, demonstration, deployment, education and workforce development. We look forward to working with the project sponsors to identify ongoing opportunities to advance the stated goals of the E-RIC project in coordination with PECO's energy efficiency and smart grid initiatives.

The E-RIC project represents an innovative and comprehensive approach to improving energy efficiency in both new and retrofit buildings, encompassing technology, public policy, human behavior, commercial, consumer education and workforce elements. PECO strongly supports this application and hopes you will consider it favorably.

Sincerely,

[Signature]

Romulo L. Diaz, Jr.  
Vice President,  
Governmental and External Affairs  
PECO Energy Company  
2301 Market Street, Suite 200  
Philadelphia, PA 19103
Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802  

Dear Dr. Foley:  

Pfizer is pleased to provide this letter of commitment to explore ways in which we can participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia. We are aligned with the goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings to improve energy efficiency, operability and reduce carbon emissions of existing buildings.  

Pfizer is a worldwide biopharmaceutical company committed to applying science and our global resources to improving health and well-being at every stage of life. As part of this commitment, we seek to be a leader in advancing responsible energy use and environmental stewardship, doing our part to address the challenge of global climate change.  

We envision the Greater Philadelphia Regional Innovation Cluster program as an ideal platform to join with like-minded enthusiasts to advance knowledge and understanding in this area and to apply experience gained to our own investment and operational decisions. Pfizer is eager to have our colleagues participate in the development of the program and, in turn, engage the E-RIC members on a consultative basis for our own deployments based on what will be learned. As a member of the US Green Building Council, Pfizer is also interested to explore extension of LEED guidelines into operational parameters and we see initiatives such as this contributing to that outcome.  

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require coordinated changes in technologies, public policies, human behavior, business models, education and workforce development. We believe that the Regional Innovation Cluster will provide continuing opportunities for Pfizer to propose and participate in projects to advance the stated goals, and we look forward to contributing to the Cluster through such projects.
Sincerely,

[Signature]

Rob Gergen
Director, Capital Management
Pfizer Global Engineering
robert.gergen@pfizer.com
484 865-9963
Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings E-RIC Partner Letter of Commitment

April 26, 2010

Dr. Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

Please accept this letter as Pittsburgh Corning’s commitment to participate as a partner in the proposed Greater Philadelphia Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia. Pittsburgh Corning fully supports the goals of the GPIC for Energy Efficient Buildings to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region, and beyond.

Pittsburgh Corning Corporation was founded in 1937 by equity affiliates Pittsburgh Plate Glass and Corning Glass Works and is headquartered in Pittsburgh, Pennsylvania USA. Pittsburgh Corning is a world leader in innovative architectural glass block systems design. However, in the past 60 plus years, Pittsburgh Corning’s high performance FOAMGLAS® insulation has offered solutions in industry and commercial building environments. Pittsburgh Corning fills very strongly concerning the goals of the GPIC and will attend as many meetings and workshops as possible. We look forward in participating in or helping to organize workforce development and educational activities. Pittsburgh Corning would also be receptive to agreeing to a 1:1 match if a Pittsburgh Corning proposed program was chosen regarding innovative research or product demonstration projects for funding consideration.

In an age where the quality of life and the survival of our planet are causing more and more public concern, Pittsburgh Corning wishes to contribute to achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. Pittsburgh Corning looks forward to be a partner in this undertaking.

Sincerely,

Axel Rebel
Pittsburgh Corning Corporation
Vice President & General Manager
North American Building Division
April 28, 2010

Dr. Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, Pennsylvania 16802


Dear Dr. Foley:

This letter expresses PJM Interconnection’s support for the proposed Philadelphia Regional Innovation Cluster for Energy Efficient Buildings that would be headquartered at the Clean Energy Campus at the Philadelphia Navy Yard. Your diversified team of prominent government, industry, and educational partners, along with leadership from Penn State, will create an effective team working together on research, development, demonstration, and deployment to accelerate the retrofit of existing commercial and multi-family residential buildings with energy efficient technologies.

PJM greatly supports energy efficiency efforts, as revealed by their inclusion into our Reliability Pricing Model (RPM) capacity auctions, starting in 2009 for delivery year 2012-13. PJM’s RPM auction is designed to ensure that sufficient capacity resources are available to meet electric demand, and the inclusion of energy efficiency projects into the auction entitles successfully cleared resources to a significant four-year revenue stream proportional to the amount of energy saved. Additionally, PJM is developing with our states and members a program of Price Responsive Demand (PRD) that will facilitate the connection of the wholesale electricity market data (including real-time prices), to retail electricity customers through the deployment Advanced Metering Infrastructure (AMI). This will enable customers to curtail or eliminate electricity usage in times of high demand and high prices.

PJM believes that we could be a valuable partner for a Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, and we look forward to working with Penn State and its numerous partners should your proposal be funded.

Sincerely,

[Terry Boston Signature]
April 21, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

We are pleased to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia. The goals of the Greater Philadelphia Regional Innovation Cluster are to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region.

As a leading green urban solutions provider, Jonathan Rose Companies is excited to be a part of this important opportunity to examine and provide further innovations in buildings’ energy efficiency. Jonathan Rose Companies is a mission-based, green real estate policy, planning, development, and investment firm. We currently manage over $1.5 billion of work, much of it in close collaboration with not-for-profits, institutions, and governmental sectors. We believe that our expertise and expertise in buildings, neighborhoods, cities, regions and the infrastructure systems make us an important partner.

As part of this endeavor, Jonathan Rose Companies proposes to explore the barriers to greening existing commercial and residential buildings in the Greater Philadelphia Region. We will examine each of the key steps in the green building retrofit process to determine how to optimize participation in these programs. We are particularly interested in the program design of each step to ensure maximum participation and reduce resistance at the individual and institutional levels.

We understand that the Regional Innovation Cluster will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals, and we look forward to contributing to the Cluster through such co-funded projects. As a partner to E-RIC, we would also be available to attend key meetings and workshops, and participate in workforce development and educational activities, as well as industry-sponsored seminars and conferences.

Achieving the vision of improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. We thank you for this opportunity to participate in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings project. Please do not hesitate to contact me directly with any questions.

Sincerely,

Jonathan F.P. Rose
President
Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings
E-RIC Partner Letter of Commitment

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

Sauer Incorporated is pleased to provide this letter of commitment to actively participate as an industry partner in the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia. The strong goals for Energy Efficient Buildings set forth by the GPIC to improve energy efficiency, operability and reduce the carbon emissions of existing buildings are greatly needed. Through achieving these goals, the efforts of the GPIC will create quality jobs in the building energy efficiency and retrofit markets throughout the industry in the Greater Philadelphia region, the Mid-Atlantic region and beyond along with stimulating private investment into projects which aim to achieve this mission. The objectives of this partnership will benefit the construction industry and the built environment of the United States.

Since 1876, Sauer Incorporated has been providing professional construction services that deliver superior performance while exceeding our customers’ expectations. We continue this tradition today by developing and efficiently implementing cost-effective, innovative solutions. We bring our strong belief in developing long-term relationships, and a true understanding of the importance of construction planning and implementation to every project. Sauer is a nationally-based company with Branch and Satellite offices throughout the Mid-Atlantic, Southeastern and Southwestern United States. Sauer is committed to achieving the goals set by the GPIC through attending meetings, workshops, participating in workforce development and other educational activities which strive to create more Energy Efficient new and retrofit buildings.

Sauer Inc. currently performs extensive building construction for the Federal Government, specifically the Department of Defense. Most of these projects are Design-Build, thereby allowing Sauer extensive latitude for incorporating design enhancements. By participating in the GPIC program, Sauer will be able to directly apply vast energy-related technologies that would ultimately benefit the Federal Government. This program will improve the quality of life and the future of the environment in which we all live.

Achieving the goals of the GPIC will result in dramatic improvements in the energy efficiency of new and retrofit buildings. To realize these goals there is a requirement for the advancement of technologies, change to public policies, human behavior, business models, education and workforce development. The rewards of implementing a program with these goals will be staggering in terms of energy savings, environmental protection, and quality job creation. Sauer Incorporated is honored to be a partner in this necessary undertaking for the future of the Construction Industry and the built environment.

[Signature]
Greg Zechman, President
Sauer Incorporated
Letter of Commitment for the
Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

We are delighted to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goal of focusing on existing buildings to improve energy efficiency, operability, and reduce carbon emissions is completely consistent with the mission of Schneider Electric. We strongly believe that applied research and demonstration projects in this area will accelerate private investment and job creation in the building energy efficiency retrofit markets.

Schneider Electric is a $25B specialist in energy management providing integrated solutions for commercial and residential buildings, data centers, and industry around the world. We are focused innovative solutions to make energy safe, reliable, efficient, productive and green. We believe that innovation around Active EE, the automated lifecycle management of energy, in our existing building stock will be critical to solving our energy dilemma.

We commit to naming a Project Director at the time the program is initiated. In addition we are interested in participating in any Industrial Advisory Board that you might create.

We also look forward to participating and contributing to ongoing opportunities for co-funded projects on a 1:1 in-kind cost match basis. For these projects we will provide expert staff and access to building management equipment and resources necessary for the project. Of immediate interest is the creation a Smart Virtual Power Community, the virtualization of energy management for a community of commercial office buildings. We are prepared to estimate, launch and demonstrate this project with our real estate partners at the launch of your program.

Improved energy efficiency in new and retrofit buildings will require a strong collaboration with business, academia, and government. The rewards for accelerated development of energy management business are enormous. We are extremely pleased with this initiative and we look forward to being a partner in this undertaking.

Paul Hamilton, Sr. Vice President Energy Efficiency Programs
Schneider Electric North America

“Make the most of your energy”.
April 26, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley:

We are delighted to provide this letter of support to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

Located in Princeton, New Jersey, Siemens Corporate Research (SCR) is one of several world-class central research and development labs within Siemens Corporate Technology. Our hundreds of research scientists and software engineers provide technological solutions to the global family of Siemens’ businesses. We also work closely with Siemens’ customers, government agencies, universities, and other organizations. Siemens sets the standards for maximum efficiency and seamless integration in buildings. Our industry-leading solutions, services, products and technologies optimize life-cycle performance for buildings to maximize energy savings, optimize performance and enhance sustainability without compromising comfort and safety. Our belief is that the key to driving real value for our customers is in focusing on the entire building life cycle, beginning from the design and build stage, through the operation and maintenance cycle, to the renewal and revitalization phases.

SCR sees a high-degree of mutual interest in the seven thrusts you have defined, and would propose collaborative efforts to include:

- Building information systems including building information modeling and science based simulation for sustainable lifecycle design, engineering, operation and maintenance
- Integration of smart building in smart grid including the orchestration of the diverse automation systems within a facility for demand response in order to achieve higher demand peak reduction and energy efficiency
- Strategic planning, test-bed design and prototype development
- Virtual World technology for workforce training & development

We look forward to the opportunity of working with your team and the federal government on this important effort to develop a regional innovation cluster to develop and demonstrate sustainable and efficient models for attaining national strategic objectives.

Silvano Dall’asta  
Chief Financial Officer
April 22, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

RE: Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings

Dear Dr. Foley:

We are pleased to provide this letter of commitment to participate as a partner in the planned Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings (E-RIC), headquartered at the Navy Yard in Philadelphia.

The goals of the Greater Philadelphia E-RIC are to improve energy efficiency and operability of existing commercial and multi-family residential buildings of average size, thus reducing carbon emissions from the existing building stock and at the same time stimulating private investment and quality job creation related to building energy efficiency retrofits.

Thornton Tomasetti is an international engineering/architectural firm with decades of experience in the design and construction of new buildings and the evaluation, alteration, upgrade, adaptive reuse of existing buildings of all vintages, construction types, sizes and uses. As such, we have the expertise to devise holistic sustainability / energy efficiency strategies and high-performance building envelope solutions for existing and new structures. We are committed to use our knowledge and resources to contribute to the realization of a more sustainable model of the built environment.

Reading through the “seven thrusts” of the planned HUB convinced us that our expertise and familiarity with all aspects of building design, construction and operation will be of value for the E-RICs R&D programs and test-bed sites. We understand that the E-RIC will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals, and we look forward to contributing to the Cluster through such co-funded projects.

The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. We would be very pleased to be a partner in this worthy undertaking.

Very truly yours,

THORNTON TOMASETTI, INC.

[Signature]

Wolfgang Werner, AIA, LEED AP BD+C  
Director of Sustainability
May 3, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

URS is delighted to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

URS supports the goals of the GPIC to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region, and beyond.

URS Corporation is a leading provider of engineering, construction and technical services for public agencies and private sector companies around the world. The Company offers a full range of program management; planning, design and engineering; systems engineering and technical assistance; construction and construction management; operations and maintenance; and decommissioning and closure services for power, infrastructure, industrial and commercial, and federal projects and programs. For the GPIC, URS will collaborate with researchers regarding industry’s energy efficiency needs and objectives and provide consultation services from energy efficiency experts.

We understand that the GPIC will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals, and we look forward to contributing to the Cluster through such co-funded projects.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. We are extremely pleased to be a partner in this undertaking.

Dr. Terri L. Marts
Program Manager
April 27, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

We are delighted to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings are to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region, and beyond.

Viridity Energy, Inc. provides large energy consumers with tools to increase energy efficiency and create energy revenues through a software platform that enables customers to dynamically shift and balance energy load, integrate advanced energy technologies and convert existing energy investments into lucrative new revenue streams. Headquartered in Conshohocken, Pennsylvania, Viridity was founded in 2008 by former executives of PJM Interconnection. In 2009 Viridity partnered with Drexel to develop a Microgrid which was a key component of PECO’s awarded $200 million Smart Grid Stimulus grant. We are committed to transferring the intellectual capital and lessons learned from this project as well as others to help inform the E-RIC collaboration and contribute to the pursuit of innovation and best practices in discovering energy savings from buildings. We will be active participants in meetings, workshops, conferences, workforce development and educational efforts as well as contribute and participate in E-RIC sponsored research projects and opportunities. The GPIC will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals, and we look forward to contributing to the Cluster through such co-funded projects.
Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. We are extremely pleased to be a partner in this undertaking.

Best regards,

Viridity Energy, Inc.

Audrey Zibelman
President and CEO
Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings
Draft E-RIC Partner Letter of Commitment

April 22, 2010
Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

We are delighted to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings are to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region, and beyond.

Specifically what has our firm energized regarding this effort is the Integrated Design, Construction, Commissioning and Operation thrust. WMF is a regional pioneer in design lead integrated project delivery. Almost 30 years ago we began providing design lead IPD and our portfolio of work represents a number of projects that have been completed successfully. With the advances in Building Information Modeling (BIM) we believe that IPD will gain favor in the marketplace akin to the days of the “Master Builder. We would love to collaborate in a research study comparing two parallel pilot projects 1) traditional design-bid-build with 2) integrated project delivery analyzing various metrics such as cost, schedule, quality, customer satisfaction. We also believe that advances in tools of our trade such as BIM and real time on-line collaboration will allow integrated design teams to focus on energy saving solutions as these technologies are enhanced and new technologies are brought online.

We understand that the Regional Innovation Cluster will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals, and we look forward to contributing to the Cluster through such co-funded projects.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. We are extremely pleased to be a partner in this undertaking.

Respectfully,

Charles P. Haynes
Principal
Weber Murphy Fox
April 21, 2010

Mr. Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Mr. Foley:

AIA Philadelphia, the regional professional association of architects, is pleased to be a partner in the creation of the Greater Philadelphia Regional Cluster for Energy Efficient Buildings. With over 1700 professional and business members AIA Philadelphia has been active in advancing the sustainability of design and construction methods among our members and in the public realm. The Center for Architecture located at 1218 Arch St, an affiliate of AIA Philadelphia, has staged exhibitions, hosted product demonstrations and seminars that teach and inform professional and lay practitioners about more sustainable products and practices. It is our intention to continue these initiatives to reach important goals of building sustainability and creating more energy independence for our nation.

AIA Philadelphia will be pleased to coordinate its ongoing program and contribute to the work of the Regional Innovation Cluster. Through the architectural, engineering and construction professions we hold the potential to quickly advance the goals and deployment of both technical innovation and intellectual capital produced by the Cluster.

We are pleased to be a partner in the important environmental and technical undertaking.

Sincerely,

John P. Claypool, AIA  
Executive Director

1218 Arch Street  
Philadelphia, Pennsylvania 19107  
Chapter Tel. 215.569.3186  
Chapter Fax 215.569.9226  
Web Site www.aiaphiladelphia.org

1-117  Bookstore Tel. 215.569.3188  
Bookstore Fax 215.569.4952
April 29th, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

We are delighted to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings.

The goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings are aligned entirely with the mission of the Alliance to Save Energy (the Alliance). Founded in 1977, the Alliance is a nonprofit coalition of prominent business, government, environmental and consumer leaders who promote the efficient and clean use of energy worldwide to benefit the environment, the economy and national security.

For over 30 years, the Alliance has worked collaboratively with industry, utilities, financial institutions, government entities, individuals, corporations, foundations and communities to make the benefits of energy efficiency better understood and practiced in the United States and around the world. In particular, the Alliance works in close partnership with more than 170 Associates – corporations, business trade associations, state energy offices, federal energy research labs, nonprofits and other entities. We also deliver award winning workforce training and employment programs focused on energy efficiency and the emerging green workforce.

The Alliance looks forward to bringing our expertise and program experience in energy efficiency to this initiative. We likewise look forward to working with the other initiative partners and to introducing the work of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings to our Alliance Associates.

We are extremely pleased to be a partner in this undertaking.

Yours Sincerely,

Gail Hendrickson
Executive Vice President
May 4, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley:

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) is a membership technical and educational society in support of the arts and sciences of heating, ventilating, and air conditioning technologies. A key element of our mission is to foster energy conservation and efficiency in buildings. We have a long history of developing building energy design standards, handbooks, and advanced guidance documents, courses, and other educational materials that are widely and credibly used in the buildings industry. Therefore we are keenly interested in supporting the establishment of an Energy-Research Innovation Cluster and believe we are uniquely qualified to be included in an E-RIC, or to collaborate with the consortium as an E-RIC Partner to develop and expand the E-RIC’s influence. We stand ready to support the application of any and all qualified organization(s) that have invited us to participate.

In the event that you are successful we are pleased to support the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia, and headed by Penn State University. We share the goals of this collaboration, which are to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region, and beyond.

Many ASHRAE members from your institution and its Hub partners have been engaged in ASHRAE for over 30 years, chairing meetings and committees, contributing to ASHRAE Handbooks, participating in conferences, writing articles and papers for the ASHRAE Journal, ASHRAE Transactions, and webinars, as well as participating in training and education programs. The proposed hub would collaborate with ASHRAE to

- Ensure that new technologies and practices are incorporated into ASHRAE Standards 90.1, 90.2, and others
- Provide high performance building data from its regional sample of buildings for multiple ASHRAE building performance monitoring projects
- Advance ASHRAE’s Building Energy Quotient commercial building energy labeling program.
ASHRAE has more than 50,000 members worldwide and has a strong and continuing interest in promoting building energy efficiency. Our headquarters is in Atlanta, Georgia with a small office in Washington, D.C. We are strongly interested in supporting the E-RIC program as we share the common goal of advancing the design, construction, commissioning, operation, and maintenance of energy efficient buildings. ASHRAE looks forward to the establishment of the E-RIC and is committed to supporting the many E-RIC programs that will align with ASHRAE’s mission.

Sincerely,

[Signature]

Gordon Holness, President

/gfc

Cc: William P. Bahnfleth, Penn State
    Larry C. Burton, Penn State
April 28, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

The Center for Environmental Innovation in Roofing (Center) is pleased to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings - improving energy efficiency of existing buildings and stimulating private investment and creation of high quality jobs in energy efficiency retrofit markets in the Mid-Atlantic region – are wholly consistent with my organization’s mission.

The Center is a not-for-profit 501 (c)(6) organization, headquartered in Washington, D.C., whose mission is to serve as a forum for the promotion of the roofing knowledge base, development and use of environmentally responsible, high performance roof systems. Combining the resources of manufacturers, contractors, design professionals, academics and other stakeholders, the Center’s uses the strength of one collective industry voice to foster the growth of the high performance roof industry.

We understand the Cluster will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals, and we look forward to contributing to the Cluster through such co-funded projects. Our focus on providing trusted research and best practices information to better understand, define and communicate technical challenges and opportunities should prove invaluable to the success of this endeavor. Further, the Center has spent the last year developing an environmental rating system for the selection of roof systems that maximize energy efficiency and minimize environmental impact – this new assessment tool would fit seamlessly with the Cluster’s objectives.

The Center is extremely pleased to be a partner in the Greater Philadelphia Regional Innovation Cluster. If I can provide any additional information, please be sure to let me know.

Sincerely,

Craig Silvertooth
Executive Director
April 21, 2010

Dr. Henry C. Foley  
Vice President for Research  
The Pennsylvania University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley:

On behalf of the CEO Council for Growth (CEO Council), a group of more than 60 prominent business and civic leaders in southeastern Pennsylvania, southern New Jersey and northern Delaware, I am writing in support of the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings located at the Clean Energy Campus at the Navy Yard in Philadelphia.

The CEO Council recommends and advocates policy initiatives, and conducts programs to enhance the competitiveness and marketability of the Greater Philadelphia region. The CEO Council’s agenda includes aggressive economy building measures, assuring a steady and talented supply of quality workers, as well as advocating for increased resources for research, proof of concept, early stage funding and new venture formation.

We are extremely pleased to be included as a partner in this effort and look forward to working with the Regional Innovation Cluster on ways to stimulate high quality jobs and private investment.

Sincerely,

[Signature]

Rob Wonderling  
Chairman, CEO Council for Growth

c: RoseAnn B. Rosenthal, President and CEO  
Ben Franklin Technology Partners of Southeastern Pennsylvania
Dear Dr. Foley,

The Chamber of Commerce Southern New Jersey is pleased to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Philadelphia Navy Yard.

Our organization is the largest Chamber in South Jersey, representing 1,700 member companies that employ 325,000 people. Our mission is to provide our members with: opportunities to meet each other and do business; resources to enhance their position in the marketplace; and a collective voice on public policy affecting operations and profitability. We are delighted to be included with the Regional Innovation Cluster and its redevelopment efforts making the Navy Yard and Greater Philadelphia area a national hub for clean energy research, education, and commercialization.

The Regional Innovation Cluster’s goals of improving energy efficiency, operability and reducing carbon emissions in existing buildings coupled with its endeavor to stimulate private investment and quality job creation in energy efficient markets is something we strongly support. We are looking forward to providing leadership, participating in education and workforce development, as well as contributing to policy research and business models.

We understand that the Regional Innovation Cluster will provide opportunities for organizations like ours to propose and participate in projects to advance in the domain of energy efficiency in both newly erected and retrofitted buildings. The prospective gain in energy savings, protection for the environment, and job creation make participating in this Cluster an exceedingly rewarding partnership. Thank you for your time. We look forward to working with you.

Sincerely,

[Signature]

Debra P. DiLorenzo
President & CEO

April 23, 2010
April 26, 2010

Henry C. Foley
Vice President for Research
Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

We wholeheartedly support the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings to be headquartered at the Clean Energy Campus at the Philadelphia Navy Yard.

The Cleantech Alliance Mid-Atlantic (CAMA) is the premier cleantech business network in the region. Our mission is to connect, support, and grow clean and alternative energy technology business opportunities in the Mid-Atlantic region. We feel the Greater Philadelphia Regional Innovation Cluster is an important step in solidifying the region's position as a hub for green business activity.

As the Philadelphia Business Journal recently reported, "Geographically, Philadelphia is located between Washington, D.C., where energy policy gets made, and New York City, where it gets financed...one of the most densely populated, and therefore largest power-consuming areas, in the country. That adds up to a lot of potential buyers for energy-efficiency technology, from construction materials to demand-management software, and for clean energy, as the area’s businesses, universities, government agencies and building owners look to reduce their carbon footprints."

The Regional Innovation Cluster will complement and enhance the region's significant energy assets and existing infrastructure, and will generate new jobs – some of which can be fed by the city's new John S. and James L. Knight Green Jobs Training Center.

The Cleantech Alliance Mid-Atlantic commits to partnering with the Regional Innovation Cluster and to participate in and provide leadership and expertise to achieve its mission.

We value the opportunity this Regional Innovation Cluster brings to Greater Philadelphia and the Mid-Atlantic region more broadly. The Cluster will also benefit the goals of our organization and its participating members as it solidifies the region as a hub of clean tech, alternative energy, and energy efficiency activities. Finally, the Cluster will provide a much-needed boost to a region that is poised to build on its strengths for the future.

Sincerely,

Scott Edward Anderson
Kevin P. Brown

Co-Founders, Cleantech Alliance Mid-Atlantic (CAMA)
Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings
E-RIC Partner Letter of Commitment

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley,

On behalf of the Delaware Valley Green Building Council, I am pleased to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The Delaware Valley Green Building Council is a chapter of the US Green Building Council, with a membership of over 1,000 individuals and companies. Our territory covers eastern Pennsylvania and the state of Delaware. Our members include the founders of the high performing building movement locally and nationally and are leading practitioners in all aspects of the green building industry. For this project, DVGBC can provide technical assistance where needed for building and sustainable site planning, development and operations. We can also provide education and outreach to our membership, our 10,000-member electronic mailing list, and through our relationships with companies, governments and non-profit organizations throughout the region.

The goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings are consistent with those of our organization: to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets. In a region in which most of the buildings that will be around in 30 years have already been built, there could be no more important target for these investments.

We are excited that the Regional Innovation Cluster will provide ongoing opportunities for DVGBC to propose and participate in co-funded projects to advance the program, and we look forward to supporting the effort through such projects.

With my best regards,

Janet Milkman
Executive Director

Janet Milkman
April 21, 2010

Dr. Henry C. Foley
Vice President for Research
The Pennsylvania University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

The Greater Philadelphia Chamber of Commerce is dedicated to promoting growth and economic development through initiatives that support a competitive business climate throughout the tri-state region. We believe that the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings will stimulate entrepreneurial and venture capital investment as well as attract and retain employers and jobs in Greater Philadelphia.

We fully support the goals of the Regional Innovation Cluster to improve energy efficiency and operability, reduce carbon emissions of existing buildings, and stimulate private investment and job growth in building energy efficient markets in the Greater Philadelphia region.

As such, we are delighted to provide this letter of commitment to participate as a partner in the proposed Regional Innovation Cluster.

Sincerely,

David L. Cohen
Chairman, Greater Philadelphia Chamber of Commerce

c: RoseAnn B. Rosenthal, President and CEO
Ben Franklin Technology Partners of Southeastern Pennsylvania
April 20, 2010

Evan R. Gaddis  
President and Chief Executive Officer

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley,

NEMA is writing to express support and our commitment to collaborate with the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia, on the Energy Efficient Building Systems Energy Regional Innovation Cluster (E-RIC).

NEMA is the association of electrical and medical imaging equipment manufacturers. Founded in 1926 and headquartered near Washington, D.C., its approximately 450 member companies manufacture products used in the generation, transmission and distribution, control, and end use of electricity. These products are used in utility, industrial, commercial, institutional, and residential applications. The association’s Medical Imaging & Technology Alliance (MITA) Division represents manufacturers of cutting-edge medical diagnostic imaging equipment including MRI, CT, x-ray, and ultrasound products. In addition to its headquarters in Rosslyn, Virginia, NEMA also has offices in Beijing and Mexico City.

NEMA has a long standing program in the area of high performance buildings through its High Performance Building Council (HPBC). Our organization and our members can lend themselves well to the goals of the E-RIC project. To learn more about us please visit our website at www.nema.org

We are confident that your consortium is uniquely poised to spur substantial growth in new technology, business and employment opportunities. It will also provide a new pool of skilled workers and professionals linked in partnership with the nation’s first E-RIC focused on energy efficient buildings. We are pleased to pledge our support and desire to collaborate in this bold initiative. Please contact (Jim Lewis, NEMA’s Manager High Performance Buildings at 703-841-3244 or at Jim.Lewis@nema.org if you have any questions or if we can be of assistance.

Respectfully,

Evan R. Gaddis  
President & CEO

National Electrical Manufacturers Association  
www.nema.org

1300 North 17th Street, Suite 1752  
Rosslyn, VA 22209  
703. 841.3210  
Fax 703.841.3310  
evan_gaddis@nema.org
April 16, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley:

We are delighted to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings are to improve energy efficiency and operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond. NJTC is extremely pleased to be included as a partner in this activity and we look forward to helping to provide leadership to the activities of Regional Innovation Cluster, and to directly participating in concurrent technology and policy research, development, demonstration, and deployment, education and workforce development, and other activities. We understand that the Regional Innovation Cluster will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals and we look forward to contributing to the Cluster through such co-funded projects.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. We are extremely pleased to be a partner in this undertaking.

The New Jersey Technology Council is a private, not-for-profit member organization which provides business support, networking opportunities, information, advocacy and recognition. The Council represents all technology sectors including companies in the Environment/Energy space. Our membership (approx. 1,000) spans technology companies from Massachusetts to Virginia, the majority located in New Jersey and Pennsylvania. We support regional activities which create greater opportunity and support our mission to foster a vibrant entrepreneurial spirit and nurture a community where great ideas take flight.

Thank you.

Very truly yours,

Maxine Ballen  
Founder, President & CEO
April 26, 2010

Dear Dr. Foley:

We are happy to submit this letter of commitment to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia. The Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings aims to improve energy efficiency of existing buildings, reduce carbon emissions, stimulate private investment and create good jobs in the energy efficiency sector. The Sustainable Business Network of Greater Philadelphia is pleased to be part of this project.

The Sustainable Business Network of Greater Philadelphia (SBN) is a business organization that brings together local leaders who share a common passion to grow successful businesses that are socially and environmentally responsible. SBN works with businesses from startups to older companies who want to create or maintain organizations that respect their employees, value the community and protect the earth. Over 530 local businesses are current members of SBN.

As the convener of Philadelphia’s Green Economy Task Force, SBN has played an integral role in the development of the region’s network of green job training programs. The Green Economy Task Force is a coalition of green businesses, organized labor, education and training institutions, environmental policy groups, government, and community organizations. Now more than 650 stakeholders strong, the Task Force’s dual mission is to grow green businesses and to expand training opportunities to meet the needs of 21st century employers and the region’s workforce. As this project will have multiple education and training institutions supporting it, SBN and the Green Economy Task Force will conduct bi-annual meetings of these institutions and bi-annual networking events for employers. These quarterly meetings will be essential to the success of the partnership. The meetings will engage the network of training institutions not only for troubleshooting, but to plan collaboratively and improve their responsiveness to both businesses and students.

Sincerely,

Leanne Krueger-Braneky
Executive Director
Dear Dr. Foley:

The World Business Council for Sustainable Development (WBCSD) is delighted to provide this letter of commitment, on behalf of the invitation by United Technologies Corporation (UTC), to assist in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings (GPIC). The stated goals of the GPIC are of high interest to the WBCSD members along with our specific interests in Energy Efficiency in Buildings (EEB).

The WBCSD brings together the CEO’s of 200 leading international companies that share a commitment to the principles of sustainable development via economic growth, ecological balance and social progress. Members are drawn from 36 countries and 22 major industrial sectors. The Council benefits from a global network of 60 national and regional partners. WBCSD members, which have a combined turnover of some US$ 7 trillion and employ more than 15 million people, are committed to market transformation. The EEB is a project of the WBCSD and was co-chaired by UTC and Lafarge. The project’s six principle recommendations to transform the buildings sector are based, in part, on a first-ever techno-economic policy model and data inventory for six of the world’s largest economic regions, including the USA.

The role of the WBCSD/EEB in the GPIC would be first to act as the information link to its members. Additionally, with our different stakeholder networks, we can broaden global reach and reinforce advocacy. We have access to international and national organizations, and access to regional knowledge and thus can support the GPIC in workshops and building knowledge networks. It will also be possible to jointly leverage on-going WBCSD projects in EEB “In Action” and Urban Infrastructure Initiative including its WBCSD Manifesto for EEB implementation, modeling EEB impact, supporting IEA roadmap activities, and urbanization studies.

We understand that the GPIC will provide opportunities to propose and participate in co-funded projects to advance the stated goals, and we look forward to contributing to the GPIC through such projects, both directly co-funded and with in-kind support.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require transformative changes in technologies, public policies, human behavior, business models, education and workforce development. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. The WBCSD is extremely pleased to assist in this undertaking.

Christian Kornevall

Director, World Business Council for Sustainable Development
April 23, 2010

Dr. Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, Pennsylvania 16802

Dear Dr. Foley:

I am writing to convey the support of the World Trade Center of Greater Philadelphia (WTCGP) for the "Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings" proposal. We would be pleased to be a supporting partner for this groundbreaking and promising initiative.

A 501 c (3) non-profit organization, the WTCGP is the leading international trade services organization helping companies in Southeastern Pennsylvania and Southern New Jersey succeed in global markets. We are part of a worldwide network of over 326 world trade centers in 93 countries. Through individual trade counseling and market research programs as well as educational events and conferences, in 2009, we helped some 270 regional companies generate over $81M in incremental exports. We also facilitate commercial exchanges between local companies and international partners seeking to invest in the region. In short, the WTCGP serves as the region's global business resource, fulfilling its broader mission of acting as a catalyst for regional economic growth.

This proposal supports the goals of the Greater Philadelphia Regional Innovation Cluster, headquartered at the Navy Yard in Philadelphia, to become a national model for clean energy research, education, and commercialization. The development and commercialization of energy efficient technologies will support the technological leadership of the region in this sector, thus contributing to national objectives. In this regard, the WTCGP stands ready to work with our Federal, State, and local partners to help advance the global and commercial competitiveness of the many entrepreneurial companies created and sustained by this effort.

The WTCGP is pleased to be considered as a partner in this important initiative.

Sincerely,

[Signature]

Linda Mysiwy Conlin  
President

Serving Southeastern Pennsylvania and Southern New Jersey  
Two Penn Center, 1500 JFK Boulevard, Suite 305  
Philadelphia, PA 19102  
One Port Center, 2 Riverside Drive  
PO Box 1949, Camden, NJ 08101-1949  
T (215) 586-4240  F (215) 636-9026  
www.wtcphila.org  T (856) 968-2057
April 23, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

On behalf of the Workforce Investment Boards of Southeastern Pennsylvania, the Regional Collaborative, which includes Bucks, Chester, Delaware, Montgomery, and Philadelphia Counties, we are very pleased to provide this letter of commitment to participate as partners in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the Greater Philadelphia regional Innovation Cluster for Energy Efficient Buildings are to improve energy efficiency and operability and reduce carbon emissions of existing buildings and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond. We are extremely pleased to be included as partners in this activity and we look forward to helping to provide leadership to the activities of REGIONAL Innovation Cluster, specifically regarding its education and workforce development activities. We commit to aligning existing WIA and other workforce funding with the activities of the Regional Innovation Cluster, to the greatest extent possible. We understand that the Regional Innovation Cluster will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals and we look forward to contributing to the Cluster through such co-funded projects.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, quality job creation and a better prepared and more highly skilled workforce are enormous. We are pleased to be a partner in this undertaking.

Sincerely,

Sallie A. Glickman
CEO
Philadelphia Workforce Investment Board

Patrick Bokovitz
Executive Director
Chester County Workforce Investment Board

Elizabeth Walsh

Francis J. Carey
Executive Director  
Bucks County Workforce Investment Board  

Gerald J. Birkelbach  
Executive Director  
Montgomery County Workforce Investment Board  

Executive Director  
Delaware County Workforce Investment Board
April 27, 2010

Mr. Henry C. Foley, PhD.
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Re: Letter of Support E-RIC
Greater Philadelphia Regional Innovation Cluster
For Energy Efficient Buildings

Dear Dr. Foley:

The Camden County Workforce Investment Board and One-Stop Career Center support this Clean Energy Initiative at the Navy Yard in Philadelphia, PA. Camden County is considered part of the sprawling Delaware Valley and support regional collaborations. The ability to create private sector jobs with sustainable wages is part of our ongoing mission.

I understand that this Regional Innovation Cluster will be providing ongoing opportunities to assist in this job creation. Our One-Stop Career Center can reach out to our underserved communities and assist in diversifying the labor pool in this energy industry cluster.

Improving energy efficiency through research and development is a national priority. We are pleased to be a partner in the formation of a world class cluster in our own backyard.

Should you require additional information, please contact my office.

Sincerely,

Jeffrey S. Swartz
Executive Director
Dear Dr. Foley:

Thank you for the invitation to participate as partner in your exciting initiative. It is a pleasure to provide this letter of support and commitment to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

Your goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings: (i) to improve energy efficiency and operability and reduce carbon emissions of existing buildings; and (ii) to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond, resonate well with our interests and programs at The Franklin Institute.

Our brand new exhibit Electricity and Changing Earth speak directly to some of the points emphasized in your proposal, and as such, we are extremely pleased to be included as a partner in this activity and we look forward to helping to provide leadership within the Regional Innovation Cluster, and to directly participating in concurrent technology and policy research, development, demonstration, and deployment, education and workforce development, and other activities. We understand that the Regional Innovation Cluster will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals and we look forward to contributing to the Cluster through such co-funded projects.

Our mission “to inspire a passion for learning about science and technology” is perhaps most relevant today around issues of energy efficiency and environmental science literacy. This program will undoubtedly provide a richer theoretical appreciation and practical experience and training which ultimately will precipitate in changes in technologies, public policies, human behavior, business models, education and workforce development – all for the betterment of society – and as such, The Franklin Institute supports wholeheartedly.

Sincerely,

Frederic Bertley
April 29, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley:

The Garrison Institute is committed to becoming an E-RIC partner which we understand will include attending meetings and workshops, and carrying out our proposed project.

The Garrison Institute (‘Institute’) is a nonsectarian non-profit organization and retreat center that has three program initiatives focused on Education, Transforming Trauma, and Climate Change Leadership. The Institute provides professional development, with a contemplative approach, in each of these fields. The Climate Change Leadership Program has held seven successful retreats for climate change leaders. Through field development, mapping studies, assessing gaps in knowledge, and bringing people together to see the larger whole, the Institute has become a neutral hub for the growth of knowledge within the multidisciplinary field of climate change.

In 2009, the Garrison Institute developed the Climate, Mind and Behavior (CMB) Project to link behavioral, neuro- and social scientists to professionals working in the areas of climate change policy, regulation and communications, investment, and real estate. In March, the project hosted a successful symposium that brought together behavioral and social scientists, with climate scientists, government officials, investors, communications professionals, and others working in the field of climate change. At the event, working groups developed projects in different areas. Currently, these working groups are carrying out their projects and all symposium participants may join an online CMB community that includes a reference library, links to symposium presentations, and links to relevant organizations.

As an E-RIC partner the Institute will integrate DOE HUB project policy-makers, industry leaders, planners, researchers, businesses, building owners and managers, and non-profit leaders into the CMB project. Through CMB, they will gain access to the behavioral and social sciences that will help them improve the effectiveness of energy efficiency programs and practices in the HUB project area.

We look forward to working with you.

Stephanie Bosco-Ruggiero  
CMB Project Coordinator  
The Garrison Institute
Greater Philadelphia Regional Compact for STEM Education

Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings
E-RIC Partner Letter of Commitment

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

What an outstanding opportunity has been presented by the Energy Efficient Building Systems Regional Innovation Cluster Initiative! Please accept our thanks for taking the lead in organizing a response to this Funding Opportunity Announcement in the form of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings (GPRIC), and please know that our group fully supports this project in all its scope and dimension.

The project is a natural to capitalize on and leverage the great momentum of the Clean Energy Campus at the Navy Yard in Philadelphia and on the substantial multi-dimensional work underway through partnerships with economic development organizations, the Navy and institutions of higher education.

The goals of the GPRIC are laudable and achievable and have long-term implications for Greater Philadelphia and the larger mid-Atlantic region. The large envelope of Energy Efficient Building Systems is a perfect fit for a region with the educational enterprise we are so fortunate to have and will create multiple opportunities among the various systems that comprise a regional innovation system.

The collaboration required for this kind of project has precedent in the Regional Compact. We look forward to contributing to the GPRIC and helping the partners realize a vision that benefits all citizens and contributes to wealth creation and an improved quality of life.

Utilizing research, collaboration, and communication, The Greater Philadelphia Regional Compact for Science, Technology, Engineering, and Mathematics Education represents a commitment among institutions and organizations to empower the Greater Philadelphia tri-state region's capacity to develop a talented, robust, and eclectic science, technology, engineering, and mathematics (STEM) oriented workforce that is capable of performing, adapting, and thriving in a dynamic, knowledge-driven economy. Over 100 institutions and organizations have signed on to the Compact.
As members of the Regional Compact Steering Group we are extremely pleased to offer this letter of support and look forward to working with the GPRIC members on this important undertaking.

Sincerely,

Joseph Bordogna  
Alfred Filter Moore Professor of Engineering  
University of Pennsylvania

Gary Cooper  
Former Superintendent, Radnor School District  
Math Science Partnership of Greater Philadelphia

Mark Curchack  
Associate Vice President for Planning and Assessment  
Arcadia University

Frederic Bertley  
Director, Center for Innovation in Science Learning  
Franklin Institute

Carol Fixman  
Executive Director  
Philadelphia Education Fund

Anthony J. Girifalco  
Executive Vice President  
DVIRC
Greater Philadelphia Regional Compact for STEM Education

Claire Greenwood  
Director, Policy Development  
Select Greater Philadelphia

Jamie Bracey  
Assistant Director of Training  
Temple University Center for Intergenerational Learning

Don McKinney  
Program Coordinator  
Philadelphia Education Fund Math + Science Coalition

F. Joseph Merlino  
President and CEO  
The 21st Century Partnership for STEM Education

Chad Womack  
Founder, President and Executive Director  
Philadelphia Biotechnology and Life Sciences Institute
April 29, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley:

I am writing at to express Liberty Science Center’s strong interest in participating as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia, especially in the education outreach portion of the project.

Liberty Science Center is the largest science museum in the New Jersey-New York area with 700,000 visitors a year, and reaching an additional 60,000 students through our Traveling Science program. Our mission is to provide lifelong exploration of nature, humanity and technology, strengthening communities and inspiring global stewardship. To that end, the Center is already providing exhibits and programs that align very well with the goals of the Innovation Cluster to improve energy efficiency, reduce carbon emissions of existing buildings, and educate and develop the workforce:

- We feature exhibits on Green Building technology in our Skyscraper! Achievement & Impact exhibition, the largest on tall buildings in the world.
- We teach middle and high school students about energy efficiency and green building techniques in our Electronic Field Trip program of videoconferenced lessons and School Residency program, in which students come to the museum for two days of hands-on, interactive study.
- Our recently renovated building contains many green features; solar arrays, wind turbine, green roof
- Through an innovative program of monitoring, control, and changes in equipment and procedures, we’ve reduced our energy consumption by over 46% in the last year, in a replicable process we could share with other museums or facilities.

We are currently investigating the possibility of covering our entire 125,000sq foot parking lot with a 1.8Megawatt solar system, both as a means of generating power and of educating the public. Unlike most installations, the entire array would be visible by everyone passing by on the elevated portion of the New Jersey Turnpike Extension next to our facility, providing a perfect opportunity for drawing attention to this technology.

Liberty Science Center would welcome partnering with the Innovation Cluster to raise the public’s understanding of building energy efficiency by providing a means to communicate the Cluster’s findings and developments to our audience, both on-site in the museum and through our Traveling Science Program. If accepted, we look forward to working with the Innovation Cluster in developing innovative educational experiences to increase awareness and deployment of technologies that can have a profound effect on energy usage and carbon emissions.

Sincerely yours,

[Signature]

Deborah Cook, EdD  
Vice-President, Learning & Teaching
April 23, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

I am happy to provide this letter of commitment to participate as a partner and supporter of the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

As a veteran venture capital investor with a strong interest in the growth of clean technology, I strongly support the goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings. The organization’s goals which are to 1) improve energy efficiency and operability and reduce carbon emissions of existing buildings, and 2) stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the greater Mid Atlantic region are very much in synch with the need to support the development of a robust venture capital ecosystem which will support job creation around the region.

We are extremely pleased to be a partner in this endeavor and we look forward to helping provide leadership to the activities of the Regional Innovation Cluster, and to directly participating in concurrent technology and policy research, development, demonstration, and deployment, education and workforce development, and other activities. We understand that the Regional Innovation Cluster will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals and we look forward to contributing to the Cluster through such co-funded projects.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. I am extremely pleased to be a partner in this undertaking.

Sincerely,

Bruce Luehrs
Partner
Emerald Stage2 Ventures
April 28, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

We are delighted to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings are to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region, and beyond.

Mid-Atlantic Angel Group Funds I & II, LP were created to bridge the gap between angel funding and institutional venture capital funding serving the Greater Philadelphia Region. These member-managed funds provide investors with an opportunity for active involvement in diversified venture capital investment. The funds seek to leverage various public and private funding resources and networks by providing equity capital to seed and early-stage, technology-based, high-growth companies. Fund members include experienced entrepreneurs, high net worth individuals, institutions, and other accredited investors interested in realizing a high return on invested capital in Regional technology companies and being a key part of Regional growth. Companies that seek to improve energy efficiency thru new technology are one of its key investment targets of Fund II.

We understand that the Regional Innovation Cluster will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals, and we look forward to contributing to the Cluster through such co-funded projects.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. We are extremely pleased to be a partner in this undertaking.

Sincerely,

Peter Linder

Peter Linder, Chairman
Building 100 Innovation Center
4800 S. 13th St., Suite 200
Philadelphia, PA 19112
April 23, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley:

We are delighted to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings are to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region, and beyond.

The Minority Angel Investor Network is supportive of this initiative in our role as private angel investors seeking investment in young companies implementing improved energy efficiency technologies. Our support of this effort, along with other regional partners, will enhance the overall economic vitality of our region and ultimately the nation.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. We are extremely pleased to be a partner in this undertaking.

Best Regards,

Terrence Hicks  
Co-Founder, Minority Angel Investor Network
Dear Dr. Foley:

The Economy League of Greater Philadelphia is pleased to provide this letter of commitment to serve as a partner in the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings to be headquartered at the Clean Energy Campus at the Philadelphia Navy Yard.

The goals of the Greater Philadelphia Regional Innovation Cluster are to improve the energy efficiency of existing buildings and to grow energy efficiency retrofit markets in the Philadelphia and Mid-Atlantic regions. We look forward to participating as a partner in this Regional Innovation Cluster and to applying the Economy League’s public policy research and leadership convening expertise to strengthen the cluster’s efforts.

Achieving dramatically improved energy efficiency in both new and retrofit buildings will stimulate regional growth, with positive impacts on Greater Philadelphia’s innovation economy, entrepreneurship, education and workforce development, and public policy. We are extremely pleased to be a partner in this undertaking.

Sincerely,

Steven T. Wray
Executive Director
Economy League of Greater Philadelphia
Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

We are pleased to provide this letter of support for the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

It is our understanding that the goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings are to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region, and beyond.

These are important and timely goals as they will help leverage Philadelphia’s existing commitment to energy efficiency. For example, Greenworks Philadelphia, a citywide program helping to promote energy efficiency, is working to retrofit homes and reduce municipal energy demand. In addition, PECO is currently implementing Act 129 energy efficiency programs throughout the region which provide financial incentive to residential, commercial and industrial customers throughout the region to increase the efficiency of appliances, heating and cooling equipment, motors and building envelope.

The proposed Greater Philadelphia Regional Innovation Cluster will help the region further achieve the vision of dramatically improved energy efficiency in both new and retrofit buildings. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. We are extremely pleased to support this proposal.

Sincerely,

Tom Tuffey,
Director
PennFuture Center for Energy, Enterprise and the Environment
April 21, 2010

Dr. Henry C. Foley
Vice President for Research
The Pennsylvania University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

On behalf of Select Greater Philadelphia (Select), the regional economic
development organization in the Philadelphia metropolitan region, I am writing
this letter of commitment to participate as a partner in the proposed Greater
Philadelphia Regional Innovation Cluster for Energy Efficient Buildings located at
the Clean Energy Campus at the Navy Yard in Philadelphia.

Renewable portfolio standards established by the State of Delaware, the State of
New Jersey and the Commonwealth of Pennsylvania are helping to make a
market for alternative energy technologies in the Greater Philadelphia region.
Select pursues a regional economic growth agenda designed to attract
companies and jobs to the tri-state metropolitan area and we recognize the
importance of the alternative energy sector to Greater Philadelphia’s prosperity
and future competitiveness.

The Greater Philadelphia region is home to a diverse and growing concentration
of public and private assets that are establishing alternative energy development
and commercialization as a foundation for new economic growth. We fully
support the goals of the Greater Philadelphia Regional Innovation Cluster for
Energy Efficient Buildings to stimulate both private investment and high quality
jobs in building energy efficiency retrofit markets in the region. We look forward
to helping provide leadership to the activities of this Regional Innovation Cluster.

We are pleased to be a partner in this important initiative.

Sincerely,

[Signature]

Thomas G. Morr
President and CEO

cc: RoseAnn B. Rosenthal, President and CEO
Ben Franklin Technology Partners of Southeastern Pennsylvania
April 23, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley,

The University City Science Center ("Science Center") is providing this letter of commitment as a partner in the proposed Greater Philadelphia Regional Innovation Center of Energy Efficient Building, to be headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia. We enthusiastically support the goals of this initiative, namely to improve energy efficiency and operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region. Many of the objectives of this initiative are directly aligned with the Science Center's mission to advance technology commercialization and entrepreneurship in our region.

Located in West Philadelphia, adjacent to the University of Pennsylvania and Drexel University, the Science Center is the nation’s oldest and largest urban science research park. Our campus includes 2.0 million square feet of research lab and office facilities. The Science Center is a unique organization that supports and promotes regional economic development in three states (PA, NJ and DE). Our mission is to accelerate technology commercialization and the market availability of life-enhancing scientific breakthroughs, by bringing together innovators, scientists, entrepreneurs, funders, and business service providers.

Sincerely yours,

Stephen S. Tang, Ph.D., MBA  
President & CEO
Dr. Henry C. Foley  
Vice President for Research  
Dean of the Graduate School  
Pennsylvania State University  
304 Old Main  
University Park, PA 16802


Dear Dr. Foley:

This letter expresses our support for the proposal being led by the Pennsylvania State University titled “Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings” in response to the U.S. Department of Energy’s announcement noted above.

By way of background, the National Electrical Contractors Association (“NECA”) is the voice of the electrical contracting industry (www.neca.org). NECA has provided a century of service to the $130 billion electrical construction industry that brings power, light, and communication technology to buildings and communities across the United States. NECA advances the industry through advocacy, research and standards development. Penn-Del-Jersey Chapter, NECA, the local Chapter headquartered in Philadelphia, PA (the “Chapter”) represents approximately 200 electrical contractors, employing over 10,000 employees who perform over $1 billion of work in Pennsylvania, Delaware and parts of New Jersey and Maryland (www.neca-pdj.org). Our Chapter is a joint sponsor with the IBEW, of 14 local apprentice and journeymen training centers throughout our jurisdiction.

It is our understanding that this program will be devoted towards, 1) tools for integrated design, construction, commissioning, and operation; 2) advanced building components and sub-systems; 3) building controls and diagnostics; 4) high performance computation for buildings; 5) policy, behavior, business, and economics; 6) education and workforce development and; 7) demonstration and deployment.

We are in support of your proposal to the U.S. Department of Energy directed toward the development of Energy Efficient Buildings. We look forward to working with you and your team on this project should it be funded.

Sincerely,

Jeffrey P. Scarpello  
Executive Director

JPS/dme
April 29, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

The National Roofing Contractors Association (NRCA) is delighted to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the GPIC are to improve energy efficiency, improve operability and reduce carbon emissions for existing buildings, and to stimulate private investment and quality job creation in building energy efficient retrofit markets in the greater Philadelphia region, the larger Mid-Atlantic regions, and beyond.

The National Roofing Contractors Association has a well-established partnership with the Pennsylvania State University, and we are excited about the opportunity to be a part of this program. NRCA is a 124-year old trade association with more than 4,000 members, including many prominent firms in the Mid-Atlantic region. Currently, NRCA offers its members a good deal of education, training and information resources to help foster energy efficiencies in building design and retrofit. We will be able to call on the talents of experienced members of our association – in both the contracting and manufacturing segments – as well as our professional staff, which includes a number of people with demonstrated expertise in energy-efficient buildings.

Should the GPIC move forward, NRCA is prepared not only to participate as a partner, but to attend meetings and workshops, help to organize workforce development opportunities (including identifying potential employers), and act as a liaison to the roofing industry generally about opportunities provided by the project.

We understand the GPIC will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals, and we look forward to contributing to the Cluster through such co-funded projects.
Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, among others. The potential rewards in terms of energy savings, environmental protection and quality job creation are enormous. We are extremely pleased to be a partner in this undertaking.

Sincerely,

[Signature]

William A. Good, CAE
Executive Vice President
Dr. Henry C. Foley  
Vice President for Research  
Pennsylvania State University  
304 Old Main  
University Park, PA 16802

21 March 2010

Dear Dr. Foley:

I am please to provide this letter in support of the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings proposed to be developed at the Navy Yard.

As the largest private foundation in Greater Philadelphia dedicated solely to improving the quality of life in our region, the goals of the proposed center appear to be very much in alignment with many of our own strategic interests, including:

- Promoting cross-sectoral collaboration in support of technological innovation
- Encouraging public and private sector partnerships in support of regional initiatives
- Exploiting the economic development potential of the region’s vast research capacity
- Capitalizing on and preserving the city and the region’s historic built environment through new, more energy efficient approaches to building retrofit.
- Supporting public policies that enhance environmental stewardship and economic competitiveness through sustainable development practices

We look forward to learning more about the work of Regional Innovation Cluster and how we can collaborate to extend and maximize its potentially significant local and national benefits and impacts.

Sincerely,

Feather O. Houstoun  
President
Dear Dr. Foley:

The Department of Architecture and Built Environment and the Lund Center for Control of Complex Engineering Systems (LCCC) at Lund University are delighted to provide this letter of commitment to participate as an international academic partner in the proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the GPIC strongly align with our research interests in the development of modeling, simulation and analysis tools for buildings, measurements of the performance of energy efficient building components, participation in design, construction and evaluation phases of demonstration buildings (e.g., passive houses), and efforts in the development of design tools and informative books and brochures. Furthermore, we see strong overlap with our ongoing efforts at the Lund Center for Control of Complex Engineering Systems where we seek to make fundamental contributions to a general theory and methodology for design and operation of complex systems. This will include language support and tools for modeling, scalable methods for analysis and control synthesis, as well as reliable implementations using networked embedded systems, with applicability to energy efficient building system design and operation.

Lund University is one of Scandinavia’s largest institutions for education and research. Through the partnership with Department of Architecture and Built Environment and the Lund Center for Control of Complex Engineering Systems, we anticipate attending key reviews and meetings, supporting workshops, leveraging educational activities, and conduct research collaborations with pre and post doctoral level student exchange.

We understand that the GPIC will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals, and we look forward to contributing in these endeavors.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. We are extremely pleased to be a partner in this undertaking.

Maria Wall, Head of Division
Division of Energy and Building Design
Dept of Architecture and Built Environment

Anders Rantzner, professor
Director LCCC
Dear Dr. Foley:

The Department of Building Science and the Building Energy Research Center at Tsinghua University are delighted to provide this letter of commitment to participate as an international academic partner in the proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The objectives and research themes of the GPIC align very well with our research which is focused on a wide range of design methods and energy efficient system technologies that impact the entire lifecycle of a building. This includes the whole building modeling and simulation tools, energy performance monitoring systems, high efficiency building lighting, HVAC and power systems and controls technologies, and as well as efforts aimed at workforce education and policy and regulatory guidance. Furthermore, we see strong overlap with our ongoing efforts at the Tsinghua-UTC Institute for Research in Integrated Building Energy, Control and Safety Systems where we conduct basic and applied research on the development of integrated building system solutions.

Tsinghua University is one of China’s largest institutions for education and research, providing leadership in the fields of building energy efficiency and automation. Through the partnership, we anticipate attending key reviews and meetings, supporting workshops, leveraging educational activities, and conduct research collaborations with pre and post doctoral level student exchange.

We understand that the GPIC will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals, and we look forward to contributing in these endeavors.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. We are extremely pleased to be a partner in this undertaking.

Yi Jiang, Head
Department of Building Science, Building Energy Research Center
Tsinghua University
GPIC | Greater Philadelphia Innovation Cluster for Energy Efficient Buildings

Proposal to:
- U.S. Department of Commerce – Economic Development Administration
- U.S. Department of Commerce – National Institute of Standards and Technology
- U.S. Department of Energy
- U.S. Small Business Administration

Date: May 6, 2010

FOA: Fiscal Year 2010 Energy Efficient Building Systems Regional Innovation Cluster Initiative

DOE HUB CO-APPLICATION
GREATER PHILADELPHIA INNOVATIVE CLUSTER (GPIC)
FOR ENERGY EFFICIENT BUILDINGS

DOE Co-applicant: Pennsylvania State University (PSU)
HUB Location: Philadelphia Navy Yard Clean Energy Campus
Director: Dr. Henry C. “Hank” Foley, Pennsylvania State University
Vice President for Research and Dean of the Graduate School
Dep. Dir: James Freihaut, Pennsylvania State University

The HUB objective is to transform the commercial building retrofit process by demonstrating energy savings of 50% by 2014 in a scalable, repeatable solution that can be affordably applied to a broad spectrum of buildings.

GPIC includes five Pennsylvania counties (Bucks, Chester, Delaware, Montgomery, and the city/county of Philadelphia) and five adjacent New Jersey counties (Burlington, Camden, Gloucester, Mercer, and Salem). The partners in the Greater Philadelphia initiative have uniquely positioned the region to become the national leader in energy efficient buildings research, education and training, and technology development, demonstration, and deployment. This initiative will coalesce, develop, and leverage the region's substantial energy related assets to support a robust strategy for economic growth through alternative energy development and commercialization. The HUB members, roles and planned DOE dollar levels of effort are:

<table>
<thead>
<tr>
<th>Entity</th>
<th>SM</th>
<th>Focus</th>
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<tbody>
<tr>
<td>Bayer</td>
<td>2.5</td>
<td>Advanced materials and energy-efficient building solutions</td>
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<tr>
<td>Ben Franklin TP</td>
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<td>Demonstration, deployment and IP management</td>
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<tr>
<td>Carnegie Mellon</td>
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<td>Architectural design, high performance computing</td>
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<tr>
<td>Collegiate</td>
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<td>Education and Training</td>
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<td>NIST/MEP co-applicant, outreach education</td>
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<td>IBM</td>
<td>10.0</td>
<td>Cloud computing for design, database management</td>
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<td>LLNL</td>
<td>4.0</td>
<td>Software tools, math libraries, uncertainty analysis tools, HPC</td>
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<tr>
<td>Morgan State U</td>
<td>3.14</td>
<td>Workforce development, archiving of data</td>
</tr>
<tr>
<td>NJIT</td>
<td>2.0</td>
<td>Market assessment, industry/utility liaison, documentation</td>
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<tr>
<td>PIDC</td>
<td>5.0</td>
<td>EDA co-applicant providing facilities at the Navy Yard</td>
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<tr>
<td>PPG</td>
<td>1.0</td>
<td>Enabling component technologies</td>
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<td>Architectural engineering and design, processes</td>
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<td>Purdue U</td>
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<td>Test bed facility for components, and CFD</td>
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<td>Rutgers U</td>
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<td>Energy efficiency decision support tool design, human behavior</td>
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<td>Turner Construction</td>
<td>1.0</td>
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<tr>
<td>UTC</td>
<td>10.0</td>
<td>Components, diagnostics, controls, integrated systems &amp; policy</td>
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<tr>
<td>U Penn</td>
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<td>Policy, small business model development</td>
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<tr>
<td>U Pittsburgh</td>
<td>2.0</td>
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<tr>
<td>Virginia Tech</td>
<td>5.0</td>
<td>Model reduction, optimization &amp; sensitivity analysis tools</td>
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<td>Wharton SBDC</td>
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GREATER PHILADELPHIA INNOVATION CLUSTER
DOE HUB CO-APPLICATION

FEDERAL AGENCY: Department of Energy (DOE)

SOLICITATION TITLE: Fiscal Year (FY) 2010 Energy Efficient Building Systems Regional Innovation Cluster Initiative

LEAD ORGANIZATION: Pennsylvania State University
304 Old Main
University Park, PA 16802

BUSINESS TYPE: Educational / University

PROJECT TITLE: Greater Philadelphia Innovation Cluster

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Email: hallacher@psu.edu

DATE SUBMITTED: May 6, 2010
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3.0 PROJECT NARRATIVE

3.1 DIFFERENTIATORS: THE PENNSYLVANIA STATE UNIVERSITY HUB

3.1.1 Problem Statement

Commercial and residential buildings consume more than 40% of US energy, greater than either the transportation or industrial sector, and their energy efficiency is not improving despite huge public and private investments.

The nation’s 111 million households and more than 4.9 million commercial buildings collectively consume more energy than either the transportation or industry sector, accounting for nearly 40 percent of total U.S. primary energy use (Figure 3.1.1-1). In particular, over 18 quadrillion Btu (or “Quads”) of energy alone are consumed (either productively used or wasted) to light, heat, and cool commercial buildings, and operate the equipment in them.

![Figure 3.1.1-1 Commercial Buildings Consume Much of the US Primary Energy](image)

Togethe, the US government and private industries have spent hundreds of millions of dollars to reduce building energy consumption by developing technologies and products that are primarily targeted to improve the energy efficiency of buildings. For example, more efficient lighting or HVAC options are available for either building retrofit or building expansion purposes. However, despite these investments and consequent advances in component and subsystem efficiencies, little progress has been made to significantly improve the energy efficiency of the building stock. As shown in Figure 3.1.1-2, both commercial and residential sectors did exhibit some reductions in specific energy consumption (energy use per square foot) during the late 1970’s to mid 1980’s, primarily due to decreased outside air ventilation rates and structurally

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1 National Academy of Sciences, National Academy of Engineers and the National Research Council report *America’s Energy Future: Technology and Transformation*
related infiltration rates. From the mid 1980’s onward there has been little change in specific energy consumption in the two building sectors.

Figure 3.1.1-2 Specific Building Energy Use Has Not Significantly Improved

3.1.2 Root Cause for Status Quo

The building industry is not achieving transformative levels of energy savings because its processes, motives, and technologies are fragmented.

As the World Business Council on Sustainable Development stated:

“Attention to individual design or technical solutions, such as natural ventilation or insulation, can lead to suboptimal solutions. While each component may be valuable in saving energy, the greatest energy efficiency is achieved by taking a whole-system, integrated approach...An integrated approach is just as important in retrofitting...We recommend that government authorities introduce process incentives for developers to submit application for energy-efficient buildings based on a holistic approach. Whole-system design approaches including both passive and active measures can reduce energy use by as much as 70%. Yet the segmented structure of the building industry hampers attempts to bring together the different players in an integrated project team.”

The current state of the building delivery process compromises energy performance during all three stages - design, build, and operation - as it contains many serial handoffs from one phase to the next. For example, as represented in Figure 3.1.2-1, potential energy savings are lost (1) during design due to inaccurate building load models, design tools that only consider a single aspect of building energy use, and improperly specified (or unavailable) systems and components; (2) during construction because of deviations from the design specifications (e.g. proper equipment ventilation, ducting or controls) and inadequate workforce skill; and (3) during

---

operation soon after initial commissioning because of a lack of actual performance data, poor control algorithms, and the degradation of equipment.3

Figure 3.1.2-1 Fragmented Process Lose Potential Building Energy Savings

The building industry is also fragmented because the motives of key individuals are not aligned. Salespeople market a potential property based on location and financial sales incentives, such as tax breaks or favorable financing, but usually not because the property offers innovative, energy savings features. Developers are often driven by minimizing the investment capital they must finance, undervaluing long term operating cost savings from energy efficient building technologies. Frequently landlords lease the property to tenants who desire the lowest payments that include the energy costs apportioned to all tenants. Further, there is a split incentive between the landlord and the tenant as neither has the economic drive to efficiently operate, maintain or upgrade the building equipment. Designers are often driven by tight schedules and cost constraints that favor well established design practices over more risky new approaches. Builders and major equipment Suppliers, whether for new construction or retrofit, often enter the value chain after the design is nearly complete, too late to integrate the energy efficiency experience they have learned from real world applications.

New predictive tools and technologies are required to support an improved design/build/operate process. For example, despite many efforts to do so, building loads are not accurately predicted. Therefore it should not be surprising that many energy retrofits install improperly sized building equipment. Load prediction tools must be easy and affordable use, producing rapid, accurate assessments over a wide range of building sizes. Such tools must interface with a comprehensive design/build/operate design system so the final retrofit achieves maximum benefits.

In addition to these challenges, public policy and workforce skill level barriers exist. For example, the benefits of greenhouse gas avoidance because of increased energy efficiency are not widely available, in part because they are not understood, and healthcare cost offsets resulting from a healthier, more productive work environment are not common. Recent history

has shown that energy cost avoidance due to higher efficiency is insufficient to create a winning value proposition; government subsidies are need as well. It is essential to identify policies that will be effective at driving building energy efficiency while also understanding their impact on the many commercial stakeholders who will be affected. Policies that help monetize additional values of efficient designs will minimize the need for government subsidies; new business models are required to create the “win-win” value proposition for the seller, buyer, and the public’s concerns for energy security and clean air. A high degree of coupling is required among technology development, policy formulation, business case model development, and workforce education to successfully transform the building industry.

Transformative changes in system performance, while reducing product lifecycle costs, have been achieved in industries that recognized that design/build/operate functions must be vertically integrated. For example, the automotive industry recognized that powerplant/chassis integration, from design through operation, could improve the performance and appeal of their products. A five year transformation yielded >50% improvement in specific fuel consumption while vehicle emissions were dramatically reduced and safety improved. Additionally, the aerospace industry appears on the verge of achieving a 10% reduction in specific fuel consumption in air transport systems with the new systems engineered, geared turbofan engine. The building industry must replicate the commitments of these industries and achieve similar transformative improvements.

3.1.3 Retrofit Opportunity

A significant reduction in buildings energy consumption can result by focusing on the full spectrum of retrofits for commercial buildings with less than 100,000 square feet of area.

Alternative analyses were sought to properly scope the energy reduction opportunity from commercial buildings. According to a 2003 CBECs analysis, buildings with less than 100,000 square feet of area consume 58% of commercial building energy or 10.7 Quads. According to commercial building statistics, this size includes 99% of the existing building stock (Figure 3.1.3-1) with over a million existing commercial buildings with between 10,000 and 100,000 square feet of area. A 50% reduction in the energy consumption of these commercial buildings could result in 5.3 Quad of energy savings.

The National Academy of Science, National Academy of Engineering and National Research Council report Real Prospects for Energy Efficiency in the United States, projected that a 5.9 Quad energy savings (from reduced electricity and natural gas use) could be achieved by 2020, and 9.5 Quads by 2030, from a full spectrum of retrofits (a 30% and 50% reduction, respectively, from current levels) to the existing commercial building stock.

Since the average lifetime of a commercial building is 50 yr, it is essential to focus on building retrofits. While the greatest energy savings come from a “major retrofit”, any new design/build/operate process must be applicable to the full spectrum of retrofits. Obviously, the retrofit design/build steps must always be tightly integrated to maximize energy savings and satisfy the energy demands of the building. This latter requirement must not be overlooked – the energy demand of the occupant must be met – but the energy solution must not be overdesigned or ineffectively operated. The former requires great advances in tools to efficiently understand building energy demands; the latter recognizes that all design/build/operate aspects are interdependent. The successful HUB project will take this integrated approach, and once the retrofit innovation is realized, the new tools, methodologies, policies, and workforce will be positioned to similarly affect new commercial construction and residences, essential elements to
meeting long term energy and environment goals. Unless the HUB program focuses on the retrofit of existing buildings, the primary energy usage and carbon footprint of the building sector will not change appreciably for several generations.

![Graph showing energy consumption by building size](image)

**Figure 3.1.3-1 Retrofit of Commercial Buildings < 100,000 Sq Ft Includes 99% of Stock**

### 3.1.4 Expanded Technical Requirement

| Worker comfort, health, safety, and productivity must be preserved while achieving energy savings. |

Generally, when the building industry has implemented the simplest component technologies to reduce energy use in a commercial or residential building by altering ventilation and infiltration rates, the indoor air quality as reflected in occupant comfort, lost time, and productivity have degraded. Since the purpose of a building system is to provide a comfortable, healthy, safe and productive environment for its occupants, this is a fundamental system design failure.

For example, the epidemiologic increase in allergic sensitization, which had been decreasing to the mid 1970's in the U.S, and which led to the epidemiologic increase in chronic asthma, is directly correlated with the decrease in the indoor air quality of buildings that employed reduced ventilation to minimize energy rejection as an isolated approach to energy efficiency.

A similar consequence is also evident for “tighter” homes that sought to reduce energy loss when it was reported that: *The tighter building construction of modern housing and the increasing time that children spend indoors has undoubtedly increased indoor allergen exposures.*

Any solution to save energy, whether as a change in design methodology or the use of more efficient subsystems and components, must comprehensively consider all other aspects of a

---

4 Bukowski, J.A. Lewis, r. J., et. Al. (2002), Human and Ecological Risk Assessment 8(4); 735-765
building, particularly preserving worker health and safety in order to never compromise productivity.

3.1.5 HUB Innovation Solution

The commercial building industry must be transformed to operate like a vertically integrated manufacturer. Enablers include: (1) efficient, integrated design/build/operate methods and tools; (2) innovative system technologies; (3) policy, regulatory and financial structures that accelerate solution adoption; and (4) enhanced workforce capabilities.

Research to understand real-world building performance and improve process methodology and modeling tools, particularly for retrofit applications, is essential. Key enablers are an expert team immersed in a collaborative research environment, and a dedicated research infrastructure to develop, demonstrate, and deploy solutions for buildings, building clusters, and districts. The HUB (1) establishes this spherically integrated team - a team that works in an environment divorced from conventional institutional boundaries and is continuously confronted by all design/build/operate interdependencies – and (2) provides the Philadelphia Navy Yard to use as a virtual municipality test bed to develop, demonstrate, and deploy solutions.

While formalized design methodologies, calibrated design and system simulation tools, and new building subsystems are required, the virtual vertical integration of the commercial building retrofit process requires more than just technology advances. The HUB must focus on: (1) developing a series of design/build/operate tools to quantitatively guide practitioners to successful solutions, (2) innovative systems technologies, (3) identifying and verifying public policies, regulatory and financial structures to achieve success combined with deep understanding of, and methods to modify, behavioral factors, and (4) educational programs that develop the requisite workforce capabilities.

Integrated Design/Build/Operate Tools
Analytical tools to economically, reliably, and quantitatively assess the full spectrum of retrofit component, sub-system and fully integrated technologies must be developed. These retrofit assessment tools must exhibit the following qualities: 1) accurate and repeatable performance predictions for building assessments, 2) simple human interface usable by engineering firms of all sizes and experience, and 3) able to assess system design concept for a small-medium sized building in one day. The same building assessment model should be capable of assessing building operation, performing operational modifications and building diagnostics. These analytical tools do not exist today and will require novel and practical computing solutions that use high fidelity building simulation tools.

Innovative Systems Technologies
Component and system technologies that deliver high efficiency performance are required to achieve the HUB innovation solution. These technologies will be developed by (1) employing the computational capabilities and design/build/operate tools for rapid synthesis and selection of integrated systems, (2) defining component requirements that enable optimal integrated systems, (3) designing robust control systems, (4) developing performance monitoring and diagnostics systems, and (5) performing technology demonstrations in sub-scale and full-scale test beds.

Comprehensive Value Proposition, Public Policy, Regulations, Business Models
The commercial building sector is diverse and complex, with many participants involved in the decision making process for a retrofit or new construction. The inter-relationships and value engineering that occurs between designers, engineers, builders, and operators create a high likelihood of compromised outcomes. Combining the varying behaviors and interests of investors, developers, tenants, and owner/operators with local regulators and utilities further complicates the value stream. The HUB collaborative environment will promote a deeper understanding of the inter-related value propositions, recognizing that there may be many monetized attributes including energy savings, maintenance savings, automation savings, labor savings, and productivity improvements.

The impact of potential public policy changes must be quantitatively understood to facilitate standards, regulations and incentives that enhance the building energy efficiency marketplace. For example, it can be anticipated that public policies will be crafted to: (1) monetize energy efficiency improvements directly or indirectly through carbon reduction, (2) develop building energy rating requirements, (3) restructure energy rate tariffs to promote behaviors that result in greater energy efficiency, and (4) develop effective market financial instruments and business models that address the barriers of high capital cost hurdles and associated low investment returns to owners, occupiers, and investors.

**Workforce Capabilities**

Skilled technical and non-technical workers will be essential to transforming the built environment. It will be essential to train all levels of industry participants in new processes, procedures, analytical tools and technologies. Such training shall cover building assessment, design, retrofit, operation, maintenance, as well as, business operation, energy management and public policy. Workforce development includes K–12, trade school, junior college and university programs.

A HUB innovative solution that delivers affordable energy savings will be adopted by the commercial building industry. Adoption rates will be accelerated because of “win-win” value propositions, reliable solutions that satisfy the 24/7 building energy demands, suppliers supported by a skilled workforce, effective building regulations, and incentives. Consequently, the percentage of highly-efficient commercial buildings will increase. After being developed, demonstrated, and deployed at the regional level, solutions can be commercialized nationally for explosive adoption in retrofit and new construction markets. The demands for economically sound solutions and high-quality, sustainable jobs will increase with this market expansion.

As depicted in Figure 3.1.5-1, the HUB solution will transform building energy consumption as solutions achieve 50% average energy reduction for retrofits and 80% average energy reduction for new construction. Three scenarios were modeled using the DOE CBECs data base and EIA statistics/forecasts for the commercial building stock. The top curve of the figure projects building energy consumption following a “business as usual” scenario. The middle curve tracks energy consumption if conventional improvements are employed (e.g. improved ASHRAE standards and component efficiencies) while the bottom curve predicts consumption if the HUB solution is followed. The HUB innovation saves ~10 Quads of energy in 2030, very similar to the predictions presented in Section 3.1.3. More importantly, the yearly trend of increasing commercial building energy demand is reversed.
3.1.6 Program Objective

The program objective is to transform the commercial building retrofit process by demonstrating energy savings of 50% by 2014 in a scalable, repeatable solution that can be affordably applied to a broad spectrum of buildings.

Commercial building stock turns over slowly. Major retrofit demonstrations are emerging, like the Empire State Building, but they are rare, achieve less than 40% energy improvement, and are not generally scalable to the less than 100,000 square foot building stock. The HUB solution must be scalable and have broad applicability. Successful execution of the program will yield the transformative results of Figure 3.1.5-1.

Scalable 50% retrofits

DOE’s building energy goal is to reduce the annual energy use by 80% in the year 2050. New approaches to design/build/operate technologies, business models, public policies, and workforce development are required. A 2014 goal of demonstrating 50% energy efficiency improvement stretches well beyond insufficient, conventional solutions and must be applicable to a range of building sizes.

Task level objectives

Tasks are defined to deliver the following specific objectives:

- Develop system design tools and scalable and robust solutions for energy efficient buildings which are applicable to both retrofit and new construction.
- Deploy solutions to individual buildings, clusters of buildings and district systems.
- Promote public policy and workforce education that enable the transformation to highly energy efficient buildings and the creation of high-quality sustainable US jobs.
- Develop business value propositions and business models appropriate for virtual vertical integration of the building industry for retrofit and new construction.
3.1.7 Key Program Differentiators

The program approach includes three key differentiators: (1) a spherically-integrated, co-located team, (2) a physical infrastructure at the Philadelphia Navy Yard to serve as a real world, virtual municipality test bed, and (3) an Active Engagement program to maximize innovation.

Spherically Integrated Team
To demonstrate highly efficient, scalable retrofits in 2014, while preserving workplace quality, requires revolutionary departures from the traditional approach to research, business and workforce development. A radically new form of cooperation and innovation is required to break down institutional, cultural and financial barriers. In particular, to achieve a high level of HUB success, system-driven design and delivery processes (and tools) supported by intellectual property platform that promotes HUB innovation, and industry, policy and workforce transformations, are required. “Spherical integration” is the term used to reflect this supreme level of immersion where diverse entities work seamlessly. It is a HUB goal that requires focus, effort and diligence; it is a critical success factor.

The HUB brings together pre-eminent organizations and researchers from academia, local government, industry, and two National Laboratories to transform the commercial building industry. It is led by Pennsylvania State University and contains these 21 additional members: Bayer MaterialScience, Ben Franklin Technology Partners of Southeastern PA, Carnegie Mellon University, Delaware Valley Industrial Resource Center, Drexel University, IBM Corporation, Lawrence Livermore National Laboratory, Morgan State University, New Jersey Institute of Technology, Philadelphia Industrial Development Corporation, PPG Industries, Princeton University, Purdue University, Rutgers University, Turner Construction, United Technologies Corporation, University of Pennsylvania, University of Pittsburgh, Virginia Tech, and Wharton Small Business Development Center.

Expert members of these organizations will be co-located at the HUB building in the Philadelphia Navy Yard (Figure 3.1.7-1). This historically significant building will receive a major retrofit renovation. Experiences from design, build, commissioning, and monitored operation phase of this retrofit will be used by the HUB team for tools and methodology development.

Figure 3.1.7-2 depicts the proposed advances in integrated design methods enabled by high performance computational tools, robust integrated building system solutions, and automation system platforms. The proposed research addresses not just building design or operation, but the entire delivery cycle to ensure that: (1) designs maximize the energy savings, (2) building construction and installation procedures preserve the design intent, and (3) operations are robust and adaptive to ensure the persistence of the energy efficient building performance. These advances will alleviate the failings of the fragmented process previously shown in Figure 3.1.2-1.
Philadelphia Navy Yard Virtual Municipality and Supporting Sites
A transformative building methodology to achieve 50% energy savings must be validated. The Navy Yard Campus provides a unique virtual municipality test bed for the full spectrum of commercial building retrofits. It will be the test platform to demonstrate all elements necessary to achieve scalable retrofit energy solutions that can be applied to buildings, building clusters, and districts. This is a test bed that can validate all elements of potential value propositions, technology solutions sets, workforce processes, and public policies. With a master plan for mixed commercial, industrial and residential development, the Navy Yard has 282 existing buildings of which approximately 200 are candidate historic structures for retrofit renovation.
The Navy Yard campus (Figure 3.1.7-3), is already the host of the PSU-managed DOE Mid Atlantic Clean Energy Application Center which promotes the implementation of CHP, large scale waste heat recovery and Distributed District Energy Technology. PSU also operates and manages DOE Centers at the Navy Yard that focus on Education and Workforce Development for Solar Energy and Smart Grid technologies.

In addition, the City of Philadelphia was recently awarded a $25 million Energy Efficiency and Conservation Block Grant “to deploy the most cost effective and reliable energy technologies available in renovating urban housing units in Philadelphia for the purpose of reducing associated fossil fuel emission, reducing total energy use by the units, and creating and maintaining jobs via the on-going renovation processes themselves.” This grant will be applied to the Navy Yard, and directly relates to the central mission of the Greater Philadelphia Innovation Cluster and the specific Research, Development, Demonstration and Deployment (RDD&D) focus of the HUB. The technical, policy, workforce and economic issues encountered in the retrofit and renovation site applications of the EECBG program in Philadelphia will provide the HUB team with both specific data and defined parameter constraints. Hence, the HUB team innovations in each of these issues areas will be developed in the context of actual implementation in Philadelphia. The EECBG application and the HUB RDD&D interactions will facilitate the formulation of technology, policy, workforce training, and economic models that will be easily translatable to other regions and conditions.

![Figure 3.1.7-3 Philadelphia Navy Yard is a Virtual Municipality](image)

The Commonwealth of Pennsylvania, in conjunction with Philadelphia Industrial Development Corporation, has committed $30 million of capital funds to construct a new research and education facility (outside of the proposed program) at the Navy Yard (Figure 3.1.7-4). This laboratory will facilitate student interactions with scientific, business, and policy leaders. The education and training of the next generation of designers, builders, contractors, and tradespersons is essential to ensure that new design/build/operate principles and methodologies become firmly established best practices.
Other HUB research facilities include: the new NIST sponsored High Performance Building Research Center at Purdue University (Figure 3.1.7-5); the Virginia Tech URI Center for Optimal Design And Control; the supercomputing center at the University of Pittsburgh; the Lawrence Livermore National Laboratory Computational Department; the buildings and energy research and development at the United Technologies Research Center; and the buildings and energy research at IBM Laboratories. In addition to face-to-face meetings at the Navy Yard, all research facilities will be linked by state-of-the-art, Cisco TelePresence video conferencing (acquired with the Commonwealth capital funding) to effectively expand the HUB research capabilities.

Strategic global HUB partners providing building energy research collaboration and outreach opportunities are at Lund University, Sweden (Lund Center for Control of Complex Engineering Systems), and the Tsinghua University Building Energy Efficiency Center in China.

**Active Engagement**

HUB team experiences, and scientific research, reveal that many good ideas are not vetted or even recognized because researchers are often focused on a single feature or result. To overcome this historical innovation and deployment gap, the HUB has developed an active engagement infrastructure for the innovation and deployment process.

**Internal engagement:** Knowledge generated from the HUB activities will be captured during the course of the project, and housed in a repository along with contributed data from HUB members, with the intent to create a unique database that will inform other building researcher, architects, designers, developers and construction personnel throughout the industry. A Scientific Information System (SIS) developed and operated by Morgan State University to collect, catalogue, and store information on the RDD&D projects and activities to be used. The HUB/GPIC Intellectual Property management plan (Appendix 3) has been approved in principle by the all GPIC and HUB members and provides an unprecedented information sharing platform.

**External engagement:** The HUB commercialization, communications and outreach plans leverage the extensive and well established networks of the HUB and GPIC members and
partners for every aspect of building design, engineering, construction, operation, maintenance and retrofit. The HUB and GPIC members and partners networks are also deeply engaged with the regulatory, public policy, economic development and small and disadvantaged business community. These networks will be a strategic focus of the HUB outreach program.

Figure 3.1.7-5 Purdue High Performance Buildings Research Facility
3.2 OVERVIEW OF THE PROPOSAL PLAN

3.2.1 Relationship Between the HUB and the Greater Philadelphia Innovation Cluster

The HUB and Greater Philadelphia Innovation Cluster combine expertise and resources concentrated in the Philadelphia Navy Yard to develop, demonstrate, and deploy a transformative change in commercial building energy consumption.

The HUB consists of a spherically integrated team of 22 academic, industry, US National Laboratory, public policy, and workforce experts, co-located at the Philadelphia Navy Yard, that will transform the commercial building retrofit process by demonstrating energy savings of 50% by 2014 in a scalable, repeatable solution that can be affordably applied to a broad spectrum of buildings. The term “spherical integration” is used to reflect a new culture of innovation and delivery that will only be accomplished by establishing a new organizational approach in an environment divorced from conventional institutional boundaries. The team will be continuously confronted by all design/build/operate interdependencies.

The Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings (EEB) is a collection of regional industrial, education, workforce, financing, and government partners/stakeholders who share the common objective to achieve transformative improvements in commercial building energy efficiency in the greater Philadelphia area, a four season coastal climate region representative of other high population and commercial centers of the eastern United States, to promote the local economy and increase high-quality, sustainable US jobs. The co-applicants for the GPIC are Pennsylvania State University (DOE); Philadelphia Industrial Development Corporation (EDA); Delaware Valley Industrial Resource Center (NIST/MEP); and Wharton Small Business Development Center (SBA). Further, the Navy Yard, home of the HUB and integral part of GPIC, provides a collection of existing buildings and planned economic growth that serve as a real world, virtual municipality for development, validation, and deployment of the HUB concepts.

3.2.2 Short, Intermediate, Long Term Goals of the HUB

Specific short, mid, and long-term HUB goals reflect the interdependent accomplishments required to transform a fragmented industry to a virtual vertically-integrated industry that delivers retrofit solutions of 50% building energy reductions with a 3-year payback.

<table>
<thead>
<tr>
<th>Short-term Goals (Program Year 1-3):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Develop database structures, protocols and computer analysis tools for energy efficient building systems to enable 5X faster design cycle</td>
</tr>
<tr>
<td>• Develop sub-scale prototypes of building systems and controls platforms with potential to reduce whole building energy consumption by 20-30% with less than 3 year payback</td>
</tr>
<tr>
<td>• Create a database of building and energy codes, standards, and incentives as a national resource for policy developers, market decision-makers and behavioral researchers</td>
</tr>
<tr>
<td>• Develop models of incentive structures to reduce adoption time for retrofit solutions by 50%</td>
</tr>
<tr>
<td>• Develop benchmarks and identify best practices of educational programs in the Energy Efficiency Services Sector</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mid-term Goals (Program Year 4-5):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Develop project delivery methodology and computer design tools focused on retrofits that are 5X faster and provide 5X reduction in performance predictions certainty</td>
</tr>
</tbody>
</table>
Demonstrate full-scale prototypes of system solutions with potential to reduce energy usage by 50%, provide paybacks or less than 3 years and persistence of energy efficiency for at least 10 year

Develop policy modeling and simulation capability that enables greater than 50% acceleration in ROI using portfolio-based asset management

Complete assessments of policy instruments and loan and grant programs to assess take-up rates for new building system technologies

Establish centers to provide training to future Energy Efficiency Service professionals

Create professional, undergraduate and graduate courses and K-12 curricula to catalyze workforce development

Long-term Goals (Program Years > 5):

Develop project delivery methodology and design tools for buildings and district systems that are 10X faster and provide 10X reduction in energy performance predictions

Demonstrate full-scale prototypes of system solutions to enable net zero energy buildings with less than 10 year payback and persistence of energy efficiency for at least 3 years

Implement & prototype new business models and policy instruments for new building projects applicable to GPIC and other regions

Create new professional occupations via program administrators, consulting firms, construction firms, engineering and architectural firms, and energy service companies

3.2.3 Strategy for Developing and Operating the HUB

The HUB builds on current successful collaborations to establish a 22 member team focused on a common objective; the HUB has clear strategic and tactical management responsibilities.

The HUB will leverage the successes of existing collaborative efforts among Pennsylvania State University (PSU), University of Pennsylvania, Temple University, Drexel University, The Philadelphia Industrial Development Corporation (PIDC), Delaware Valley Industrial Resource Center, and Ben Franklin Technology Partners of Southeastern Pennsylvania, all members of the HUB, to re-invent the Philadelphia Navy Yard into an Energy Innovation Campus. The current collaboration initiated the following programs there:

- The Department of Energy (DOE) Mid Atlantic Clean Energy Application Center focused on reducing technical and policy barriers to the implementation of combined heat and power, waste heat recovery and district energy systems in the Mid Atlantic region.
- The DOE Solar Workforce Development Program focused on the training of the next generation of educators and workers required for the implementation of solar energy.
- The DOE Smart Grid Workforce Development Program focused on the training of the next generation of educators and workers required for the implementation of smart grid technology on a distributed basis.

The HUB organization, originating from those collaborations, has been expanded to the 22 HUB members identified in Section 3.1.7. They represent a spherically integrated team focused to transform the commercial building industry and achieve great energy reductions while preserving worker productivity.

The HUB and GPIC Director is Dr. Henry C. Foley, Pennsylvania State University VP for Research (Figure 3.2.3-1). An Executive Board provides primary oversight to the Director. Executive Board members will provide strategic direction and be responsible for review and
approval of all funding allocation and/or reallocation decisions involving amounts greater than $100,000. The HUB Operating Committee will be responsible for managing the day-to-day operations. All members of the Operating Committee will work at the Navy Yard. Members will meet weekly as a whole committee but interact continuously. The Operating Committee will be chaired by the Deputy Director (red sector), who with the Facilities Director and the Associate Directors for each task, foster the spherically-integrated team approach. An Advisory Committee will provide guidance to the Deputy Director and the Operating Committee in the management of the HUB. A key role of the Advisory Committee will be to ensure that the Operating Committee maintains continuous and dynamic engagement and integration of GPIC and HUB members, partners, and stakeholders across all tasks and activities. The Advisory Committee will be comprised of senior officials possessing experience spanning government, industry, and educational sectors, and particular knowledge in areas such as building energy efficiency, joint government-industry-university research, technology transfer, and commercialization, and organization development and management.

The Commonwealth of Pennsylvania has committed $30 million of capital funds to construct a Navy Yard R&D building, including a Cisco TelePresence video conferencing system for communication among co-applicants, partners, and stakeholder groups. This video conferencing system provides easy involvement and access in live, face-to-face communication, fostering collaboration among co-applicants, partners, and members of stakeholder groups from distant locations. While the many members of these groups who are located in the Greater Philadelphia region will be able to easily attend meetings at the Navy Yard location or elsewhere in the region, others – e.g., faculty from Purdue University or Virginia Tech – may not easily be able to attend due to difficult logistics, the cost of travel to meetings, or scheduling conflicts. Continuous interchange across all co-applicants, HUB members, partners, and members of stakeholder groups is critical to program success.

### 3.2.4 Integration of HUB R&D Components

(The key HUB differentiators - the spherically integrated team of experts, the Navy Yard infrastructure, and Active Engagement - ensure a thorough integration of tasks, test beds, and idea capture required to develop and deploy commercial building energy solutions.)

The HUB project is built around the following five interdependent, critical RDD&D Tasks that are required to create a transformation of the commercial building industry:

1. Interoperable Design Tools and Team Dynamic Processes for Integrated Design, Modeling and Verification of Building Systems
2. System Driven Advanced Components, Sub-systems, Controls and Diagnostics for Metrically Characterized High Performance Buildings
3. Economic, Policy, and Behavioral Factors Influencing Building Energy Consumption
4. Education and Workforce Development of High Efficiency, High Performance Buildings
5. Site Specific Demonstration and Deployment of Results from 1-4 with Intellectual Property Management
While results from all component tasks are necessary, only the sum of them is sufficient for industry transformation. This essential integration will be achieved because of the spherically-integrated HUB team and the Navy Yard resources. The team of 22 academic, industry, US National Laboratory, public policy, and workforce experts, co-located at the Philadelphia Navy Yard, will be immersed in the collaborative atmosphere required to identify and resolve the interdependencies of the tasks. Further, the collection of buildings at the Navy Yard will serve as a real world, virtual municipality for development, validation, and deployment of the HUB concepts. An Active Engagement program will overcome the historical problem that an investigator may miss a key innovation because he is focused on a single feature or result, by intentionally harvesting and archiving data using a Scientific Information System. Developed by Morgan State University.
3.2.5 Addressing Critical Research Needs in Energy Efficient Building Systems

Critical HUB research needs will be identified by internal and external oversight, with stage-gate metrics and Active Engagement used to track and archive innovation.

As described in Section 3.2.3, the HUB organization includes an Executive Board and an Advisory Committee to provide strategic and tactical guidance to the HUB Director and Operating Committee. The makeup of these entities includes leaders from academia, industry, government, co-applicants, key HUB members, and national organizations (e.g. ASHRAE, and Alliance to Save Energy) to ensure expert evaluations of, and inputs to, strategic direction and tactical execution.

Tactical progress toward task objectives will be driven by a stage-gated process that requires that efforts in one stage must achieve pre-defined milestones before proceeding to a subsequent development stage. In this manner, clear metrics for all resources (people, funding, and facilities) will be tracked to ensure timely progress or re-direction. Such technology and product development processes are routinely employed by many of the HUB members. The HUB will employ a Scientific Information System developed and operated by Morgan State University to Actively Engage investigators to collect and archive information on the many RDD&D projects and activities to be undertaken across the HUB and GPIC.

3.2.6 Strategy for Transitioning from R&D into Demonstration and Deployment

The Navy Yard provides the HUB with a unique resource to develop, validate, demonstrate and deploy methodologies, policies, and practices into the commercial building industry.

History demonstrates that the building industry requires explicit demonstration and deployment activities to convince end-users to adopt revolutionary technologies and systems. That is why the virtual municipal feature of the building collection at the Navy Yard is a critical asset for the HUB. The Navy Yard provides numerous retrofit demonstration opportunities at the single building and building cluster levels. The Philadelphia Industrial Development Corporation, owner of the Navy Yard, controls its district grid operation, permitting real world demonstration of Smart Grid technology to reduce conventional grid demand. The site is also ideal for policy and regulation development and simulation. Clearly, the Navy Yard asset, by allowing the team to test and validate their approaches, and providing the building industry and the public an opportunity to “see, hear and feel” the results, provides an ideal pathway to transition from R&D to Demonstration and Deployment.

HUB members and partners have decades of experience throughout the building industry that includes: educating design engineers; developing and producing building materials and equipment; developing, constructing and commissioning new buildings; and establishing policies, and training the workforce. For example, over 2000 PSU Department of Architectural Engineering graduates work in over 200 US Architectural & Engineering (A&E) firms. Other similar networks exist throughout the architectural, engineering, contracting, tradecraft, and policy arenas.
### 3.3 ORGANIZATION AND MANAGEMENT PLAN

The principle that guides the organizational and management plan is an ability to drive rapid fact and data based decision making focused on the delivery of short-, medium-, and long-term energy use impacts, improved economic health of the US economy, and the creation high value sustainable jobs. Rapid action will be facilitated by using well established decision-making criteria. The HUB deliverables are balanced between technology maturation, economic impact and workforce transformation. The management plan will encourage spherical integration of the team by promoting synergy and cohesion among the investigators, facilitating a culture that empowers the research team.

#### 3.3.1 Leadership, Organization and Team Structure

The HUB has clear strategic leadership, tactical direction, and external oversight.

The HUB adapts successful leadership models from the university and industrial laboratory partners. These models have proven to be more effective than traditional technology driven processes by focusing an agile decision making process on a balanced set of technical, market, intellectual property, and workforce data.

The Leadership structure that enables rapid data-based decisions fosters dynamic reconfigurations of specific research projects under consistent research themes. This balance of flexibility and consistency is critical for the HUB ability to adapt the technology maturation agenda while providing a level of consistency for staff researchers, member and partner organizations and external collaborators. The HUB Operating Committee and its relationship to GPIC is shown in Figure 3.3.1-1. Pennsylvania State University (PSU) leads the DOE portion of GPIC. Other co-applicants are Philadelphia Industrial Development Corporation (EDA), Delaware Valley Industrial Resource Center (NIST), and Wharton Small Business Development Center (SBA). The GPIC Director is Henry C. Foley, Vice President of Research, PSU. He is also the HUB Director, serving as the DOE co-applicant Principal Investigator, and is responsible for managing and directing all aspects of the GPIC and HUB with oversight from the Executive Board.

The PSU HUB leadership role is well justified based on their portfolios of building energy research and development and architectural engineering, and DOE awarded DOE programs including the Mid-Atlantic Clean Energy Application Center, Solar Workforce Development Program, and Smart Grid Workforce Development Program.

A GPIC Executive Board provides primary oversight to the GPIC Director. Executive Committee members will be responsible for review and approval of all funding allocation and/or reallocation decisions involving amounts greater than $100,000. The Executive Board will meet quarterly to review progress of the GPIC and to approve or disapprove recommendations for allocation and/or reallocation of funds in amounts greater than $100,000. Membership composition of the Executive Board may be modified based on levels of participation and resources committed to the DOE HUB by members. The members of the Board are:

- Henry C. Foley (Executive Board Chair), Vice President for Research, Penn State University
- Dona Crawford, Associate Director for Computation, Lawrence Livermore National Laboratory
- Richard McCullough, Vice President for Research, Carnegie Mellon University
- Therese Flaherty, Director, Wharton Small Business Development Center
- Stephen Fluharty, Vice Provost for Research, University of Pennsylvania
- Katharine Frase, Vice President of Technical and Business Strategy, IBM
- Joseph Houldin, President, Delaware Valley Industrial Resource Center
- Peter Longstreth, President, Philadelphia Industrial Development Corporation
- David Parekh, Vice President, United Technologies Corporation
- RoseAnn Rosenthal, President, Ben Franklin Technology Partners of Southeastern Pennsylvania
- J. Stewart Smith, Dean for Research, Princeton University
- Robert Walters, Vice President for Research, Virginia Tech

*Figure 3.3.1-1 HUB and GPIC Organization*
A GPIC Advisory Committee will provide guidance to the HUB Deputy Director and the Operating Committee in the management of the HUB. A key role of the Advisory Committee will be to ensure that the Operating Committee maintains continuous and dynamic engagement and integration of GPIC and HUB members, partners, and stakeholders across all tasks and activities. The Advisory Committee will be comprised of senior officials possessing experience spanning government, industry, and educational sectors, and particular knowledge in areas such as building energy efficiency, joint government-industry-university research, technology transfer and commercialization, and organization development and management. The GPIC Advisory Committee will meet quarterly. The Advisory Committee is chaired by the Dr Joseph Bordogna, University of Pennsylvania, and will include leaders from government, academia, and energy-focused non-profit organizations such as DOE, NIST, ASHRAE, and Alliance to Save Energy.

The HUB Operating Committee will be responsible for jointly managing the day-to-day operations of the HUB. All members of the Operating Committee will work at the Navy Yard. Members will meet weekly as a committee and interact continuously. The Operating Committee is responsible for ensuring continuous and dynamic engagement and integration of GPIC and HUB members, partners, and stakeholders across all tasks and activities. The Operating Committee will be chaired by the HUB Deputy Director who has final responsibility and authority for day-to-day HUB operation. The Research Facilities Director will also interface with all the Task Leaders to assure proper availability and capability of required Navy Yard facilities. In addition to the HUB Director, members of the Operating Committee are:

James Freihaut (Operating Committee Chair)
Director, DOE Mid Atlantic Clean Energy Application Center, PSU
HUB Deputy Director

John Grady (Research Facilities Director)
Executive Vice President, Philadelphia Industrial Development Corporation
HUB Associate Director for RDD&D Facilities Development and Management

Jane Snowdon (HUB Task 1 Leader)
Senior Manager, Industry Solutions and Emerging Business, IBM Corporation
HUB Associate Director for Integrated Design, Verification, and Modeling

William Sisson (HUB Task 2 Leader)
Director of Sustainability, United Technologies Corporation
HUB Associate Director for Advanced Components, Sub-Systems, Controls, and Diagnostics

Mark Alan Hughes (HUB Task 3 Leader)
Distinguished Senior Fellow, PennDesign and TC Chan Center, University of Pennsylvania
HUB Associate Director for Public Policy, Behavior, Economics, and Business

Andrew Zwicker (HUB Task 4 Leader)
Head, Science Education, Princeton Plasma Physics Laboratory
HUB Associate Director for Education and Workforce Development

James Gambino (HUB Task 5 Leader)
Vice President, Technology Commercialization, Ben Franklin Technology Partners
HUB Associate Director for Demonstration, Deployment, and IP Management
The availability of HUB Operating Committee members is presented in Table 3.3.1-1.

**Table 3.3.1-1 HUB Operating Committee Availability**

<table>
<thead>
<tr>
<th>Member</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henry Foley</td>
<td>100%</td>
</tr>
<tr>
<td>James Freihaut</td>
<td>100%</td>
</tr>
<tr>
<td>John Grady</td>
<td>100%</td>
</tr>
<tr>
<td>Jane Snowden</td>
<td>80%</td>
</tr>
<tr>
<td>William Sisson</td>
<td>80%</td>
</tr>
<tr>
<td>Mark Alan Hughes</td>
<td>80%</td>
</tr>
<tr>
<td>Andrew Zwicker</td>
<td>80%</td>
</tr>
<tr>
<td>James Gambino</td>
<td>80%</td>
</tr>
</tbody>
</table>

The HUB has a large and diverse team of 22 outstanding academic, industrial, National Laboratory, policy and workforce members who will work in a highly collaborative environment. HUB members will co-locate personnel at the Philadelphia Navy Yard, and leverage both human resources and facilities in several other locations. This physical co-location will create a critical mass of between 50 and 100 researchers enabling continuous interactions between investigators for the various projects. Through a combination of face-to-face and video-conference interactions, all project interdependencies will be continuously discussed. HUB members and the expertise they provide are summarized in Table 3.3.1-2.

**Table 3.3.1-2 HUB Members and Expertise Pertinent to the Program**

<table>
<thead>
<tr>
<th>Entity</th>
<th>Expertise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bayer MaterialScience</td>
<td>Advanced materials and energy-efficient building</td>
</tr>
<tr>
<td>Ben Franklin Tech Partners</td>
<td>Demonstration, deployment and IP management</td>
</tr>
<tr>
<td>Carnegie Mellon University</td>
<td>Architectural design, high performance computing</td>
</tr>
<tr>
<td>Collegiate Consortium</td>
<td>Education and Training</td>
</tr>
<tr>
<td>Delaware Valley Industrial Resource Center</td>
<td>NIST/MEP co-applicant, outreach education</td>
</tr>
<tr>
<td>Drexel University</td>
<td>Indoor air quality technology and controls</td>
</tr>
<tr>
<td>IBM</td>
<td>Cloud computing for design, database management</td>
</tr>
<tr>
<td>Lawrence Livermore National Lab</td>
<td>Software tools, math libraries, uncertainty analysis tools, dynamics and thermal modeling</td>
</tr>
<tr>
<td>Morgan State University</td>
<td>Workforce development, archiving of data</td>
</tr>
<tr>
<td>New Jersey Institute of Technology</td>
<td>Market assessment, industry/utility liaison, documentation</td>
</tr>
<tr>
<td>PPG Industries</td>
<td>Enabling component technologies</td>
</tr>
<tr>
<td>Pennsylvania State University</td>
<td>Architectural engineering and design, processes</td>
</tr>
<tr>
<td>Philadelphia Industrial Development Corporation</td>
<td>EDA co-applicant providing facilities at the Navy Yard</td>
</tr>
<tr>
<td>Princeton University</td>
<td>Outreach programs for teachers and students, wireless</td>
</tr>
</tbody>
</table>
Purdue University: Test bed facility for components and CFD
Rutgers University: Energy efficiency decision support tool design, human
Turner Construction: Integrated design construction methodologies & techniques
United Technology Corporation: Components, diagnostics, controls, integrated systems & policy
University of Pennsylvania: Policy, small business model development
University of Pittsburgh: Building-level heat transfer analyses, novel materials
Virginia Tech: Model reduction, optimization & sensitivity analysis tools
Wharton Small Business Development Center: SBA co-applicant, small business model development

3.3.3 Communication Plan

The co-location of HUB leaders and investigators, and the close proximity of all co-applicants, is a major advantage to promote frequent, thorough communication. Cisco video conferencing technology facilitates virtual meetings between all members.

The HUB enjoys the major advantage of location to promote communication. This occurs for both the co-located HUB team and GPIC co-applicants that are all in the greater Philadelphia region. The Operating Committee and the co-located investigators are spherically integrated to continuously confront all project interdependencies. The Executive Board and Advisory Committee meet quarterly, and will address the HUB and GPIC on strategic direction and emerging issue pertinent to the program objective.

The HUB has a clear plan for the use of state-of-the-art technology to support frequent virtual (video conference) meetings to promote meaningful long distance collaboration. As part of the Commonwealth of Pennsylvania $30 million capital fund commitment, a Cisco TelePresence system will be acquired as a primary medium for ensuring communication among co-applicants, partners, and stakeholder groups. Members of these groups that are located in the Greater Philadelphia region will be able to easily attend meetings at the Navy Yard location, or elsewhere in the region. However, others – e.g., faculty from Purdue University or Virginia Tech – may not easily be able to attend due to difficult logistics, the cost of travel to meetings, or scheduling conflicts; the video conferencing technology mitigates this communication barrier. Continuous interchange across all co-applicants, Hub members, GPIC partners, and members of stakeholder groups is critical to success.

A HUB website will also be established as a key communications tool, featuring continuous updates on all activities, links to other relevant sites and best practices in related fields such as retrofitting, developing new energy sources, creating green jobs, financing of new energy technologies and businesses. This easily-navigable, attractive site will provide open access to these topics by all Internet users. The web site will also include an interactive energy asset map, which will show HUB related energy resources, including companies, research and buildings in the region. The energy asset map will allow for the identification of opportunities and collaboration in the region. There will be password-protected availability for those directly involved in the program, including representatives of co-applicants, HUB members and selected constituent organizations. This area within the web site will be used for ongoing online collaboration, sharing of proprietary or project-specific information, internal communications,
and other features to facilitate communications and the efficient, effective meeting of project goals.

The HUB will also establish a cadre of spokespersons who will be available for speaking engagements, interviews, or presenting seminars on HUB-related topics. The HUB will publicize its history, activities, strengths, challenges, successes, and other features both in general media and in specialized journals such as the *International Journal of Renewable Energy Technology*, *Renewable Energy*, and the *Journal of Energy Resources Technology*. Information on the structure, implementation, and results of the HUB will also be presented in regional and national meetings of professional societies such as the American Institute of Architects, Association of Energy Engineers, and the IEEE Power and Energy Society.

### 3.3.4 Technology Management Process

| HUB technology development and transfer to product is managed by Operating Committee oversight and tracked by Stage Gate processes. |

The technology management process will use proven stage-gate processes for both technology development and technology transfer into products. The development process begins with the voice of the customer through requirements gathering, and proceeds through market-driven selection, technology development, and demonstration. Once a proper maturity is reached, the technology is transferred to member stage-gated product development processes. This approach, as depicted in Figure 3.3.4-1, is clearly differentiated from the traditional university and National Laboratory process in that market influence and technology innovation are tightly vetted and coordinated. In this construct, industrial partners have the ability to incorporate technology into products and quickly go to market with new solutions because market, policy and workforce issues have been addressed concurrently with technology maturation. With this approach many of the intellectual property pitfalls associated with the traditional approach can be avoided. That is, the traditional process of technology development without understanding market, policy and workforce issues has been shown to be less than ideal and is a catalyst for HUB formation.

On an annual basis the HUB Executive Board, with guidance from the Advisory Board, will commission a set of research themes called program task elements. These tasks will be of two types: fundamental enabling research and technology maturation/transition. Task elements will only be stopped when the stage-gate process identifies unaffordable technology risks or vanishing market impact. New elements will be created when data indicates that alternative technology investments would significantly enhance progress towards the program objective. Each element will be led by an Associate Director who will create a research strategy. Research associates from HUB member or partner organizations will be able to propose projects. These projects will be selected, funded and executed using the formal stage gate process described in Section 3.3.5 HUB Quality Assurance Systems.

In addition to these long term projects, a process to enable funding smaller innovation ideas will also be implemented. Its goal will be to reach out beyond the formal boundaries of the HUB to capture ideas and innovations that can be explored rapidly and cost effectively. This process will be facilitated through element area workshops attended by HUB members and partners, as well as, other leaders in the field. Workshop participants will provide input to the HUB in terms of feedback on current projects, gap assessments, and information about innovations they are pursuing outside of the HUB. These projects would be of short duration, such as associated with a visiting researcher, but could be the basis for a larger HUB funded project, an industrial partner...
funded project, or a proposal to another funding agency. Another key output from the formal workshops will be archival documents which will be placed on the HUB website and communicated through DOE, other government agencies, and policy setting bodies.

**Figure 3.3.4-1 HUB Technology Management Process**

The HUB members are responsible for the quality and integrity of goods and services they deliver. PSU, as prime contractor, will have responsibility to track the partners’ progress for DOE. HUB members and partners will be responsible for:

- Delivering and documenting technology prototypes, pilots, commercialization roadmaps, and milestones.
- Actively participating in reviews of technology prototypes, pilots, and commercialization roadmaps.
- Launching the initial set of HUB projects at the Navy Yard and Purdue University sites.
- Providing site data that will support regional and national cost-benefit analysis.
- Installing and maintaining persistent capital assets in support of Navy Yard development, demonstrate, and deployment tests.

PSU will establish subcontracts with all of the participating HUB members, acquiring material, equipment, and technical services in strict accordance with PSU procurement policies and guidelines. For these subcontracts, PSU will assume responsibility and accountability for subcontracted work and pass down quality assurance and other requirements as appropriate. Costs and schedules of subcontractors will be closely monitored to maximize the probability that work scope is met on schedule and within budget.
3.3.5 Quality Assurance Plan

Rigorous application of Stage Gate metrics ensures high value project execution. A proactive Active Engagement program identifies and archives known and unknown innovations.

Projects are advanced through a formal stage-gate process for both innovation and product development processes as illustrated in Figure 3.3.5-1. Periodic gate reviews are held to ensure that the project maintains commercial potential, the technology continues to be relevant and state-of-the-art, and all milestones are being met. Each stage of the process will have clearly defined success criteria to enable passing to the next stage of maturity. Table 3.3.5-1 provides an example of the focus questions and the focus areas used for each gate. When a project has advanced the technology to a sufficient level of maturity (generally technology demonstration), technology is transitioned to the product development and commercialization processes of member and partner companies.

![Figure 3.3.5-1 HUB Stage-Gate Process for Technology and Product Development](image)

**Active Engagement Using Scientific Information System (SIS)**

HUB team experiences, and scientific research, reveal that many good ideas are not vetted or even recognized because researchers are often focused on a single feature or result. To overcome this historical innovation and deployment gap, the HUB has developed a proactive Active Engagement infrastructure for the innovation and deployment process.

In large research projects the collection of data to manage and track the progress has produced challenges for research in their own right. There is a need to develop strategies for collecting data for building models, researcher communication and collaboration as well as project evaluation. The data structures possible when using object-oriented technology are ideal for developing static models of phenomena over time. There are automated tools (e.g., Enterprise Architect, Rational Modeler, etc.) available to model, archive and index these large complex data models. Also, researchers generate large volumes of research information which must be captured, archived and tracked over time for researcher communication and collaboration as well as project evaluation. A process developed at Morgan State University in collaboration with Johns Hopkins University provides a very good platform for this type of data processing, and it will be applied to the HUB program.
Table 3.3.5-1 Focus Questions for Each Stage Ensure High Quality Development

<table>
<thead>
<tr>
<th>Path-to-Impact Topic</th>
<th>Stage 1 Opportunity Analysis</th>
<th>Stage 2 Concept Synthesis</th>
<th>Stage 3 Critical Risk Reduction</th>
<th>Stage 4 Feasibility Demonstration</th>
<th>Stage 5 Technology Readiness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market</td>
<td>Market Need, Characteristics &amp; Trends</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customer Value Proposition</td>
<td>Decision makers, Economics &amp; Tradeoffs, Solution vs. Alternatives</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry Value Proposition</td>
<td>Path to Deploy; Gaps; Impact Values</td>
<td>Impact Value (NPV$)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competitive Position</td>
<td>Preliminary Competitive Assessment</td>
<td>Competitive Assessment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intellectual Property</td>
<td>Landscape; Preliminary Strategy</td>
<td>IP Strategy &amp; Plan; Disclosures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>Plausibility of Suitable-Concept Existence</td>
<td>Rich Collection of Candidate Concepts; Best Concept w/ Selection Criteria; Critical Risks &amp; Key Assumptions</td>
<td>Critical Risk Reduction; Key Assumption Validation; Refined Concept; Risks Remaining</td>
<td>MASC Pre-Test Predictions &amp; Model Validation; Marketing / Customer-Feedback Prototype; Unknown Unknowns; Risk Reduction; Refined Concept; Risks Remaining</td>
<td>BU Design System / Standard Work; Risk Reduction; Refined Concept; Risks Remaining</td>
</tr>
<tr>
<td>Progress</td>
<td>Status to Plan (Action Items, Milestones, Budget, Schedule)</td>
<td>Status to Plan (Action Items, Milestones, Budget, Schedule)</td>
<td>Status to Plan (Action Items, Milestones, Budget, Schedule)</td>
<td>Status to Plan (Action Items, Milestones, Budget, Schedule)</td>
<td>Status to Technology Transfer Plan (Action Items, Gate 5 Deliverables, Budget, Schedule)</td>
</tr>
<tr>
<td>Plan</td>
<td>Stage 2 Concept Synthesis Plan &amp; Rationale</td>
<td>Stage 3 Critical-Risk Reduction Plan &amp; Rationale; Gate 5 Deliverables</td>
<td>Stage 4 Feasibility Demo Plan &amp; Rationale</td>
<td>Stage 5 Technical Transfer Plan &amp; Rationale; BU Plan after Gate 5</td>
<td>BU Plan after Gate 5</td>
</tr>
<tr>
<td>Resources</td>
<td>Needs, Obstacles &amp; Changes</td>
<td>Needs, Obstacles &amp; Changes</td>
<td>Needs, Obstacles &amp; Changes</td>
<td>Needs, Obstacles &amp; Changes</td>
<td>BU Resources</td>
</tr>
<tr>
<td>Leveraging</td>
<td>Other Potential Impact</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Legend: (Focus) Focus of stage work  
(Required) Additional required element of stage work  
(Update) Update based on assumption validation and need for / availability of information

To understand the complexities in the research of energy efficient buildings requires large volumes of data to be collected to model, analyze, simulate and evaluate these phenomena. The data collected for this study will be analyzed and archived in static object-oriented models. This means that the data structures will be defined by classes and objects. Object-oriented models make it possible to store key building attributes as well as relationships between critical building components. A CASE (Computer-Aided Software Engineering) tool, the Enterprise Architect, will be used to model as well as archive the structures. This approach to data collection and archiving facilitates the HUB Active Engagement program.

3.3.6 Personnel Development and Recruiting Program

A comprehensive recruitment, development, and training program will be followed for the full spectrum workforce required to develop and deploy innovative energy solutions.

The goal for the education and workforce development is to assure that the new innovative energy efficiency technologies and systems are supported by a robust human capital infrastructure that will enable the diffusion of the technologies through demonstration and deployment. The workforce development efforts must also include outreach to diversify the workforce and include recruitment and training for members of communities who are underrepresented in the building trades to assure their participation in this important economic development effort.
The comprehensive program to recruit and develop talent in the energy sector, including under-represented groups, is fully described in Section 3.4.4, and outlines these activities:

- The HUB and GPIC will convene an Education and Training Board. The purpose of the board is to identify, document and inventory education and training resources, oversee education and training program development, assure alignment to research, development, deployment and commercialization tasks, and leverage the regional education and workforce development resources from the region’s Career and Technical Centers, Community Colleges, Universities, Workforce Boards and Building Trades Union programs.

- The Greater Philadelphia Region has an array of educational institutions with an existing energy education and training platform that will be leveraged to build the 21st Century Energy Workforce. The various education and training providers and support organizations create a continuum of programs for entry level to advanced skills. The Education and Training Board will organize this continuum into a comprehensive and integrated regional network to accelerate the rate of adoption of new education and training programs into a career lattice model to provide multiple points of entry into this sector of the economy. Current education and training partners have extensive experience coordinating and integrating programs for new technologies and industry sectors in the region. Because of its unique position in the Navy Yard and the region, the Collegiate Consortium will lead this initiative for the HUB.

- The Education and Training Board will also be charged with insuring that HUB members participate in the ongoing development of human capital for HUB members and their connections to the academic institutions in the region. The focus of this effort includes the establishment of a faculty working group and assuring the leveraging of industry members and partners.

- The Southeastern Pennsylvania (SEPA) Regional Workforce Investment Board (WIB) Collaborative includes leadership from the workforce investment boards from Philadelphia, Montgomery, Bucks, Chester, and Delaware County Pennsylvania. The SEPA WIB Collaborative joins with the Camden County WIB to provide support for regional programs that affect the regional labor pool and economy.

- To ensure that participants are a good match for the program and will gain successful employment upon graduation, a multi-tiered, targeted recruitment approach will be used. As the first tier, the recruitment team will partner with the State Unemployment Insurance office to distribute customized program marketing materials to workers who have been recently laid-off from occupations with a skill set that overlaps with those required in the program, such as construction and maintenance workers. For the second tier, the recruitment team will orient staff from all 13 one-stop centers in the region on the program, helping to define entry requirements so that the staff can correctly identify and refer dislocated workers coming into the centers. To facilitate recruitment in specifically-targeted communities that have concentrations of unemployed, low-income, minority residents, we will also work closely with Delaware County CareerLink in Chester, PA; Workforce New Jersey, with an emphasis on Camden; and the Philadelphia Workforce Development Corporation (PWDC).

### 3.3.7 HUB Intellectual Property Strategy

**HUB members agree to IP principles that form the basis for a Collaboration Agreement.**
All participants in the HUB agree, as a condition of participation, to share information. While the fact that sensitive and truly proprietary information must be protected, pilot data is not proprietary and will be made available, via a common database, to all the participants. The storing and post processing of the results will increase the value of the information and will allow analysis and re-analysis as the proof-of-concept moves forward.

The success of the HUB/GPIC integrated RDD&D program will be enabled by a comprehensive and integrated Intellectual Property management program and innovation management process, detailed in the HUB IP Management Plan (Appendix 3). All HUB participants adhere to a number of principles that will guide IP management, which will be incorporated into a comprehensive Collaboration Agreement to be executed by all members and partners. These principles include:

- All Foreground IP will be subject to any rights agreed to with the U.S. Government for the HUB activity.
- Commercialization and Creativity Institute (C2I) is the conduit for the HUB’s IP. Background IP may be donated by organizations at their sole discretion. GPIC has no ownership rights to IP either contributed as Background Intellectual Property or IP developed as a result of GPIC funding, Foreground Inventions. The inventors and their assigns retain ownership of any GPIC-generated IP.
- Members agree to participate in C2I activities through the execution of the GPIC Collaboration Agreement and provide staffing in kind, in the form of Technology Transfer or Licensing Officers plus their associated administrative costs, to support these activities.
- The GPIC Collaboration Agreement (CA) will clearly delineate ownership rights for sole or jointly developed intellectual property for both member institutions and companies.

C2I will create an Intellectual Property Team (IPT) which will serve as the conduit for the HUB’s IP management and commercialization. The IPT will perform the critical late-stage mechanisms for the HUB, accelerating an integrated pathway to successful technology IP management and commercialization. The IPT will be comprised of technology transfer officers and licensing professionals from the partners and members led by BFTP. The C2I will coordinate their activities and programs with the members and partners across all HUB and GPIC areas as an active participant in the overall management process and specific project stage-gate processes. This coordination role will focus on ensuring comprehensive demonstration, deployment, commercialization and IP connectivity between and among the on-going task research and their stage-gated project management activities.

### 3.4 PROPOSED RESEARCH AND DEVELOPMENT

The key focus of the research at the Navy Yard complex will be at the single building level, building cluster level, and district wide level of load diversified buildings. The research approach will focus on integrated design tool and design process development and dynamic subsystems: envelope, HVAC equipment, on-site energy production and waste heat utilization, energy storage, occupancy activity related loads, and control system technologies, so when combined, they act as one system. While this is not a new concept, there is a dearth of science in this area particularly focused on East Coast building design processes, methodologies and calibrated system modeling tools, construction techniques and materials, climate, and economic drivers. There is no dedicated whole-building research facility and campus capable of
performing all the levels of buildings systems research required (see below) associated with a collaborative organization such as those assembled under the proposed E-RIC.

A systems approach can realize significant gains in energy efficiency and is a clear pathway to realizing economically viable solutions to substantial reductions in building energy usage. The lack of demonstrations of highly efficient buildings points to the shortcomings that must be bridged with additional investments in science and technology. The competitive and national security environment is changing the urgency of the discussion and technology enablers are emerging that mandate a systems approach. These enablers are largely in the information technology area and are represented by much more capable ways of modeling and simulating building performance (computational abilities) and also much more capable ways of obtaining information and using the information for control (sensing and real time computation). Using these technology enablers along with unique prototyping and test facilities at the Navy Yard and partner Institutions such as Purdue to reduce risks will bring about substantial gains in energy efficiency in the building sector.

The research will focus on methodologies to design and deliver hardware and software solutions that realize the functional integration of dynamic building sub-systems and components including envelope, HVAC, lighting, on-site energy production and waste heat utilization, energy storage, and control system technologies, in a manner that is replicable across a broader building stock nationwide. The following descriptions of the HUB research are classified under five Task Groups that address Methodologies, Tools, Technologies, Policy and Market Instruments, Education and Workforce Development Initiatives, and Demonstration and Deployment programs. Under Task Group 1 specific research investments are proposed in systems for the creation of system engineering practices and associated design processes and tools, leveraging advances in high performance computing. Under Task Group 2 research investments to develop scalable (i.e. replicable) systems solutions for the full spectrum of building retrofits and the enabling component technologies are proposed. Robust control and diagnostics implementation platforms are then proposed for realizing the system solutions that lead to the deep retrofit designs proposed to be demonstrated. Task Group 3 describes the comprehensive research program targeted at understanding the policy, market and behavior obstacles to the uptake of energy efficient building system technologies and to model and implemented instruments (financial, policy and regulatory) that substantially increase the speed of technology adoption through increased ROI’s. Task Group 4 addresses the required education and workforce development that will ensure the broad adoption and use of the energy efficient system technologies proposed and demonstrated. Finally, Task Group 5 describes the path to relevant scale technology demonstrations and deployments that catalyze rapid commercialization and economic growth associated with the buildings and energy sector.

3.4.1 Task Group 1: Integrated Design Processes and Computational Tools for the Delivery and Operation of Energy Efficient Building Systems

This task addresses the challenge issued by the U.S. Secretary of Energy, Dr. Steven Chu: “We need to do more transformational research at DOE ... including computer design tools for commercial and residential buildings that enable reductions in energy consumption of up to 80
percent with investments that will pay for themselves in less than 10 years.\footnote{Secretary of Energy Dr. Steven Chu, House Science Committee Testimony, March 17, 2009} The proposed research will focus on developing a new methodology and associated tools to realize the integrated design and delivery of energy efficient buildings. \textit{Impact will be measured by the speed with which the design and delivery can be accomplished compared to current state and the quality of the designs as measured by the level of energy and built environment performance guarantees that can be made and ensured.}

Integrated designs utilized early in the building delivery process has demonstrated the feasibility of very low energy buildings, but such buildings have often failed to meet design intent\footnote{Lessons Learned from Case Studies of Six High-Performance Buildings, P. Torcellini, S. Pless, M. Deru, B. Griffith, N. Long, R. Judkoff, 2006, NREL Technical Report.}. Expected energy savings are typically lost through subsystem interactions not recognized during design and uncertainties in the operational environment. A transformation of the design and delivery of buildings is needed such that \textit{the energy and comfort performance designed into a new building or retrofit is maintained through construction and persists through operation}\footnote{Energy Performance of LEED® for New Construction Buildings, FINAL REPORT, New Buildings Institute, March 4, 2008}.

The realization of energy efficient building design and operation – and even net zero energy buildings – is possible by integrating on-site, combined heat and power with energy storage systems as well as ventilation and cooling systems with occupancy behavior. The integration of subsystems that have historically been designed, sold, installed and operated in isolation raise risks that can only be reduced by investing in a more substantial base in the \textit{design science for systems}. Current computer design tools do not enable detailed analysis of dynamic coupling between the building, its occupants and its external environment in a manner consistent with the users, design process, and required turn-around time. Even with current computer technologies, achieving the necessary fidelity and time to develop the necessary system solutions in an integrated manner will require high fidelity simulation platform, large scale data base and network based services delivery capabilities. These are unrealistic to have in-house for most building development firms.

Task 1 proposes a comprehensive program to develop and deploy integrated design methods, tools and an infrastructure that will empower a building project team, comprising architects, engineers, designers, contractors, the facility manager, and the building owner/operator to working collaboratively and efficiently in a retrofit, renovation or new build project. The advances will enable the team to rapidly conduct interdisciplinary design charrettes to develop innovative design solutions for delivering high performance buildings. The team is to access an integrated and interoperable suite of advanced computational methods, processes and tools to easily and rapidly iterate through the analysis and optimization of alternative design solutions and explicitly track cost and performance metrics with all the project stakeholders. The tools will accommodate all levels of fidelity ranging from physics based continuum models to reduced order models for rapid analysis and will handle major sources of uncertainty, building design variables, sensitivity analysis and dynamic interactions between sub-systems. The new integrated design tool kit will be capable of interfacing with both existing building modeling tools as well as with a new generation of more flexible tools based on object oriented, equation-based tools. Algorithms for high fidelity analysis will use the DOE investments and resources in high performance computing for parallel optimization. The resulting tools will yield a transformation...
in the industry’s capability to produce very low energy efficient buildings. From a practical standpoint of addressing the needs of small and medium-sized architectural and engineering (A & E), the core design tools and solutions are envisioned to be provided as services delivered from a computational cloud system.

Measured system performance through a deployed network of sensors and accessible from energy management systems will be compared with the predicted values, so that the systems can be adjusted and tuned to operate according to design specifications. This procedure will be repeated periodically as part of an ongoing commissioning protocol to sustain optimal building performance. As the model continues to collect data on “in-use” conditions, data-mining and machine learning techniques can be applied to develop new policies and context-based predictive control systems to optimize building operations and occupant services. This integrated approach will also serve as a basis for developing a rich repository of comprehensive evidence-based case studies for ongoing research and development as well as education of professionals for the building industry in the long term.

**Technical Objectives**
The goal of this task is to develop and implement integrated processes, computational tools and an associated database, software, and simulation environment for energy efficient building system design. The short and mid-term focus will be on retrofit design for buildings. The short term goals (<2 years) is to deliver a new methodology for integrated retrofit design project delivery. Computational tools will be developed that can be applied to existing building design and performance simulation methods to substantially enhance the speed with which design studies can be conducted and improve the extent to which energy performance guarantees that can be made during retrofit design. The mid-term goals (3-5 years) are to deliver a new generation of accurate, computationally tractable and user friendly modeling and analysis tools, and an interoperable computing, software and data infrastructure for building designers and operators. These will enable rapid turnaround for building design studies, interoperable digital representations and databases, and methods for rigorous requirements capture and tracking during energy efficient building system design and delivery. The methods, tools and infrastructure will be demonstrated via a deep retrofit design in an existing building in the Navy Yard, demonstrating the potential for up to 50% reduction in energy consumption with at least 5X speed up in design cycle time and with 5X less uncertainty in energy performance than achievable currently. The long term goals (5-10 years) are to demonstrate and deploy a new design environment for digital representation and visualization of building systems and new computer design tools that leverage high performance computational facilities, for the delivery and sustained operations of near net zero energy buildings.
The team will focus on four core and inter-related sub-tasks within the research, development and demonstration efforts (see Figure 3.4.1-1):

1. Integrated Lifecycle Project Delivery Process
2. Hierarchical Modeling for Building Design
3. Computational Tools for Design and Assessment
4. Data and Software Framework and Simulation Infrastructure

Subtask 1 will deliver an integrated building project delivery process that is based on parallel subsystem design techniques and when implemented can facilitate optimal planning and monitoring of the design, construction and operation of high performance buildings for both retrofit and new construction. Subtask 2 is focused on delivering a new flexible and hierarchical modeling environment along with a modular and open library of high performance building components and subsystems that can be used for design to operations. Subtask 3 will focus on developing a computational "toolbox" that will include efficient: 1) approaches and solvers for computing high resolution spatial and time variations of indoor environment when coupled to building structural elements and comfort delivery devices, 2) tools for optimal control design, 3) sensitivity and uncertainty analysis algorithms. Subtask 4 will deliver software and data infrastructure to integrate the tools developed in subtasks 2 and 3 that allows designers and operators to optimize the design and manage the operations of energy efficient buildings.

Subtask 1: Integrated Lifecycle Project Delivery Process
An integrated lifecycle project delivery process is needed to facilitate collaborative design and deliver long-term value to all project stakeholders. Requirements capture is vital to ensure that
the key performance attributes desired in a facility (for example, with respect to target levels of energy efficiency and indoor environment) are adequately captured, tracked and made visible to project team. This aspect will build on previous work by Kamara\textsuperscript{8} \textsuperscript{9} \textsuperscript{10}, ensuring that traceability is maintained throughout the project lifecycle, and that changes at an early stage of the process do not result in adverse ‘downstream’ impacts. Standard practice for facility design and construction is linear, with one participant completing a step prior to the next participant performing their work (e.g., developing the floor plan and façade design prior to energy simulations), providing participants little incentive to modify designs when better solutions arise. Specific research issues proposed to be addressed include:

\textbf{Process Mapping:} A high level process map will be developed to provide a framework for project teams to collaboratively design their detailed implementation processes. This procedure will be documented in formal guidelines for teams to use at the early stage of a project to evaluate and assess their process, along with the computational tools and data that they will use throughout the process. They will therefore be able to develop a design process which leverages existing analytical tools and allows for the integration of new computational tools to be developed in sub-tasks 2 and 3 of this task. Previous work including the Integrated Building Process Model (developed at Penn State) and the Process Protocol 2 in the development of this model will be leveraged\textsuperscript{11}. This process model will be developed using Business Process Modeling Notation (BPMN), and will be used so that the process maps can be easily converted into a Business Process Execution Language (BPEL). This is needed to convert the process diagrams into computable. The process will be validated through detailed analysis on case studies. A series of case studies will be performed to investigate the detailed decision networks within the design and construction planning processes. Process models for each case study will be developed to identify the important decisions performed by project teams within the design process through decision mapping. The decision maps will be used to inform the sequence of operations within the analysis tools, as well as identifying the information available for the computational tools as the various stages of design, e.g., schematic and detailed design.

\textbf{Change and Dependency Management:} Changes are inevitable in construction projects and are likely to occur from different sources, at any stage of a project, and with considerable impacts. Based on time, change could be anticipated or emergent, proactive or reactive, or pre-fixity or post-fixity. Based on need, change could be elective or required, discretionary or non-discretionary, or preferential or regulatory. Based on impact, change could be beneficial, neutral or disruptive. This necessitates an effective change management system for delivering energy efficient buildings. Change management relates all the internal and external factors that influence project changes. It seeks to forecast possible changes; identify changes that have already occurred; plan preventive impacts; and coordinate changes across the entire project\textsuperscript{12}. However, it is impossible to effectively manage change if there is no reliable model that captures the dependency between the key project elements. Thus, in addition to developing the detailed

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process maps, a change and dependency management tool that will provide a means to measure the level and impact of changes and process variations will be developed. This tool will enable more detailed analysis of the cost, schedule and quality impacts of fundamental process changes. A study of the impact of process variations between highly effective and integrated project teams vs. less integrated teams will be conducted to evaluate the timing and value of the computational tools used by the team. The detailed processes and task workflows used will be mapped to identify the detailed processes and best practices implemented.

Design Management: Given that energy efficient buildings can only be effectively delivered by integrated and collaborative teams, appropriate mechanisms and tools for these teams to explore innovative design solutions and to manage the collaborative input to the design process are needed. A design management process model will be developed that facilitates creative design space exploration and supports the iterative nature of design. Emphasis will be placed on ensuring that the design decisions are based on the most up-to-date information.

Subtask 2: Hierarchical Modeling for Building Design
Research will focus on developing and validating computationally tractable data- and physics-based models that accurately capture a broad range of building systems and physics, including architectural and structural models, material and property databases, dynamic thermo-fluid and component models, indoor environment and control design and lifecycle cost models. These models will provide virtual (or digital) representations of the building for use in design. The integrated design environment and required infrastructure, described in subtask 4, will enable multiple domain models to be seamlessly connected and concurrently exercised for rapid system trade studies and perform detailed whole building design and optimization studies. The key deliverables are model libraries and representations that can be easily ported to and exercised in the integrated design environment (see subtask 3). The models developed will also lend themselves to detailed analysis using the analytical and computational tools described in subtask 3. There is also a need to develop more robust models to represent the overall lifecycle cost impacts of design decisions so that teams will focus on lifecycle performance and costs instead of initial costs. Accurate first cost estimates for the design and construction of the subsystems of the facility will be developed. This will be accomplished by tying the facility component data and appropriate cost estimating databases. With capital cost data, along with the simulation data which provides lifecycle energy use, a lifecycle cost analysis will be developed.

Current building simulation programs (DOE-2\textsuperscript{13}, EnergyPlus\textsuperscript{14}) are monolithic tools that tightly integrate physical models with solution algorithms and program logic. These characteristics make it difficult to integrate models from different disciplines, to extend the modeling capabilities to emerging thermal, controls and communication systems, and even to model standard control sequences because of inherent limitations in the code architecture (data structure, solution methods, and lack of model encapsulation). Existing modeling tools assume coarse, lumped parameter, time-averaged, or steady state conditions that simplify the underlying building physics. These assumptions limit the fidelity of and hamper interoperability between models to simulate simultaneous states of different building components (e.g., thermal and mass transport). Tradeoffs between model complexity and accuracy are not well understood.

\textsuperscript{14} Crawley et al, \textit{ENERGYPLUS: NEW CAPABILITIES IN A WHOLE-BUILDING ENERGY SIMULATION PROGRAM}, 7\textsuperscript{th} IBPSA Conference, 2001.
particularly uncertainties arising from occupants, weather conditions, or operational uncertainty due to sensor/actuators/software malfunction. Flexible modeling environments for use in design and operation are lacking, and are critical to moving designs involving controls, diagnostics implementation with consistency and accuracy from conceptual to detailed design and verification.

The development of reduced-order building models amendable to controls design is proposed. The models must address heterogeneity involving multi-scale dynamics, mechanical equipment and controllers, with logical models for computation and communication. A modular modeling platform will be developed with reusable component libraries to capture the multi-scale dynamics of buildings and for assembly of heterogeneous components. The modeling platform is critical to enable a highly automated, process usable by designers and operators that will be scalable to the entire building stock. Automation is the key to reducing design cycle time and cost. And using models to quantify uncertainty is critical for system robustness and ensuring the persistence of energy savings throughout building operation. Use of advances in object oriented, equation based modeling methods is proposed. For example, open source platforms such as TRNSYS and Modelica platforms will be utilized. Energy dynamics models can be described by discretized partial differential equations and tools such as Matlab/Simulink or Dymola or EnergyPlus when appropriate will be used to describe these. Airflow dynamics model (for low energy consumption systems involving natural convection and thermal stratification) can be obtained by Galerkin projection of Navier-Stokes or Boussinesq models onto reduced set of modes and represented in Matlab/Simulink or Dymola. The modeling techniques will address the needs of the algorithm design and implementation into embedded systems described in sutask 2.

For physical system modeling, the Modelica language is an ideal choice. Its object-oriented design provides a formal method for implementing component models with different fidelity (for example steady-state vs. dynamic, and performance-curve based vs. detailed physical models) in such a way that they can easily be replaced by the corresponding model that is most applicable to design and operation. The standardized component interfaces and model encapsulation also facilitates designing schematic model editors for users to assemble system models graphically. Furthermore, since in Modelica, models can be assembled as a mechanical designer would assemble components, there is a unique mapping between HVAC system models expressed in whole building digital model and those expressed in Modelica. Such a paradigm allows each component to only see interfaces that a real object would interact with (such as a temperature and heat flux boundary condition or a data bus), making the integration of system models for different physical domains possible on the mathematical modeling layer (by linking model equations) as opposed to the program code and solver layer (by linking executables). The acausal modeling paradigm allows not only model reuse but also the use of symbolic processing to reduce the size of coupled equation systems1516; this is key to run-time efficiency and enables the simulation of large engineering systems17. The modeling will be based on the following principles: (a) separation of models from data and from numerical solution methods; (b) separation of modeling and simulation, allowing designers and users to spend their time defining the system topology, not examining causality needed to be imposed to make the system computationally tractable; (c) representation of models to the modeler in the most intuitive form,

such as schematic editor for HVAC and power generation systems, block diagram and finite state machines for control algorithms, and 3D object-oriented CAD for geometry; and (d) modularization of the environment (such as in Unix and Modelica). This will make the environment significantly easier to collaboratively develop and maintain, since different models and tools can be separated and individually tested.

Detailed and validated envelope and façade models are not readily available in Modelica and will achieve maturity later in the proposed program. We therefore propose to start in the short term with an EnergyPlus or TRNSYS building modeling framework in which conventional building systems and envelope characteristics can be modeled and suitable modifications can be made to evaluate novel control strategies for retrofit (see subtask 2). Models will also be developed to capture inhomogeneous indoor air distribution models to compute temperature, humidity and contaminants, dynamic envelope behavior, radiant floor and ceilings, and cooling plant dynamics. These can easily be integrated into an object-oriented framework such as in TRNSYS in the short term. These models also lend themselves to integration with a Modelica framework.

Subtask 3: High Performance Computational Tools and Applications

The importance of addressing both the fundamentals of scientific computing as well as taking a system level approach to the energy efficiency problems in buildings is well recognized as DOE challenges for R&D focus\textsuperscript{18}. Figure 3.4.1-2 illustrates the computational tools that will enable robust (with respect to model and operational uncertainties) and rapid design (i.e. computationally tractable and user friendly) of integrated building systems and are further described below.

(a) An important challenge in building simulation is flexible analysis tools that will allow architects and building design engineers to easily simulate the three-dimensional airflow and heat transfer in buildings on the scales of single rooms, multiple rooms, floors, and full buildings. The team will build such a tool based upon LLNL's parallel incompressible flow solver, Cgins, and the multi-physics solver, Cgmp, which supports coupling fluid and air flow with heat transfer in solids\textsuperscript{19}. These solvers, which are built upon the Overture object oriented framework, use efficient high-order accurate finite difference methods and matrix-free multi grid algorithms on overlapping structured grids and as a result can be orders of magnitude faster than other widely used approaches. In addition, Overture extensive CAD and grid generation capabilities will be extended to interface to architectural design programs and develop automatic grid generation capabilities, enabling rapid design changes for optimization. Appropriate turbulence models (e.g. LES) for internal flows will also be incorporated and Overture adaptive mesh refinement capabilities and error estimation techniques will be extended for building flows problems. The internal flow simulations will take advantage of a methodology developed at the Pennsylvania State University for selecting relevant boundary conditions. This can significantly decrease model input time for building designers.

\textsuperscript{18} Secretary of Energy Dr. Steven Chu, Caltech Commencement, June 12, 2009

(b) The team will develop new design specific reduced-order modeling methods that are fast and accurate for complex thermal fluid and energy flows and allow for robust parametric and control variations. These models will be created for whole building systems to model the dynamics of energy throughout the building. Traditionally, optimal designs and controllers are developed and deployed using a reduce-then-design approach. Until recently, this has been the only methodology available to enable simulation based design and optimization on time-scales that allow designs to be completed within reasonable time lines. Initially, we will take advantage of the reduced order modeling tools developed in the projects above and existing low dimensional design tools to develop fast optimization, sensitivity and uncertainty quantification algorithms. This work will have an immediate impact on the efforts proposed in Task Group 2. The reduced-order design models will also provide the backbone for the hierarchical modeling required in subtask 2 above. The resulting reduced-order design models will also be applied to data assimilation/real-time estimation, PDE control algorithms and design tools. The enabling technologies that will be brought to bear on this task are the recent development at Virginia Tech of sensitivity analysis tools for design specific reduced-basis functions, application of modern fluid dynamics closure models to account for the severe truncation of modes in reduced-order models, and multi-level algorithms to efficiently treat non-polynomial terms in model equations. Current approaches that couple dynamic thermal (energy) models based on transfer function approaches with indoor environmental quality models based on CFD are unbalanced since the integrated programs spend 99% of the time computing airflows and 1% on energy simulation. The computational speed makes the integrated model practically useless for design and as result this coupling is rarely considered in practice. However, the fluid flow calculation speeds can be increased by at least 3 orders of magnitude with reduced order flow modeling (Fast Fluid Dynamics) on graphical processing units, according to preliminary studies at Purdue. It is anticipated that an integrated model could be faster than real time for combined simulations of energy use, indoor air quality, and thermal comfort for moderately sized commercial buildings. This approach developed at Purdue will enable widespread use of coupled models for both design and operations. To ensure accuracy of reduced-order models for retrofit design, we envision that the models will need to be calibrated measured in-situ data. The Pennsylvania State University recently developed reduced-order airflow models that produced reliable simulation results when calibrated with on-site data.
(c) The second phase of this effort will produce advanced tools that take full advantage of HPC methods and software developed at LLNL, UTRC and VT to create holistic tools based on high fidelity physics models. A revolutionary new suite of computer design tools for buildings that are applicable to both reduced order design models and high fidelity physics models are to be developed. New control design tools, high fidelity sensitivity analysis and PDE optimization tools will be based on modern continuous sensitivity and adjoint methods. The holistic design-then-reduce approach will yield much greater accuracy and have a wider range of model applicability than the traditional reduce-then-design method. To achieve this level of improvement in speed and accuracy requires the solution of non-traditional partial integral equations in multi spatial dimensions. LLNL, IBM and Virginia Tech have developed various mathematical and software libraries that will be modified and integrated to rapidly build prototype solutions to this challenging problem. These include SUNDIALS (Suite of Nonlinear and Differential / Algebraic Equation Solvers) to solve the complex set of differential-algebraic partial differential equations that define the high fidelity physics models. In addition, these tools can be modified and extended to compute optimal control laws and to provide gradient information for optimization based design algorithms. SUNDIALS also provide the capability to perform sensitivity analysis directly on the partial DAEs. Since the Ricatti PDE equations that are central to optimal estimation, control and sensor/actuator placement must be solved on a 6-D mesh, it will be critical to adapt grids around sensors and regions of greatest sensitivity. The SAMRAI (Structured Adaptive Mesh Refinement (AMR) Application Infrastructure) library will be employed for this. This library is unique in that it provides AMR in an arbitrary number of dimensions. SAMRAI has scaled to 10,000s of processors on LLNL systems and is used in many of our important simulation codes. Parallel tools to carry out uncertainty quantification studies on high dimensional uncertainty parameter spaces are to be developed. These tools will include sophisticated Adaptive Sampling Refinement techniques to produce efficient and robust ensembles of simulations results, and methodologies to reduce the dimension of the uncertainty parameter space. The project will develop and test scalable algorithms for the purpose of generating response functions of very high dimensionality and also develop data assimilation techniques to incorporate sensor acquired data into the simulation data for a better characterization of uncertainties and for system optimization.

(d) Understanding and quantifying uncertainty and simulation error is critical to informed design decisions. Parallel tools will be developed to carry out uncertainty quantification studies on high dimensional parameter spaces. These tools will include sophisticated Adaptive Sampling Refinement techniques to produce efficient and robust ensembles of simulations results, and methodologies to reduce the dimension of the uncertainty parameter space. Existing software will be leveraged to develop an Uncertainty Quantification framework capable of managing the workflow associated with large scale systems. Developed data assimilation techniques are to incorporate sensor acquired data into the simulation data for a better characterization of uncertainties and system optimization. These efforts will leverage existing software and tools that will be redesigned to be optimal for the building studies and the associated codes. LLNL has extensive experience in the development of such tools, an example being the PSUADE software library, which supports uncertainty and sensitivity analyses via providing a rich set of experimental design and analysis method and a parallel environment for automated evaluations of the simulation models.
3.4.1.5 Subtask 4: Integrated Delivery Process Infrastructure

A cloud-based platform is proposed to support information integration, monitoring and decision support and optimization of energy efficiency building energy retrofits. The cloud will support the proposed integrated design framework that includes a robust process, a suite of mathematical models and computational tools for rigorous design, an integrating software framework which will allow plug-and-play assembly of individual design tools for different design tasks, and an interoperable data exchange and simulation infrastructure that will enable rapid analysis and robust optimization of low energy consumption building designs in the presence of uncertainty. A cloud platform provides many benefits including a flexible, vendor agnostic platform for data representation and exploration; effective re-use of assets that have been developed; incompatibilities and redundancies; fostering cross-functional design coordination and software compatibility; shortening development times through end-to-end process visibility; and reducing risk of quality, design, cost and schedule impacts. A conceptual schematic of the platform and enabled services is given Figure 3.4.1-3.

A hybrid approach is proposed that takes into account the state of a building over a period of time in conjunction with a behavioral model of the occupants of the building. Without factoring in the behavior of the occupants of the building much of the potential savings through energy efficient retrofits can be lost and become unsustainable. A measurement capability to rapidly acquire dynamic sensor data for temperature, air flow and other environmental parameters into an integrated monitoring, warehousing and reporting environment will be developed. The data acquisition capability will be tied to a platform that is easily accessible by the computing and design environment for ongoing calibration of models and for operational use. The approach will be to iteratively and incrementally calibrate the models used earlier for design with real-time sensing within the actual building so as to reflect actual building operation. As part of the continued building operation, the most active or fault-prone zones may be instrumented first for predictive maintenance while other zones may be simulated to provide for whole building performance assessments. As more data is made available, the calibrated models can be used to develop alternative building operation policies that adapt to changing load and environmental conditions.
The team will focus on the expansion of current model server approaches by developing a building data server approach based on open standards. Significant progress has been made in the area of common data exchange in the building industry with the development of information technology. Currently, the Industry Foundation Class (IFC), Green Building XML (gbXML) and Construction Operations Building Information Exchange (COBIE) initiatives which provide several informational infrastructures in the architecture, engineering and construction (AEC) industry. IFC and gbXML can both be used for common data exchange between AEC applications such as CAD and building simulation tools in a file based approach. However, the current data exchange schema from CAD tools is frequently limited to building geometry information. Other relevant material, component and system properties are very frequently separately specified within the energy modeling tools.

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The IBM-LLNL team will work to enable an industrial quality service solution to deliver the complete modeling, simulation and optimization environment to the design team’s desktop(s). This solution will include GUI front ends and interfaces that allow transparent linkage between data sets, secure and robust data management systems and cloud provisioned computational systems. This implementation will enable user friendly environment such that the problem set up, processing and analysis is automated. The resulting tool will take advantage of HPC capabilities being developed in subtask 3 to build workflow processes that can be managed from each designer or engineer’s workstation while delivering cost effective, accurate solutions of appropriate fidelity and speed to be practical for design. An integrating software framework and platform will be required to assemble the many data, analytics, modeling, simulation, optimization, sensitivity analysis, and uncertainty analysis elements which have to be included within the overall toolset. This framework and platform will have to support plug and play assembly of elements and tools to produce the separate workflows which are required for all the contributors to a building design process. The platform and object oriented software proposed will support the assembly of information from the buildings and its components to deliver the required analytics, modeling, design and optimization tools. The effort will take advantage of the process planning procedure developed in subtask 1 to allow project teams to design an integrated process and information flow. Furthermore, the platform will interface HPC tools such as LLNL’s parallel solvers *Cgins* and *Cgmp*, the hierarchical modeling tools and reduced order models developed in subtask 2 and subtask 3 with existing BIM and model-based design tools and software such as TRNSYS, Modelica, Matlab-Simulink, EnergyPlus etc.

Data modeling initiatives will follow a procedure which is similar to the overall development process defined within the NBIMS Version 1, Part 1 document for developing the National BIM Standard. This approach will focus on the development of specific information delivery manuals (IDMs) which target the specific use case areas where we will need to support the process with information. The IDMs will include the detailed process map for the use case, a description of the information exchanges which occur between the processes and a mapping of these information exchange elements to the Industry Foundation Class data structure. In some cases, we anticipate that IFCs may not support the full functionality desired within our modeling initiatives, and we will propose any required revisions to IFC to building SMART International for potential expansion within the next version of the standard. This will support the open standards initiative for the development of the NBIMS, and will also provide the fundamental framework that we need to support existing and new computational tools.

It is necessary to define a standard, open XML schema, to accelerate the delivery of innovative products for use in the architecture, engineering and construction industry. An open schema will remove barriers of uncertainty and vendor lock-in to allow vendors to compete on features and functionality in a fair and competitive manner, thereby, maximizing the choice of the end user. It will create the commercial conditions for vendors to include building performance metrics, concepts, documentation, and requirements within new and existing applications in popular use.

An important task will be to develop an underlying data and software framework for hierarchical modeling and data capture from a variety of disparate sources such as sensors, file based information exchanges, and public data resources. The scale of data management and tools interoperability, analytics, modeling and optimization involved will demand significant computational capacity. The systems required to host this solution are best provisioned using emerging cloud computing technology. Cloud computing solutions allow deployment of
complex computational services solutions cost effectively to communities of architects, engineers, contractors and building managers. The deployed solutions do not require special computing or information technology skills from the users, and can be maintained centrally. For typical building design projects where modeling costs have to be maintained at a reasonable cost percentage, cloud service provisioning of the modeling and management solution could be a very viable and cost effective approach for gaining access to advanced analytical applications and data server approaches. The cloud solution to be developed will include software architecture together with packaging of the framework and platform elements. This packaging will enable interoperability among components and support the addition of custom elements and tools at all levels within the platform. The goal will be to provide an extensible framework and platform together with a broad selection of tools, capabilities and workflows which can allow the cloud solution to be continuously enhanced with both open source and proprietary elements.

Knowledge management is also critical to engage the capture of lessons learned on project, codify this information within a computable structured system, and allow users to query this information as well as pushing it to them in a ‘just-in-time’ manner. In addition to the data server, we will develop a knowledge management system which provides a user friendly interface, as well as method to allow application programmers to easily embed knowledge query functionality into new application and interface designs. For example, imagine if a designer professional selects an exotic flooring material for a building space. If the design application is maintaining a communication link with the knowledge management server, then the knowledge management system can identify this potential issue based on rules that are operationalized within the KM system. Suggestions or issue descriptions can then be provided to the professional, in accordance with the particular context.

During the design and construction planning processes, it is critical to identify targeted design review checkpoints when all project stakeholders analyze the status of a project and make critical decisions regarding the path forward. Design support tools should provide the team with a real-time assessment of project performance with respect to a chosen certification procedure and requirements and will facilitate the final submission of materials for formal approval. Interactive forms of information visualization are needed to allow the team to quickly understand the design and extract valuable knowledge and innovative suggestions from team members. This becomes even more important as more sophisticated modeling tools are implemented since the team will require methods to quickly understand, interpret and verify the results of the computational models. Interactive visual prototyping methods will be developed to experiment and interact with the decisions that stakeholders are making throughout the process.

3.4.1.6 Expected Benefits

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<tr>
<th>Key Deliverable</th>
<th>Success Metric</th>
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<tbody>
<tr>
<td>Lifecycle process model which includes the a detailed integrated design process</td>
<td>Process model which can be used to develop integrated modeling approaches</td>
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<tr>
<td>Process planning procedure which allows project teams to design an integrated process and information flow for integrated design</td>
<td>A guide that can be implemented by project teams to design the integrated delivery process.</td>
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<tr>
<td>Measurement tool to quantify the impact of process change in the project delivery</td>
<td>Validated tool for measuring process variation which provides a framework</td>
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<tr>
<td>Reduced-order high fidelity models suitable for design environment and a hierarchal modeling toolset for design</td>
<td>Verified against HPC solutions and validated in full-scale buildings. Reduce design cycle time by 10X. Increase in design alternatives considered by 10X</td>
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<tr>
<td>Computational algorithms for design, control, optimization, uncertainty quantification and sensitivity analysis of whole building systems</td>
<td>10X speed up with enhanced fidelity models for design and engineering. Demonstrated on a full-scale energy efficient building design problem.</td>
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<tr>
<td>An integrated software and solutions framework to provide robust automatic coupling of the data, analytics, modeling, optimization and service delivery solutions.</td>
<td>A standards-based integration framework which supports plug and play capability for multiple elements and capabilities from many different sources within the total solution.</td>
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<tr>
<td>HPC based simulation algorithms, tools and environment to enable the development of high fidelity modeling for design of integrated whole building systems</td>
<td>Demonstrate the computational infrastructure (tools, software and user interface) on the design of a full-scale building</td>
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Performers

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<tr>
<th>Institution</th>
<th>Key Role</th>
<th>Key Personnel</th>
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<tbody>
<tr>
<td>Penn State University</td>
<td>• Process map integration&lt;br&gt;• Mapping of integrated design, construction and operations process&lt;br&gt;• Integrate modeling tasks with the National Building Information Modeling Standards (NBIMS) initiative</td>
<td>John Messner, Chimay Anumba, James Freihaut, Jelena Srebric, John Yen, Dan Willis</td>
</tr>
<tr>
<td>Purdue Univ.</td>
<td>• Reduced-order energy-thermo-fluid coupled modeling</td>
<td>Jim Braun, Y. Chen</td>
</tr>
<tr>
<td>United Technologies Corporation</td>
<td>• Object-oriented models for building systems and controls underlying low energy consumption designs&lt;br&gt;• Model libraries for promising enabling component technologies&lt;br&gt;• Model reduction techniques based on dynamical systems theory/tools</td>
<td>Satish Narayanan, Amit Surana, Zheng O’Neill, Sunil Ahuja, Yuan Shui, Dong Luo, Rohini Brahme</td>
</tr>
<tr>
<td>IBM</td>
<td>• Integrated data and software framework&lt;br&gt;• Overall software management, testing and</td>
<td>Jane Snowdon, James</td>
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3.4.2 Task Group 2: Whole Building Systems, Enabling Components, Robust Controls and Diagnostics

Efforts to integrate design early in the building delivery process have shown that very low energy consumption buildings are feasible while improving indoor climate and occupant comfort. But such buildings require significant engineering effort to design and implement (not achievable with current building sector workforce) and even so have often failed to meet design intent\textsuperscript{20}. Actual energy performance of low energy buildings versus design intent shows a gap of more than 30\%\textsuperscript{21}. Furthermore, building energy performance degrades after initial commissioning due to lack of actionable information, facility usage changes, and aging of equipment\textsuperscript{22}. The mid-to-late 1970’s approaches to reducing energy utilization by merely reducing building ventilation and infiltration rates resulted in the onset of indoor air quality (IAQ) induced health issues of epidemiologic proportions. The reduced ventilation rates in the context of the lack of controlled moisture, humidity, PM \textsubscript{2.5} and PM \textsubscript{10} particles resulted in the


production of allergic sensitization and asthma inducing species in indoor environments. The resultant health costs and reduced productivity, salary-related, costs associated with poor indoor air quality were 10 to 100 times that of any energy savings accrued. In short, approaches to reducing building energy utilization must take into account occupant environment and health.

It is accepted that using available state-of-the-art building materials, component and subsystem technologies with improved controls one can achieve 30% reduction of building energy utilization in retrofit and new construction applications. But energy reductions in the range of 70% to 80% cannot be achieved by incremental improvements to individual component efficiencies. For this, a systems view of the building or campus of buildings must be adopted, in which the sub-systems are functionally integrated during both design and operation to optimally and holistically manage ambient sources and sinks for heating, cooling, ventilation, lighting, energy storage.

The goal is to flatten and time shift the peak load expressions of dynamic heat gains or losses by integrating passive features into the building structural and site orientation characteristics. Optimizing passive design features facilitates the implementation of actively responding components and sub-systems to enhance load flattening and shifting. The intent is to establish a relatively constant thermal-to-electric load ratio for a building(s) application – deep retrofit or new construction. Once a relatively constant thermal/electric load ratio design goal is realized, the potential to utilize relatively mature systems technologies such as combined heat and power (CHP) becomes feasible for a wide range building and district applications. As on-site, renewable primary energy and hybrid energy production systems with short term energy storage technologies are developed for building systems, the building sector would evolve to having a net zero carbon footprint.

Robust operation of integrated building systems is critical to achieving and maintaining energy efficiency and high performance building environments. Current design practices ignore subtleties of dynamic and uncertain operational load characteristics, including seasonal variations in lighting requirements, temperature control, and occupancy patterns. Focus on peak load demands rather than on strategies for dynamic load shifting, for example, results in over- or under-sizing system components with detrimental effects on cost and utilization efficiency. The failure to robustly integrate controls that can adapt to changing usage within building automation systems prevents them from achieving optimal performance. Building operation is also severely compromised by poorly designed or malfunctioning control systems, resulting in substantial waste of energy, impaired indoor environmental conditions, and reduced productivity. Estimates of the impact of poor building operation on energy usage range from 15 to 30%, compared to the intent during commissioning23.

Behaviors of the subsystems are dissimilar, so their coupling is non-intuitive and overall system behavior can be difficult to predict and control. Furthermore, each building is unique with specific operational, environmental and occupant factors that are not easily predicted. An integrated approach to building controls should consider interactions between sub-systems and components to guarantee performance over the full range of environmental conditions and occupant factors likely to be encountered. Adaptive and predictive control strategies would

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follow from these considerations and be based on real-time modeling and utilization of robust sensor and actuator networks. Realizing energy efficient system solutions that persist over the building lifecycle requires:

- Establishing a set of building envelope, structural and energy storage technologies that can dampen and shift both ambient, envelope load and occupant, internal, transient load profiles
- Integration of high-efficiency, load responsive, components/sub-systems with passively optimized building system features
- Matching optimized building designs – relatively constant thermal/electric load ratio profile-with on-site generation and short term energy storage technologies.
- Rapidly configurable, easily installed and commissioned, robust controls and diagnostics algorithms and implementations that adapt, optimize and sustain energy performance at whole building and district scales while enhancing occupant comfort and health.

Finally, policy and business model developments that facilitate the application and rapid adoption of these advanced approaches to energy efficiency are necessary (see Task Group 3). The ultimate impact of the proposed research will result from delivering energy savings that last throughout the building lifecycle – not just meeting the design intent through commissioning.

Technical Objectives

The goals of this task group research are to develop scalable, deployable and robust hardware, firmware and software modules for building system solutions. The short term goal is to deliver system solutions to substantially improve the energy efficiency of existing buildings, demonstrating up to 30% reduction in energy consumption relative to a state-of-the-art building (a CBECS average24). The mid-term goal (3-5 years) is to prototype energy efficient retrofit system solutions that have less than a 5 year payback, are deployable with a 5X reduction in retrofit system installation and commissioning time, and enable a 50% reduction in installed system cost. The long-term task goal (5-10 years) is to deliver prototypes and demonstrations of systems solutions that deliver substantial reduction in energy consumption in existing buildings (> 50%) and in new buildings (60-80%) with attractive economics. The specific objectives are:

- Employing the computational capabilities and design tools from Task 1 for rapid synthesis and selection of system solutions for building retrofits and identify system solution sets, i.e. configurations of sub-systems matched to building types and usages. The hardware specification and control performance requirements will then be extracted.
- Demonstrate in sub-scale and full-scale testbeds, prototypes of system-level and enabling component solutions for deep retrofits applicable to a class of commercial and multi-family housing buildings and capable of up to 50% reduction in whole building energy demand with less than 5 year payback.
- Implement software tool prototypes for robust building control and diagnostics systems, and demonstrated reduction design time for algorithm and embedded system implementation from months to less than a week.
- Demonstrate prototypes of integrated control, performance monitoring and diagnostics platform and algorithms in sub-scale and full-scale testbeds, reducing retrofit installed cost by 50%, and with performance that is verifiable over an extended period.

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24 Commercial Buildings Energy Consumption Survey (http://www.eia.doe.gov/emeu/cbecs/)
Technology Roadmap and Multi-Year R&D Plan

The research, development and demonstration (RDD) is to be conducted with interdependent and phased projects under four technology themes – Integrated Systems, Enabling Component Technologies, Integrated Control Systems, and Performance Monitoring and Diagnostics Systems. Figure 3.4.2-1 illustrates the key research projects and annual milestones annotated against the “technology demonstrations” row. The effort will deliver system-level prototypes to ensure persistence of energy savings in sub-scale test facilities at Purdue University, Penn State University, University of Pennsylvania, Carnegie Mellon University, and at the Navy Yard and at least one full-scale, operational, retrofit building environment in the Navy Yard, achieving technology readiness level that is suitable for field trials and commercialization. Initial phase (< 2 years) will focus on technology development and demonstration at a sub-scale building level. Existing design tools and available building system hardware and automation system platforms will be used for the retrofit demonstrations. Later phase (3-5 years) will demonstrate technology scaling for applications at a full-scale building and district level with multiple buildings, using newly developed system and component hardware, automation and embedded systems and specified by design tools developed in Task Group 1.

The emerging technologies that will be exploited are: (i) networked distributed systems to support the computations in real time for measurement and decision support to maintain energy savings; (ii) object-oriented modeling platforms that enable modular and rapid assembly and design of system configurations and automated data analytics techniques for diagnostics; and (iii) advances in component technologies for efficient and cost effective delivery of primary building functions (e.g. lighting, HVAC etc.). Obstacles to be overcome are the lack of automation in: (a) translating energy efficient system designs and associated control strategies into embedded systems; and (b) failure mode identification and mitigation into diagnostic implementations. The research, development and prototyping efforts proposed are described below as subtasks.
3.4.2.4 Subtask 1: Integrated Systems

Deployment of systems solutions, i.e. configurations composed from standard components and controls and optimized for a building, in a repeatable manner requires a paradigm shift from the existing design and delivery process, whereby configurations are assembled sequentially and involve time consuming customization. Replicable system solutions can be accomplished by appreciating the fact that given a building type and an understanding of its usage and its micro-climate, design principles exist that can substantially reduce energy demand (such as daylighting, thermally activated solutions for heating and cooling, independent moisture management and humidity control, etc.). These system-level designs can be realized by a moderate number of system alternatives and hardware (see Figure 3.4.2-2). The challenge is to automate this procedure.
The research proposed will utilize models, tools, and methods developed in Task Group 1 for rapid synthesis of systems. The effort will implement user friendly, tools to explore and select system configurations resulting from functional integration of envelopes (curtain walls and fenestration), lighting and HVAC equipment technologies. Tools to rapidly assimilate data from existing buildings into the analysis framework are included and addressed in Task Group 1. The resulting database will serve as a technology option repository for techno-economic studies to be conducted in Task Group 3 projects and model validation studies conducted in Task Group 1.

A phased approach will be used to assess the integration of building systems at various levels, namely involving building envelope modification, component and control system modifications, and integration of on-site, distributed energy production and short term energy storage systems. The initial phase will prioritize system-level concepts and alternatives from energy and comfort performance, and economic standpoints, providing functional requirements. Architectural exploration will be conducted using constrained comparison studies to identify candidates and benefits for retrofitting existing buildings. Tools developed in Task Group 1 will be used to conduct these trade-off studies, including cost-benefit analyses of approaches to reducing building loads through passive and active management of thermal sources and sinks. Efforts will then aim to integrate across a broader range of sub-systems, spanning building envelope, lighting, space conditions and other components, and district energy systems such as cooling/heating plants, on-site power generation and renewable systems. An initial set of system solutions have been identified for early investigation and are described first (see Figure 3.4.2-3).
Building Integrated Combined Heat and Power Systems: The conventional use of dedicated heating, ventilation, and air conditioning systems for space conditioning has several shortcomings, including poor efficiency of grid electricity (only 32% of the energy input at a central power plant reaches buildings), large carbon and emissions footprint signatures due to the high fraction of coal and fossil fuels used in central power plants and the fragility of aging electrical grid and its susceptibility to outages. These issues can be addressed by Combined Heating and Power (CHP) systems that generate electricity locally, eliminating transmission and distribution losses, and are capable of converting, in time, to renewable biomass based fuel stocks. The “waste energy” from the power generation can be captured for cooling and heating for buildings, increasing the overall efficiency and system utilization. The use of combined heat and power approaches would immediately lower the fossil fuel use associated with building systems by 20-30%, relative to SHP (Separate Heat and Power = grid supplied electricity with separate on-site boiler system) configurations. First generation packaged CHP systems are available that comprise multiple micro turbines or internal combustion (IC) engines with heat recovery technologies with a manifold system of hot exhaust and/or oil and jacket heat recovery from IC prime movers generally vectored to a single absorption chiller. The systems are limited to providing cooling or heating depending on the season. A new CHP system that utilizes highly efficient, low emission micro turbines or IC engines to provide simultaneous cooling and heating is proposed. Alternative CHP system architectures including integrated fuel cell-micro turbine configurations and fuel cell-absorption cycles will also be explored. A thermo-fluid analysis of the overall system will be combined with heuristic descriptions of individual components using micro- to meso-scale performance models. Adaptive control and optimization to operate the system with dynamic building load profile, energy price and weather will be investigated. When the micro turbine system generates more electricity than needed on site it can be exported to the
local utility grid, a matter of policy development focus in Task Group 3. The characteristics of short time scale electrical and thermal storage systems to be operated in conjunction with the CHP prime movers and heat recovery technologies will be identified. The stored energy forms are to be used to meet production and load mismatches of the CHP system output and enable the building to remain grid independent over a wider range of operating conditions while maintaining optimal performance states of the prime mover system.

Building-Integrated Photovoltaic (BIPV) Systems: The impact of BIPV systems on thermal space loads, lighting levels and indoor environmental comfort will be studied through simulation and testing in both Purdue and Navy Yard facilities. As the market penetration of BIPV increases, economics and reliability considerations may require operation of BIPV systems as autonomous islanded entities or as part of hybrid CHP systems with integrated electric storage. Current utility practice requires that BIPV systems be disconnected from host distribution systems in the event that the distribution is disconnected from the main grid. Research will be conducted to investigate BIPV systems with battery storage to optimize system performance, efficiency, storage capacity, life time and costs. New concepts will also be developed for envelope systems designed to incorporate photovoltaic technology as part of the building architectural and structural design.

Improved whole building energy performance for most climates requires increased use of insulation. The proposed effort will develop new and increase existing bio-based content of insulation systems (rigid insulation board, insulated architectural panels, and spray-in-place insulation) to reduce reliance on currently prevalent use of petroleum based raw materials. Studies will also be conducted to evaluate the enhancements that reflective coatings, phase change materials, and thermal mass can have on building system performance, when integrated with advanced insulated panel systems.

Subtask 2: Enabling Component Technologies

Enabling high performance building component technologies, such as radiant cooling and heating with dedicated outdoor air systems and independent heating, cooling, ventilation and moisture management solutions, have the potential to substantially reduce whole building energy consumption while improving indoor comfort and environmental quality. However, these technologies have not been widely adopted due to lack of established metrics, models and prototyping capabilities to accurately verify and quantify the performance of the components and the system. Several component and sub-system technology advances are proposed to enable whole building system solutions for energy efficiency and superior indoor environmental quality.

Advanced Independent Sensible/Latent Cooling and Ventilation Systems: Most buildings condition a combination of outside (ventilation) makeup air and recirculated (return) air. Latent (humidity) loads are typically handled by cooling the air below the dew point to reduce humidity and then re-heating it to reach the desired air temperature. A highly integrated, high-efficiency HVAC system for commercial buildings can be at least 30% more efficient than conventional approaches. It decouples the sensible (air temperature) and latent and latent (humidity) cooling loads and is based on integrating an optimized, high-efficiency chiller and a Dedicated Outdoor Air System (DOAS). The high efficiency chiller is designed to provide sensible cooling by providing chilled water at a higher set-point than conventional systems. This allows for the integration of low energy cooling devices such as chilled beams (induction diffusers), radiant ceilings, and ground source heat pumps. The DOAS module provides dehumidification and cooling using liquid desiccant technology. This system can reduce the ventilation required to
meet ASHRAE Standard 62 (Ventilation for Acceptable Indoor Air Quality)\(^{25}\), thereby reducing both the fan energy and the energy required to condition the ventilation air. To compliment this, hybrid ventilation technology will be developed to ensure uniform outside air distribution without pollutants, noise and draft. This will combine solutions for cross ventilation, stack ventilation, solar induced ventilation, night ventilation, thermal mass heat exchange and re-radiation, while eliminating condensation on internal building surfaces. Concepts to combine energy recovery with ventilation are proposed to be integrated within windows, such as the dual-airflow window concept, that operates like an efficient heat exchanger while providing fresh air to occupied spaces and reducing ambient noise associated with operable windows.

**Integrated Indoor Air Quality Management Systems:** This subtask will focus on the RDD of critical IAQ technologies for energy efficient and productive building environments. Moisture and humidity control over the building lifecycle are also critical. The principal metrics are materials moisture management control in building material, humidity and airborne PM\(_{10}\) and PM\(_{2.5}\) particle control throughout the building indoor environment. Volatile organic vapor (VOC) contaminants from non-biological sources – paints, synthetic fabrics, insulation, etc. - will be addressed by source control, i.e., the development of non-volatile, building materials. The IAQ research will focus on developing moisture and humidity control technologies as well as small particle (PM\(_{10}\) and PM\(_{2.5}\)) particle monitoring and control technologies. Non-volatile, biochemical compounds are transported into the indoor air spaces on “carrier” particles in the <10.0 micron (PM\(_{10}\)) regime, with the less than 2.5 micron (PM\(_{2.5}\)) fraction and are associated with the greatest health risks due to their high probability of inhalation and deep respiratory system deposition. Recent advances in humidity ratio sensors and Light Emitting Diode (LED) enable real time, reliable monitoring of humidity and PM\(_{10}\) and PM\(_{2.5}\) at reasonable costs. Real time monitoring of these species enables real time, demand activated control technologies to be integrated into the building HVAC system. Independent humidity control technologies noted above can be utilized to control humidity levels so that fungal and dust mite growth is not viable in the building. Viable microbe contaminants – virons, fungal spores, bacteria – can be deactivated by Ultra Violet light technologies. Size distributions and size dependent number concentrations of protein allergen, pesticide, insecticide, plasticizer and flame retardant chemical carrying particles could be identified by low cost, multiple wavelength LED based light scattering sensors. Control device activation signals can be sent to particle arrestance technologies embedded in the HVAC system. These deactivation and arrestance devices are too energy intensive to run continuously but appropriate sensor technologies would enable their demand control activation to be feasible.

**Dynamic Façade, Fenestration and Lighting Systems:** Daylight harvesting, to enable light redirection and diffusion with solar heat and glare control, light transport for building depth, and bilateral lighting are proposed to be integrated with electric lights to ensure appropriate light levels for the occupants. The proposed research will translate the latest developments in high quality volume holography technology to develop multiplexed holograms and systems for application to window glazing, harvesting light deep into the building core. Research in emerging integrated glass technologies will enable control of solar heat gain and the amount of light and view in response to the ambient environment or sensors, providing energy savings.

\(^{25}\) http://www.ashrae.org/
These integrated sensor and control systems will be designed into building window glazing to satisfy not only energy saving requirements, but also aesthetics to ensure adoption.

Opportunities for lighting system energy savings also will be explored by implementing integrated lighting and shading controls. Retrofits to building lamps and luminaires must address lighting quality as well. A task-ambient lighting approach has the potential to save energy. Controls, such as occupancy sensors and integrated lighting control in daylight zones offer opportunities to harvest additional savings when spaces are unoccupied, or when daylight levels are sufficient across an area or space. Digital and wireless lighting control equipment make implementation of control into existing systems cost effective (without rewiring), although the development of packaged systems for retrofit are needed. Solutions focusing on reliable and inexpensive electric lighting control systems that respond to daylighting appropriately and that can be easily and cost-effectively integrated into existing buildings will be explored. These studies will investigate daylight quality and its impact on occupants (glare, comfort, satisfaction, and performance), and explore the energy implications of glazing materials, daylight and shading configurations across different climates.

**Subtask 3: Integrated Control Systems**

The implementation of energy efficient systems and components described above requires robust control and diagnostic algorithms that will be realized through networked embedded processing, sensor, and actuator systems. Control systems must be effective over a wide range of conditions, some of which may not have been anticipated during the design phase. Achieving robust operations is challenging because of the wide variations in usage patterns, unpredictable environmental factors, and equipment degradation and failures. The proposed approach will extend beyond traditional controls, and utilize optimization-based prediction, machine learning, and embedded system and network design and verification techniques. The methodology will, on the one hand, automate many of the difficult control system design and programming tasks, while encouraging much greater engagement by building occupants in tailoring their environments. The control design and implementation must be automated for deployment in a scalable and cost effective manner. A model-based and modular approach is proposed that uses automated validation and verification tools\textsuperscript{26}. A new set of control algorithms and implementations will be pursued that provide guaranteed performance with robustness margins for whole building system solutions. These algorithms would be packaged much like today’s PI controls that use graphical programming, but would allow a larger set of design options and operation strategies. The following obstacles to robust implementations must be tackled:

- In current practice extraction of control algorithms for software and hardware implementation is manual requiring tuning during commissioning and occupancy phases.
- The embedded hardware development cycle time becomes significant when assessing computational and communication requirements for control algorithms.
- Current software implementations require exhaustive field testing and tuning.
- Current control architectures are inherently Single-Input, Single Output feedback loops (typically PID type) that ignore variables associated with sub-system coupling, and do not utilize prediction. Fixed parameters are used that are not optimized and do not adapt to indoor and outdoor changes, resulting in low performance and instabilities.

• Tools for distributed control analysis and designs to handle multi-scale dynamics associated with energy efficient system solutions are lacking.
• Performance analysis of distributed embedded systems is complex as a result of wired and wireless communication, computational resources, and network delays and jitter.
• Relevant variables are not all available from measurements. This includes external (weather-driven) and internal (occupancy-driven) loads, and thermal and airflow states.

To overcome the above research and development projects are proposed and will deliver:

• High level control algorithms to generate optimal set points for lower level controllers, accounting for outdoor and indoor disturbances with uncertain thermal loads.
• Adaptive control algorithms that can adapt and optimize performance with changing environmental and building usage conditions. Model-predictive controls to compensate loads in a predictive fashion while respecting state and actuation constraints
• Model-based estimators to estimate and predict the future evolution of the relevant states (including external and internal loads)
• Distributed control algorithms to enable robust controllers at the sub-system level
• Tools for analysis of the control system for robustness and stability27.
• Tools for auto-coding and model-based validation and verification to automate hardware implementation directly from control specifications.
• Prototypes of energy efficient building controls and embedded systems

The technical approach will be divided into four areas described below.

Robust Supervisory Controls Platform: The development and deployment of a controls platform is proposed that would accomplish dynamic optimization, adaptation and robust performance. There are several approaches to optimize building system performance, including first-principles predictive models, data-driven models and other system identification or adaptive techniques. An approach is needed to determine set point variations over time that minimizes overall costs, accounting for both energy and demand, and subject to comfort constraints or cost impacts of occupant comfort. This would have to be tailored to specific sites where a retrofit opportunity exists or for new construction building control design.

Real-time parameter identification methods to adapt to building and weather changes are proposed for model-based optimization and controls. Overall system performance can be optimized by tailoring operating parameters in response to dynamic environmental and occupancy conditions. Energy efficiency gains of 10-20% in existing and new buildings are feasible when utilizing dynamic knowledge of the plant loads and environmental disturbances28. Reduced-order models developed in Task Group 1 will be used to develop control and estimation algorithms and to address optimal actuator and sensor placement. “Grey-box” modeling will be used to combine first principles knowledge of building thermals with data.

New tools, methods and algorithms for distributed, optimization-based control approaches are also proposed which are suitable for controlling spatially distributed controller agents in buildings. Optimization-based control approaches such as Receding Horizon Control or Model

Predictive Control (MPC) ideas have been the industry’s method of choice for control of multi-variable, constrained nonlinear processes. Traditionally, these approaches have been used when the processes are intrinsically stable or slow. In the proposed scenarios, where sensor and actuators are distributed throughout the building, we will be able to exploit locality features for optimization based control of spatially distributed problems in which the variables are coupled in the cost function as well as constraints. The key to a distributed implementation of the model-predictive control is to be able to estimate the state and input of the nodes that are not within the communication range. A scalable MPC scheme that only requires communication of information among neighboring systems is proposed to tackle this.

This sub task will also include the development of supervisory strategies for optimal management of building energy demand with supply side (such as from distributed generation). This level of control policies will be implemented on the top of the building supervisory control described above. Adaptive response techniques will be investigated on the demand side including load-shedding solutions at peak times. These will take advantage of price variations and technologies for occupancy monitoring, smart metering and plug-in devices. Real time weather forecasts and disruptive changes will be taken into account in synthesizing demand response solutions. On the supply side, the task will include the development of optimal scheduling of the portfolio for on-site energy sources (including renewable and non-renewable), and the power grid according to the demand at various times of the day.

Hierarchical, Distributed Controls Techniques and Algorithms: Control architectures that exploit local information in concert with global (whole building) information will be investigated as a means to realize “plug-and-play” controls. This will enable modularity and fault tolerance, reducing software development costs and improving maintainability. This approach is often referred to as an agent-based control system, which consists of many subsystems (agents) interconnected by a network structure over which common resources such as energy can be shared and information can be exchanged. Distributed building control systems provide an ideal platform for applying the agent-based system model: individual agents would be embedded with separate energy-consuming devices such as envelope, lighting systems, chillers, cooling towers, terminal cooling/heating units, etc.; and these agents would collaborate to minimize total energy costs while satisfying constraints associated with comfort. Initial development and testing will occur in a simulation environment. The resulting control architecture and algorithms will then be tested within the sub-scale facilities at Purdue University.

Another often-ignored, but critical, source of uncertainty for terminal controllers is occupant-driven loads, which are dynamic and spatially distributed, and occupant behavior. Research is proposed for robust and scalable algorithms to estimate occupancy involving dynamic models that describe the aggregate movement of occupants that will be integrated with available occupancy presence or level measurements (e.g. motion sensors, access control devices, and cameras). Furthermore, a large-scale Agent-Based Model (ABM) to simulate occupant behavior and interactions between equipment and occupants will be used to assess the impact of operational settings of equipment and energy conserving initiatives on occupant behavior. Advanced machine learning techniques such as sequential data mining and pattern recognition

n\textsuperscript{31}, and Hidden Markov Models\textsuperscript{32} on aggregated sensor data will be used to assess occupant behavior. Building upon occupancy level-based controls, methods for highly localized comfort control will also be explored. For instance, occupancy sensors, coupled with directional radiant emitters have shown heating energy consumption savings of up to 40\% without sacrificing personal comfort\textsuperscript{33}.

**Automatic Embedded Code Generation Tools:** To realize the advanced control algorithms in robust implementations, tools are needed to automatically program controllers from specified control sequences. The heterogeneous composition of computing, sensing, actuation, and communication components in building automation systems is very challenging, particularly for control systems in which sensors send data to actuators via a bus shared with other applications. An approach is proposed to specify and implement dynamic scheduling policies for the bus with performance guarantees. A scheduler is automatically generated from a model of the controlled plant and the controller\textsuperscript{34}. In addition to ensuring performance, the approach allows adjustments to dynamic conditions such as varying disturbances and network load. Full development from controller performance specifications (exponential stability) to control design and its implementation using Controller Area Network (CAN) will be pursued. The approach has already been integrated with Simulink, the de-facto standard for control system modeling and analysis. The approach will be integrated into Simulink via the Network Code Machine extension\textsuperscript{35} in the TrueTime library.

**Model-based Validation and Verification of Control Designs:** A key issue to be addressed is the verification of implementations of system solutions (involving components and controls), without having to rely entirely on field testing and tuning. As embedded control systems gain more functionality and complexity, a model-based design paradigm is needed to develop design models and subject them to early analysis, testing, and validation prior to their implementation. Simulation-based testing ensures that a finite number of user-defined system trajectories meet the desired system specification. However, it is impractical to test all system trajectories, i.e. conditions encountered in the operational environment. One can construct relatively detailed models of building energy and control systems using various modeling languages that mix continuous and discrete time models. However, due to numerical solver robustness issues, brute-force simulation-based testing and analysis for hybrid models of embedded control systems can be unreliable. A new framework to test the robustness of embedded control systems is proposed. The central idea is that the robustness of nominal test can be computed and used to infer that a set of trajectories around the nominal test will yield the same qualitative behavior, i.e. the margin. By computing the test margins, one can estimate the robustness for the control design and provide well-defined coverage metrics using finite number of tests.

\textsuperscript{31} Dong et al., Sensor-based Occupancy Behavioral Pattern Recognition for Energy and Comfort Management in Intelligent Buildings, 11\textsuperscript{th} Int. IBPSA Conference, 2009.

\textsuperscript{32} Lam et al. Occupancy Detection Through an Extensive Environmental Sensor Network in an Open-Plan Office Building, 11\textsuperscript{th} Int. IBPSA Conference, 2009.


Subtask 4: Performance Monitoring and Diagnostic Systems
Research will be pursued to develop an energy management and automation system with a
hierarchical diagnostic capability, i.e. one that spans all major energy-consuming systems in a
building (HVAC, lighting, on-site power generation, etc.). State-of-the-art Building Management
Systems provide facility managers with a complex and rich set of data, including system and
equipment performance (temperature, humidity, pressure, energy consumption, mass flow rates
etc.), controller status, and equipment fault status. However, the uncertainty and sheer volume of
this data hinder decision-making. The failure modes and critical parameters associated with
performance degradation in building system designs must be managed via diagnostics to ensure
persistence of energy savings and comfort performance. The system must detect faults and
operational inconsistencies at the component and system level, and help identify operational
problems in an actionable form. The following obstacles exist to robust fault diagnostics:

- Whole building performance metrics and visualization techniques are not actionable
- Fault isolation and diagnostic approaches are manual and depend on highly skilled labor
- Deploying sensing for monitoring and diagnostics is complex, ad hoc and cost prohibitive
- Complexity arising from the number of parameters, size of data streams, range of dynamics
  involved, and uncertainty in operating conditions (e.g. occupant behavior and weather),
  hinder real-time, actionable performance visualization
- Extraction of diagnostic algorithms for software and hardware implementation is manual
  requiring tuning during commissioning and operation phases

To overcome the above obstacles, research projects are proposed and will deliver:

- Performance metrics and visualization techniques aimed at energy efficiency and occupant
  comfort while improving the decision making process for a facility manager
- A scalable, robust sensor network platform comprising sensing, computation, and actuation
  that can be cost effectively deployed for retrofit applications
- Tools and methods for model-based development, auto-coding and validation and
  verification of system and equipment fault diagnostic algorithms
- Prototypes of embedded diagnostic platforms for building systems and equipment

Energy Performance Monitoring and Visualization System: The research focus will be to manage
the complexity and volume of data to improve facility operator and other stakeholder decision-
making by making relevant performance metrics visible and actionable. A methodology to select
sensor type, number, and placement for cost-effective building performance monitoring will be
developed. Research will extend the interoperable digital building information framework
described in Task Group 1 to represent static and dynamic building information, including design
specifications that are stable over the building lifecycle (e.g. equipment manufacturing
information, their locations in a building, desired equipment performance curves, equipment
interconnections, material libraries for performance modeling), and real-time building or
equipment performance, occupant comfort metrics, fault status, etc.

Model-based System Diagnostics Techniques and Algorithm: An important gap that will be
addressed is the development of models appropriate for diagnostics, in particular for off-nominal
system performance. The models include data-based models, statistical or graphical models, and
physics-based models of building systems and equipment. A specific development will be
“inverse models”, derived from empirical behavior and with parameters obtained experimentally
with system identification techniques. Such models will be used for real-time performance
monitoring and diagnostics, but also enable retrofit analysis, measurement and verification of efficiency improvements, and on-line optimization. Previous work at Purdue led to the development of an inverse model for building dynamics that utilizes a transfer function derived from a low-order state-space representation, reproducing cooling or heating requirements with rough building descriptions. Techniques such as principle component analysis (PCA) combined with wavelet transform and pattern matching methods will be explored for automated fault detection and diagnosis of building systems as well. Generalized software prototypes will be developed and tested for a number of building case studies. Initial development and testing will occur in a simulation environment. The resulting approach will be assessed within the Living Laboratory at Purdue University and the Navy Yard retrofit and new construction test beds.

Model-based failure modes and effects analysis (FMEA) for energy efficient building system designs will be performed to inform fault accommodation procedures. This will enable automatic simulation of building system behavior subject to fault scenarios not easily identified through manual and experience-based FMEA approaches. Diagnostic algorithms that utilize probabilistic pattern identification and change detection will be used to capture system level faults. The reduced-order models of building systems and equipment will enable embedded diagnostics. System identification techniques will be used to accurately estimate model parameters. A model-based system emulator for validation and verification of system and equipment diagnostic algorithms will be developed and evaluated for a number of building retrofit case studies.

**Distributed Embedded Diagnostics Techniques and Algorithms:** Prototypes for distributed embedded diagnostics are proposed. A distributed diagnostic architecture will enable equipment or subsystem diagnostics to be deployed as plug-and-play modules that can communicate with higher level system diagnostics. The distributed system will include: components with embedded “virtual sensing”, connectivity to obtain inputs for weather and utility variables and provide outputs for a user interface, and a decision-support module that utilizes inputs from the virtual sensors to reliably detect and isolate faults and combines this information with utility rates and service cost information to provide overall economic performance outputs and service recommendations. A “virtual sensor” utilizes an embedded model for device performance (e.g., a static compressor map or a dynamic thermal model) and low-cost measurements (e.g., temperatures) to estimate relevant outputs that would be expensive to measure (e.g., mass flow, power consumption). Sub-scale testing and simulations will be used to evaluate embedded diagnostics solutions for components associated with primary building functions.

**Robust Wireless Sensor Networks:** Installation and commissioning of building monitoring systems account for 70% of the installed costs. A robust wireless sensing network (WSN) platform is needed with sensing, computation, and actuation suitable for retrofits - especially facilities not served by a building management system - at a low installed cost. The research focus will be to design an optimum configuration of sensor node clusters and the network platform. Based on the power requirements and the domain information that has to be processed and communicated between nodes, the node distribution (placement, connectivity, and number) will be optimized. Technologies for self-powered wireless sensors will be explored that utilize advances in energy harvesting to enable low cost energy efficient building control retrofits.
Leveraging the proposed EDA grant and the DOE Hub proposal funding, an existing historic building located within the Philadelphia Navy Yard will be sustainably designed to LEED standards and renovated (constituting a substantial retrofit). This facility will be used as a living laboratory with a base infrastructure whose energy systems can be updated for the proposed technology developments over time. While the first iteration and major renovation will draw on cutting-edge technologies in energy efficiency and management and leading principles in sustainable design, the reconfigurable building design will allow insertion of technology advances accomplished during the performance of the Hub research as well as well beyond the initial 5 year period. Furthermore, a new Center for High Performance Buildings at Purdue University will provide a "Living Laboratory" with a working office wing designed with replaceable, modular elements such as communications, controls, equipment and façade; a reconfigurable air distribution and lighting system; and instrumentation to monitor systems and occupants. Funded by NIST and scheduled to be completed in 2012, this facility will allow testing of the proposed component, sub-system and control technologies on energy and human performance indices. In addition, a perception-based engineering laboratory is being developed for human subject testing that will allow independent control of lighting, acoustics, air quality, temperature, humidity and air flow. The existing Ray Herrick Laboratories at Purdue also provide readily available testbeds for assessment of HVAC, lighting, envelope and indoor environment control systems and for model validation in a controlled and well instrumented environment.

### Expected Benefit

Improving building operation over their lifetimes will have a dramatic impact on reducing energy usage and emissions and the cost effectiveness of accomplishing it. Over the lifecycle, more than 80% of the building cost is associated with operations\(^*\), driven by energy use by systems that meet occupant needs. The table below shows the outcomes, benefits and success metrics anticipated from the proposed research.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Key Facility Resource</th>
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<tbody>
<tr>
<td>Purdue Univ.</td>
<td>• High Performance Building Facility (NIST-Purdue funded)</td>
</tr>
<tr>
<td>United Technologies</td>
<td>• Control and diagnostic system and algorithm prototyping and testing facility</td>
</tr>
<tr>
<td></td>
<td>• Psychometric component test facility</td>
</tr>
<tr>
<td>PIDC</td>
<td>• Navy Yard renovation building project and new building</td>
</tr>
<tr>
<td>CMU</td>
<td>• Fully instrumented intelligent workplace for sub-system control system assessment</td>
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<tr>
<td>Univ. of Pennsylvania</td>
<td>• Fully instrumented campus retrofit building monitoring system</td>
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### Key Deliverables

<table>
<thead>
<tr>
<th>Deliverables</th>
<th>Success Metrics</th>
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<tbody>
<tr>
<td>Database of energy efficient retrofit system solution sets for classes of</td>
<td>System configurations matched to building types that have the potential to</td>
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<tr>
<td>commercial &amp; multi-family housing buildings.</td>
<td>reduce site energy consumption by &gt; 50%.</td>
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<tr>
<td>Prototypes of high performance component and sub-systems enabling whole</td>
<td>Quantified energy and comfort performance and robustness in sub-scale</td>
</tr>
<tr>
<td>building energy efficiency solutions</td>
<td>environments (Navy Shipyard &amp; Purdue facilities).</td>
</tr>
<tr>
<td>Prototypes of energy efficient retrofit solutions enabled by integrated</td>
<td>Demonstrate 50% energy reduction via retrofit in a full-scale existing building</td>
</tr>
<tr>
<td>building systems</td>
<td>at Navy Shipyard with &lt;5yr payback.</td>
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<tr>
<td>Software tools for design of robust building control and diagnostics systems</td>
<td>Speed of control/diagnostics design and algorithm generation (reduced from</td>
</tr>
<tr>
<td>Software and hardware implementation platforms for building control/retrofits</td>
<td>months to a week).</td>
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<td>Prototypes of integrated control, performance monitoring &amp; diagnostics</td>
<td>Low installed cost of whole building control and performance diagnostics</td>
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<td>platform &amp; algorithms</td>
<td>retrofits (50% reduction in retrofit cost, incl. hardware &amp; field tuning costs).</td>
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<tr>
<td>Demonstrate 20% energy usage reduction and persistence through building</td>
<td>(verified over at least 1 year period in existing building at Navy Shipyard).</td>
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<tr>
<td>automation system retrofit</td>
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### Performers

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<thead>
<tr>
<th>Institution</th>
<th>Key Role</th>
<th>Key Personnel</th>
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<tbody>
<tr>
<td>Penn State</td>
<td>• Building integrated CHP and on-site generation systems</td>
<td>Prof. M. Mishra, J. Freihaut, A. Momin, S. Treado,</td>
</tr>
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<td></td>
<td>• BIPV systems</td>
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<td></td>
<td>• Adaptive and optimization-based control algorithms</td>
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<td></td>
<td>• Distributed control techniques</td>
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<tr>
<td>Purdue Univ.</td>
<td>• Dynamic building facades and BIPV</td>
<td>Prof. T. Papalekis, I. Kaya, A. Bhardwaj, T. Horton, H. Krook</td>
</tr>
<tr>
<td></td>
<td>• Integrated passive façade systems</td>
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<td>• Supervisory control algorithms for hybrid systems (passive-active)</td>
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<td>• Distributed control techniques (for sub-systems/software)</td>
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<td>• Model-based sub-system/component diagnostics</td>
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<td>• System and sub-system validation &amp; prototyping facility</td>
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<tr>
<td>United Technologies</td>
<td>• Integrated systems synthesis and definition</td>
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<td>• &quot;Grey box&quot; building load modeling methods for supervisory controls</td>
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3.4.3 Task Group 3: Economic, Policy, and Behavioral Factors Influencing Building Energy Consumption

The WBCSD’s EEB Transforming the Market report outlines six principle recommendations that are needed to transform the market towards greater adoption of energy efficient building system solutions. Four of these recommendations are related to the economic, policy and behavioral factors and underlie the principle driving market mechanisms needed to create the radical departure from a business-as-usual market place for buildings. Today’s building energy codes and standards, coupled with a lack of transactional transparency, failure of effective economic price signals and the over-arching impact of behaviors and energy aware building occupants serve to substantiate the significant challenges that must be studied, experimented, test-driven, and implemented towards reaching market effective solutions and new business models for market transformation of energy efficient buildings.

The Task Group 3 objectives are to form both an independent and interdependent projects in line with the other Task Group objectives. First, independently building a knowledge and expert repository with research and designed market experiments, simulated at the scale of the region, on the market structures that drive the building industry today, inclusive of codes, standards, and economic and regulatory structures. This independent assessment will form the basis of deep qualitative and quantitative analysis on market mechanisms that influence adoption, decision behaviors, and economic and non-economic factors that will drive selection of energy efficiency solutions in buildings relevant to other tasks. These independent assessments, will then feed the interdependent aspects of the broader HUB, intersecting with the technology foundations of Task Groups 1 and 2 while at the same time supporting the education, workforce and commercialization structures of Task Groups 4 and 5. This will be accomplished through modeling the technical and economic aspects of market available solutions under schemed policy structures, shaped by exogenous factors, and is a core strength offered by the Task Group 3 participants. As well to leverage the defined HUB region, at the scale of the economic development underway within the Navy Yard, will then take these mechanisms to market trials using policy simulator experiments in the context of a well designed and controlled experiment in the HUB region.

Through the tools, research methods, and designed policy simulator experiments, Task Group 3 will form its independent and interdependent projects towards accelerated diffusion of HUB technologies through adoption by pre-engaged policymakers. These independent and interdependent objectives of Task Group 3 will serve to both drive out market failure practices in the building industry, favorably position market effective solutions that stimulate behavior making aspects of economic and non-economic based decision making, and serve to develop new business models that will integrate with the technological, educational and commercialization elements of the HUB to achieve the broad objectives set forth in the FOA.

The FOA for the DOE HUB requests a narrative that:

(3.xi) “outline[s] potential economic, behavioral, and policy-related obstacles to the deployment of technologies developed by the HUB and the strategies for developing approaches to overcoming them” and

(3.xiv) “delineate[s] plans to coordinate multiple R&D efforts, including integrating subsystems into a prototype energy technology system and incorporating results from behavioral and economic analyses.”
The following narrative embraces the theory of the problem underlying these requirements. Our Task Group 3 RDD&D proposal occupies a space defined by two dimensions.

First, we emphasize that policy, markets, and behavior (P/M/B) will be a dynamic and integrated component of the RDD&D of energy efficiency technologies, rather than be treated as an independent consideration. This emphasis derives both from the growing research that P/M/B factors represent significant obstacles to achieving energy efficiency in buildings and must be anticipated by innovative technology, and also from our recognition that policymakers must become an active and informed constituency for these technologies and also can inform the fundamental changes in economic, regulatory, and social contexts needed to deploy technologies at scale and sustainably.

Second, we argue that the optimal test bed for such integration requires a “policy simulator” as rich and informative as the techniques we employ elsewhere in this proposal for innovation on materials, controls, and so on. Many energy operations display a spatial organization that derives from technological or organizational limits37 which can be exploited by the geographically defined region of the HUB, located at the Navy Yard, which achieves a scale from buildings to regions. Examples include grid interconnections and the resulting pricing zones; labor and media markets that organize the exchange of many building energy services; and the regulatory mechanisms and policy goals of local and state governments.

The Navy Yard provides an effective location that generates unique advantages by providing a research test bed at the scale of a small city. This value proposition derives from the current scale and planned growth of new and retrofitted buildings at Navy Yard, its unique property ownership structure, and a power distribution system, discussed elsewhere in this proposal, under which policy, economic, and behavioral factors can be tested and deployed. These and other uniquely integrated attributes yield an unparalleled test bed for experimental designs capable of deploying technology in order to observe its performance in the dynamic and integrated context of a city-sized portfolio of buildings and their infrastructure.

Historically, the processes involved in building design have been fragmented, driven by the economic realities of the different players acting in “silos” to optimize their own profitability. To realize the economic impact of many of the innovations this effort will create, a more holistic, integrated solutions approach to building design, construction and operation, will be a crucial element. We recognize that a key opportunity presented by this FOA is the chance to build a venue to explore and disseminate new business and industry models that become possible as we move to more energy efficient, integrated building solutions. This will involve intensive effort and innovation in value chain analysis and modeling, building hypotheses, and the exploration of alternative business designs and profit models. We'll need to pay careful attention to the value created, and who can/should/and will harvest that value, in a way that can drive more tangible and ongoing implementation of the outcomes of this initiative in building design, retrofit and other elements of relevant practice. The proposed HUB is a necessary condition for such discovery.

The following narrative presents a problem statement and a resulting set of research and deployment subtasks designed to achieve the following Task Group 3 goals:

| Short-Term Goals: | • Gather P/M/B Expertise at the HUB through Members and Partners  
Integrate that Expertise into Technology and Commercialization Tasks |
|-------------------|------------------------------------------------------------------|
| Mid-Term Goals:   | • Discover Effective Mix of Incentive/Mandate/Automation to Achieve EE in Buildings  
Design Policy Instruments that Flexibly Deploy in Cities and States to Achieve EE |
| Long-Term Goals:  | • Deploy Policy Instruments Widely to Leverage Technology and Expand Markets  
Transform Industrial Organization of Building Sector: Design/Construct/Operate |

Problem Statement

Our understanding of P/M/B factors and the obstacles they present for energy efficiency in buildings is informed by recent research, especially that emerging from the behavioral economics literature. Importantly, the decision to act in ways that increase the energy efficiency of buildings implicates behaviors that often violate the assumptions of economic rationality. Such “behavioral failures” compound the challenges already presented by more conventional “market failures” that often exist for energy efficiency actions. While some of these behavioral failures (summarized below) may be resolved through automation that removes human behavior from the loop, there will be residual behavior at decision points such as capital investment, maintenance of operating standards, and occupant actions. All of these behaviors take the general form of weighing some initial cost (whether making a capital investment or switching off the lights) against expected future savings. Fully valuing those future savings requires an expectation of future energy prices, an estimation of changes in other operating costs that may bear energy use, and so on, all of which must be discounted to present values. The potential for a market failure when private and social costs diverge is well understood. But there are additional failures associated with human behaviors beyond the corrective capacity of the traditional Pigouvian tax.

*The pervasive impact of real-world behavior:* The accumulated evidence of violation of rational choice axioms is strong from a line of research that began with Allais and Simon; and, Shogren & Taylor review the more recent evidence with reference to energy efficiency. Humans are risk averse over gains and risk seeking over losses, with the result that impact on welfare is much greater from an expected loss than from an expected gain of the same magnitude.

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magnitude. This can lead to loss aversion, anchoring, and status quo bias. Humans have evolved brain functions to conserve on rational deliberation by use of heuristic decision making and rules of thumb. Policy designers have begun to use instruments that exploit this observation, such as “opt-in” or “opt-out” choices in participation. People also appear to discount the near future at a higher rate than the distant future as well as revealing different discount rates for different kinds of outcomes. Such hyperbolic discounting suggests that people may underestimate the long-term benefits of energy efficiency investments and behaviors. The literature also suggests that people imitate others whose actions they trust or respect, which impacts the diffusion of innovation. By imitating respected individuals, building users may establish behaviors and innovations regardless of their relative cost-benefit impact. The decisive factor in adoption appears to be an innovation’s alignment with established culture. This is further exacerbated by a recent market perception study undertaken by the World Business Council for Sustainable Development’s Energy Efficiency in Buildings project in which the average energy and corresponding CO₂ emissions impact was generally underestimated by global building professionals by 50% while the cost to address effective energy efficiency was overestimated by nearly 3 times.

These and other behavioral failures may help account for underinvestment in energy efficiency. But as noted by Gillingham, Newell, and Palmer there is a need for more research evidence on the magnitude of behavioral failures in relation to energy decision making. Still, two important maintained hypotheses arise. First, significant increases in energy efficiency could be achievable at little or no cost. Second, conventional policies designed to correct environmental externalities—such as a carbon tax—may not be effective in inducing behaviors.

The fundamental impact of information on rational choice: It is important to note, however, that there are also an abundance of “conventional” market failures in building energy efficiency in need of better research and policy measures. To return to the topic of the diffusion of innovation within a community of building occupants, the literature has theorized positive externalities associated with learning by using. For example, Blumstein and Harris and Eto, Vine, Shown et al. identify “free drivers” who install energy-efficient products as a result of hearing about them from subsidized participants in DSM programs and “program spillovers” that occur when a consumer installs additional energy efficient products, without subsidy, because what they learned by participating in a DSM program.

Perhaps the most significant set of barriers that derive from market failures are related to information as also referred by UNEP SBCI. Consumers often lack sufficient information about

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47 Gowdy, J., “Behavioral Economics, Neuroeconomics, and Climate Change Policy”, Garrison Institute, 2010
the difference in future operating costs between more-efficient and less-efficient technologies or behaviors and therefore cannot make efficient decisions. In the 1970s, Akerlof noted the impact of asymmetric information on adverse selection, suggesting that sellers (or facilities managers) might be unable to convince buyers (or building occupants) of benefits from investments or behaviors since energy efficiency is unobserved. An emerging literature identifies the importance of informational regulation in environmental risk, especially on regulation that focuses on business incentives in environmental context. And finally, the principal-agent or split-incentive problem refers to one party (the agent) who determines the energy efficiency of a building and a second party (the principal) who pays for the cost of energy in the building. Under these conditions, the agent (a builder or landlord) may underinvest in energy efficiency on behalf of the principal (a buyer or tenant) creating a market failure.

The decisive impact of policy in defining change and creating markets: In addition to these behavioral and market barriers to energy efficiency in buildings, there are also policy barriers and opportunities. Nearly all of the policy analysis and evaluation conducted to date focuses on federal and state as opposed to local governments. As the California experience demonstrates through the so-called “Art Rosenfeld Effect”, the setting of mandated standards for appliances and building systems appears to yield substantial declines in energy use over time. And yet, the slow diffusion of such measures to other states suggests that California “exceptionalism” warrants policy research grounded in the politics, climate, and building stock found in the rest of the United States. This is especially true in the retrofit market where, even in the case of deep retrofits, the energy code may not even be applied or enforced according to local statutes practiced on a more national scale.

Rather than focus on the “gazelles” (e.g., California among US states and New York among US cities) we believe that greater analytic leverage derives from a test bed more representative of median or even lagging capacity for innovation and adoption. Furthermore, if policy matters to the achievement of energy efficiency gains in buildings, then local governments are critical to achieving those gains for several reasons.

First, as noted above, many energy operations interact with other regional structures (e.g., labor markets, watersheds, the administrative geography of regulation) to form “energysheds” that exhibit spatial limits generated by technological and organizational factors. Either by policy formation (e.g., sustainability goals, property asset management, procurement targets) or by policy delivery (e.g., administration of federal or state weatherization or other programs, the visibility of local action in media markets), local governments are the critical public actors in the pursuit of energy efficiency in buildings.

Second, codes and standards combined with transparency are recognized as an important policy instrument capable of intervening in both market and behavioral failures. While codes and

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62 Hughes (2009), op. cit
64 Houser (2009), op. cit.
standards are often developed by governments and professional societies at the national and state levels, they are adopted and often modified by local jurisdictions. More importantly, codes and standards are monitored and enforced at the local level by local governments. Finally, there is a lack of mandated transparency, critical towards removing the principle-agent barriers that allow market inefficiencies to exist67.

Third, local governments are themselves significant users of energy in buildings and represent a sector of property owners and users that often display daunting principal-agent challenges. For example, until this year with the adoption of the Greenworks sustainability framework, no Philadelphia city agency paid or even saw their utility bills. The electric, gas, oil, and water bills for police and fire stations, libraries and recreation centers, office buildings and maintenance shops, all went to a central billing agency for payment. The city government has over five hundred metered accounts, yet none of that information was used to monitor or incentivize behavior. (This year, a new system of building-specific target energy budgets, along with related monthly energy usage data in a new user interface, is being developed for all departments and their buildings; departments who exceed reduction targets will receive a credit for the difference in their program budgets.)

This understanding of the policy, market, and behavioral barriers facing energy efficiency in buildings informs the research agenda of the proposed P/M/B thrust. The research approach and the structure and process by which the HUB would pursue it are illustrated in Figure 3.4.3-1. Our initial structure of research thrusts is designed to take immediate advantage of existing expertise within our HUB members and collaboration among them along existing research areas. This allows us to propose short-run foundation projects that would deliver immediate value and well as intermediate projects in the early years of the GPIC. In the next section, we present a package of sub-tasks that would advance our knowledge of these barriers and the mechanisms to overcome them.

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Figure 3.4.3-2 P/M/B Work Process Illustration

Six Subtasks
Our approach to overcoming the barriers identified above starts with our proposed governance structure. This structure is discussed in greater detail elsewhere in this proposal, but we emphasize a few salient elements: (a) academic and industry collaboration; (b) basic-to-applied RDD&DDD disciplined by shared goals of technology development, commercialization, and job creation; (c) integrated test beds, captured through policy simulators and regional trials, that foster continuous learning through experimentation, feedback, and decision-making. These elements would bear significantly on the research projects that the HUB would pursue, driven by the inquiry of leading scientists and engineers and supported by strong business interests, that will seek to have impact on the design, delivery, and operation of energy efficient buildings. The multi-disciplinary team that constitutes this thrust within the proposed HUB represents a diverse array of research and practical experience.

For example, the Princeton Plasma Physics Lab (PPPL) is a world leader in fusion research but is also a test bed for experience in monitoring and managing the behaviors of staff as building occupants. PPPL has demonstrated sustained success through a combination of facility retrofits, equipment upgrades, extensive building system automation and employee engagement, that have reduced energy use intensity by 35% between 2003 and 2007 and has maintained that performance for the past three years. These levels have been achieved in a fleet of existing buildings with an average age of over 35 years while maintaining the same level of site operations while increasing occupancy. PPPL has been recognized with awards from the State of New Jersey and U.S. EPA and DOE, and actively contributes knowledge and experience to the Department of Energy’s efforts to address the sustainability goals embodied in EO 13514, Federal Leadership in Environmental, Energy, and Economic Performance.

This rich example illustrates several points about our HUB vision, this research thrust, and our core members and partners. As the occupants of buildings, we are all participant-observers in

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some sense on research into energy efficiency in buildings. It is thus in the nature of this research area to apply a certain deference to common sense and in particular the common sense of others who may not be the “principle” occupants of buildings or other hierarchies. We seek and commit to exploit that deference as the foundation for a sustainable and sustained multi-discipline and multi-sector collaboration at the proposed HUB.

The following list derives largely from the location of the proposed HUB at the Philadelphia Navy Yard. But we repeat to emphasize that these projects all scale-down to individual building operations and scale-up to local, state, and national policy and market structures. There are also designed to help meet the short-, intermediate-, and long-term goals of the GPIC as a whole, and the particular goals of Task Group 3, presented above.

1. **Deploy Task Group 3 Expertise in HUB Process and Projects:** The P/M/B thrust will be integrated into the work of the other thrusts from the earliest phases of RDD&D. The depth of subsidy or rebate or the size of the financing of first costs will be modeled as a dynamic interaction with the performance of materials, controls, and embedded systems being developed within other thrusts. The large and growing distribution of commercial developers and tenants of retrofitted buildings will supply a venue for testing the effectiveness of financial, informational, and organizational mechanisms on the performance of technologies developed in related thrusts. In the “stage/gate” process described elsewhere in this proposal, the P/M/B thrust will be part of each review. HUB would provide the venue and capacity to assemble policy advisory teams to review and react to technology projects that emerge from other thrusts. To aid in these reviews, researchers will leverage the development of the WBCSD EEB Model, a novel and unique resource, to assess the building decision maker’s energy impact, on a regional scale, under certain policy strategies and technological options. For these analysis, the team will also leverage the DOE’s National Energy Modeling System (NEMS), a computer-based, energy-economy modeling system of U.S. NEMS projects the production, imports, conversion, consumption, and prices of energy, subject to assumptions on macroeconomic and financial factors, world energy markets, resource availability and costs, behavioral and technological choice criteria, cost and performance characteristics of energy technologies, and demographics. Further, these analysis will benefit from the broader analytical economic policy assessments derived using the MARKAL platform, a bottom-up energy-technology-environmental systems model that finds a least cost set of technologies to satisfy end-use energy service demands and user-specified constraints.

In addition to adding a P/M/B perspective, these advisory teams would develop a channel by which the initially “silo-ed” HUB research tasks will evolve into more integrated areas over the life of the HUB. These advisory teams would consist of state and local officials throughout the Philadelphia metropolitan area and region’s base of users for the technologies to be developed by the HUB, including the Building Owners’ Management Association and the General Building Contractors Association as well as the maturing networks of small building industry firms in the region represented by the Greater Philadelphia Sustainable Business Network, the Smart Energy Initiative, the Delaware Valley Green Building Council. This critical infrastructure would build HUB resources for applied research that “backward maps” from both the needs and the

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2. **Build a Real-Time Knowledge Repository on Practice and Performance:** We seek to establish the HUB as the nation’s center of and repository for knowledge and practice on energy efficiency in buildings. As such, an early research effort of the task would be to benchmark information on the policy and market contexts in which the US building industry currently operates. A database repository will be created of building and energy codes; green building and energy efficiency mandates, standards, and incentives; state and local energy efficiency goals and targets; utility-based programs, financial instruments, awareness campaigns, building retrofit best practices; current industry and academic research activities, and so on. This project would both aggregate existing efforts (such as the DOE’s Mid Atlantic CEAC) and extend them and would include a specific focus on compiling and analyzing data on proven energy and cost savings from energy-efficiency improvements across a range of building types. The database would provide a comprehensive set of market effective structures and design rules that inform the other HUB Task Group projects: the baseline context for which those technologies would be developed and deployed. It would also quickly and effectively establish the HUB as a national resource for policy developers, market decision-makers and behavioral researchers across the US.

This early project would also build an expert network of both policy makers and building industry leaders from which the HUB would draw key informants for barrier identification and vocal advocates for solution implementation. A key component of this outreach effort would be a combination of workshops, routine seminars, visits and other mechanisms to inform them of different technology choices, the incentives that can drive a choice or not, and the impact that policies can have - positive and negative - on the choices. Through discussions with the GPIC researchers, policy makers will get a better understanding of the relationship between policies and impacts, as well as the benefits and extent of the value of relying on administrative controls, processes and behavior changes.

3. **Leverage the Navy Yard to Test Market-Oriented Energy Management Strategies:** Several of our core members and partners have modeled the energy performance of our campus buildings and in some cases guide the retrofit investment on our campuses (for example, Malkawi69). Highly sophisticated simulation models of building performance, calibrated by years of experience on campus, make improved predictions about the impact of various retrofit strategies on energy consumption. Using these models to predict the returns on retrofit investments across the large portfolio of commercial properties – the “campus” - at the Navy Yard would identify a path to maximize the return on investment by accelerating the payback schedule across the portfolio. Therefore, this approach provides more than a computational model of building thermodynamics: it also provides a financial model for an asset management that creates a whole new organizational constituency (as well as resources) for energy efficiency in buildings. This research would demonstrate value to a critical channel for large-scale deployment: multiple property owners such educational and health care institutions, governments, and real estate investment trusts whose “fleets” of buildings could exploit this portfolio approach.

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The independent electric distribution system at the Navy Yard provides a unique opportunity to experiment with a portfolio of buildings as they relate to the larger environment in which they operate. The existing microgrid creates a venue for learning on the ability of price signals (and all the attendant factors of information barriers and the interfaces that convey that information to occupants) to affect building occupant and manager behavior. This research element becomes even more important given the recent FERC announcement (March 18, 2010) of an important ruling electricity pricing be set by the full value of actual generation, Peak electricity demand typically requires very high cost generating units to be brought on-line. Reducing peak demand, rather than relying on high-cost generation sources, is often less expensive in managing system peaks, enhancing reliability, and promoting long-run market efficiency. By deploying resources available through the Smart Grid Investment Program awarded to the region in 2009, the HUB would design a project to increase customer participation in demand response markets using a load aggregation program. The project would measure benefits to consumers and to the system as a whole. The proposed research would use actual participation to estimate demand curves rather than curtailment estimation as in previous studies. This would allow for estimates of the short-run direct and indirect economic benefits of distributed energy management for both direct and in-direct participating consumers, an important hypothesized aspect of the energyshed with major policy implications.

4. **Leverage the Navy Yard to Test Codes, Incentives, and Adoption:** The unique condition of public ownership, public-private development, and private occupancy of the space at the Navy Yard provides a research setting for direct experimentation on policy instruments designed and operated at the local and state level. All three of the following projects and others like them would develop replicable tools useable by governments throughout the country.

For example, under partnership with Philadelphia’s Department of Licenses and Inspections, new building codes will develop driven by performance expectations of Task Group 1 and 2 demonstrated outcomes. Given anticipated incomplete feedback, the HUB will develop hybrid policy instruments that mix regulations and incentives based prescribed requirement with others based on measured performance. In the longer run, made possible with local government engagement, the HUB would develop a new code regimen that exploits technologies that enable whole building optimization and control that enable code enforcement based solely on performance, as monitored.

As a second example, the City is developing a new zoning code, the first major revision in 50 years. Navy Yard provides both the HUB with a demonstration site for adoption and diffusion of the code by the building industry. The “natural experiment” provided by the new zoning code will create an unparalleled opportunity for pre/post studies of the impact of the barriers removed and incentives provided in the new code for energy-aware design and construction. Working with the City, the HUB would enhance this natural experiment with a designed treatment that would accelerate adoption and technical assistance on the code’s new elements. Navy Yard would also provide a test bed for future iterations of the zoning code related to building energy performance.

And as a final example, the HUB would work with the city’s Department of Public Property to create an asset management tool that would embed energy-aware capital planning and state-of-good-repair into life cycle cost accounting tools. This project would build on ongoing work for the Philadelphia Housing Authority, and expanded with specific efforts at Navy Yard, in which technical building performance models are coupled with financial analysis tools to develop an
asset management framework for building investment decision making. The work will apply the lessons learned to the approximately 500 facilities owned by the City of Philadelphia (nearly all of which operate on 1800 separate metered utility accounts.) ranging in type and size from office buildings to, public health centers and labs. Pennsylvania’s model Act 77, the Guaranteed Energy Savings Act, allows local governments and school districts to engage energy companies without affecting their capital budgets. This essential procurement innovation was employed for the first time last year by the City of Philadelphia to fund a $15 million renovation of its largest office building. The capacity of the program is constrained only by the ability of energy savings to amortize the investment costs and creates a valuable connection between HUB technology research and leveraging policy practice. The development of a citywide asset management tool would facilitate the use of Act 77 at an unprecedented scale.

5. **Study Behavior within the Technology and Policy Deployments:** The sixth WBCSD recommendation\(^\text{70}\) is to mobilize for an energy aware culture – and this will be pursued in the context of the regional cluster. Interviews and observation would document the decision-making process and barriers to energy efficient decision-making within the institutional setting as these “policy experiments” proceed at the Navy Yard. These interviews would focus on the social sense-making and communicative processes by which participants (building managers, owners, users) in the process come to understand the need for energy efficiency measures and actions available to them. Insight on these processes would be used to help identify decision support processes for aiding decision-makers in moving towards energy efficiency. For example, interviews could yield information on the kinds of information sought, sources looked to and trusted by decision-makers, useful forms of the information, and points of decision-making where information matters. Both Pennsylvania and New Jersey have robust and mature energy efficiency incentive programs and have “on the ground” experience with behavioral issues affecting energy use and a good understanding of what drives the energy efficiency marketplace. Utilities in both states will serve as key resources for the activities undertaken as part of this subtask. A third source of “on the ground” experience with behavior will be ongoing work with the Philadelphia Housing Authority in which researchers are eliciting the knowledge and attitudes of residents toward energy efficiency through semi-structured interviews and surveys. This existing effort will identify key concerns, knowledge gaps, and promising behavioral changes. The proposed project will extend these results by pilot testing and evaluating different resident engagement strategies, ranging from brochures to PowerPoint presentations, to home intervention visits. The results of this evaluation would provide guidance to public housing authorities and other owners of residential properties on how to work with residents to improve energy efficiency.

6. **Develop New Business Models to Unlock Value in Building Energy Efficiency:** This effort will focus on three sets of related projects: financing, contracting, and the resulting restructuring of the entire building industry. First, energy efficiency projects are often self-financing but never self-implementing and there is a fundamental need to incentivize energy efficiency investments\(^\text{71}\). A stream of reduced operating costs can be used to amortize the initial investment needed to generate the reduced operating costs. The implicit “payback” of such an investment is often quite short. But even in the absence of the market and/or behavioral failures discussed


\(^{71}\) WBCSD Energy Efficiency in Buildings – Transforming the Market report, pp56-57, April, 2009
above, without a financial instrument this amortization cannot be implemented by many building owners. Using the instrumentation provided by the City of Philadelphia’s Greenworks Fund (capitalized by the DOE’s EECBG formula and recently awarded competitive grants to the City) as well as other funding sources, we would experiment with the loan and grant programs to observe differences in take-up rates and how the magnitude of needed incentive varies with the performance of building technologies.

Second, the FOA calls attention to a critical problem in the energy efficiency marketplace: the lack of persistence of energy savings over time. As the FOA states: “When designed performance is compared with measured performance, the data suggest that few buildings operate according to their designed levels of efficiency. Commissioning, which can improve building energy performance to bring it up to the designed level of efficiency, generally loses its effectiveness within a few years, as buildings drift away from their optimal performance parameters.” HUB partners will initiate a series of feasibility studies on the barriers and opportunities for creating energy management business models that shift responsibility for maintaining energy savings from a building’s owner and occupants to a third party. The goal will be to determine if such models are effective at maintaining energy savings over time; if they provide cost-effective benefits to both the building owners/occupants and the third party; and if they can be brought to sufficient scale to have a significant impact on energy use within the HUB region and beyond. This effort will complement and extend other HUB work on energy efficient operations technologies and occupant behavior modification. Related to this effort, the HUB will work closely with the Utility Working Group as a test bed for the business model that emerges from the project. HUB partners would study existing institutional innovations that attempt to resolve some of the behavioral problems identified with ESCOs and examine new directions in long-term contracting as potential solutions to these problems.

Third, this effort will identify each element of the value chain involved in the creation and retrofit of more energy-efficient buildings. As in many business markets, this is a complex set of players, with a complex set of interactions -- and a deeper more thorough understanding of each of these players and what they value will be required. The forensic work involved in connecting with the technical research and development teams, and creating tangible calculations of the economic value they are creating, will identify the pathways likely to create the most value downstream. That value chain includes component manufacturers, original equipment manufacturers, systems integrators, retrofitting firms/ESCos, contractors, construction firms, building owners, utility companies, and other players yet to be identified or newly constructed.

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### Task Group 3 Expected Benefits

<table>
<thead>
<tr>
<th>Key Deliverables [Phasing]</th>
<th>Success Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 3 expertise embedded in stage/gate of RDD&amp;Ds [Operational from start up]</td>
<td>Accelerated diffusion of Hub technologies through adoption by pre-engaged policymakers</td>
</tr>
<tr>
<td>Real-Time repository of state and major local government codes, mandates, and incentives related to retrofit [Operational in 6 months]</td>
<td>Dominance in the information space for search and download under cognate keywords</td>
</tr>
<tr>
<td>Portfolio-based model and management of assets using real-time simulation [Complete within 12-18 months]</td>
<td>Greater than 50 percent acceleration in ROI from portfolio approach over individual approach</td>
</tr>
<tr>
<td>Building owner load aggregation program to dispatch virtual generation to grid [Operational within 12 months]</td>
<td>Reduction in direct usage energy costs by participants, reduction in indirect wholesale energy costs by grid-wide customers</td>
</tr>
<tr>
<td>Model code and training regimen for local governments and inspectors [Complete with 24 months]</td>
<td>Improve energy code compliance by 50 percent</td>
</tr>
<tr>
<td>Model zoning and incentive structure for local governments for retrofit [Complete with 24 months]</td>
<td>Reduce adoption time by 50 percent and average energy performance of retrofits by 50%</td>
</tr>
<tr>
<td>Model sustainable asset management tool for capital and operating budgets for local government facilities [Complete within 36 months]</td>
<td>Increase deployment of energy-aware asset management in public building portfolios by 50 percent</td>
</tr>
<tr>
<td>Key Informant and Survey of Influence and Behavior among Retrofit Occupants [Operational within 6 months]</td>
<td>Increase behavioral adoption by 50 percent while creating positive returns to behavioral program investments</td>
</tr>
<tr>
<td>Slate of Financial Instruments for Retrofit [Complete with 24 months]</td>
<td>Increase applications by 200 percent, reduce repayment cycles by 50%, accelerate churn in existing capitalized programs</td>
</tr>
<tr>
<td>Long-Term Energy Management Business Models [Complete within 36 months]</td>
<td>Persistent energy savings over long time periods through “win-win” energy management partnerships that benefit service providers and building owners</td>
</tr>
</tbody>
</table>
### Performers

<table>
<thead>
<tr>
<th>Institution</th>
<th>Key Role</th>
<th>Key Personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penn State</td>
<td>Measuring the environmental performance of energy-efficient buildings</td>
<td>S. Blumsack, M. Bose, S. Echols, P. Hallacher, A. Kleit, R. Oliva, B. Orland,</td>
</tr>
<tr>
<td></td>
<td>Policy design for restructured electricity markets</td>
<td>A. Rangaswamy, M. Sliwinski</td>
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<td></td>
<td>Environmental influences on physiological dysregulation and cognitive</td>
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<td></td>
<td>decline</td>
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<tr>
<td></td>
<td>Best practices in sustainable site planning and design</td>
<td></td>
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<tr>
<td></td>
<td>Decision support systems for environmental planning and design</td>
<td></td>
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<tr>
<td>Penn</td>
<td>Econometric analysis and valuation of environmental attributes</td>
<td>E. Birch, M. Hughes, H. Kunreuther, A. Malkawi, E. Michel-Kirjan, E. Orts, S.</td>
</tr>
<tr>
<td></td>
<td>Behavioral aspects of risk assessment and decision-making</td>
<td>Wachter</td>
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<tr>
<td></td>
<td>Legal and regulatory framework for environmental policy</td>
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<tr>
<td></td>
<td>Portfolio analysis and management for building retrofits</td>
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<tr>
<td></td>
<td>Applied policy development in state and local energy and environment</td>
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<tr>
<td>United Technologies</td>
<td>Policy impact modeling leveraging techno-economic analysis tool developed</td>
<td>W. Sisson, J. Fritz, K. Otto</td>
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<td></td>
<td>for WBCSD EEB project, NEMS and MARKAL capability</td>
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<td></td>
<td>Building regulatory analysis and structures expertise</td>
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<td></td>
<td>Behavioral aspects of risk assessment and decision-making</td>
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<td></td>
<td>Business model development and analysis for maximizing ROI and minimizing</td>
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<td></td>
<td>transaction costs</td>
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<td>IBM</td>
<td>Smart Grid technology and deployment</td>
<td>M. Tihami</td>
</tr>
<tr>
<td>Rutgers</td>
<td>Effects of human behavior on building performance</td>
<td>C. Andrews, M. Brennan-Tonetta, F. Felder, R. Shwom</td>
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<td></td>
<td>Human reaction to technology policy experiments and deployments</td>
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<td></td>
<td>Energy efficiency economics and policy</td>
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<td></td>
<td>Energy efficiency evaluation</td>
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<td></td>
<td>Electric power system and smart grid modeling</td>
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<td></td>
<td>Social and political aspects of energy efficiency</td>
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<tr>
<td>Princeton PPL</td>
<td>Modeling building retrofit evaluation criteria</td>
<td>A. Cohen, R. Schneeman</td>
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<td></td>
<td>Behavior change through policy in a highly regulated environment</td>
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<tr>
<td>Drexel</td>
<td>Semi-structured interviews and surveys on attitudes toward energy efficiency</td>
<td>J. Wen, M. Waring, P. Gurian</td>
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<td></td>
<td>Design and evaluation of communication and stakeholder engagement on complex technological issues</td>
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<td></td>
<td>Integration of energy forecasting with financial analysis and decision analytic tools for asset management</td>
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<tr>
<td>NJIT</td>
<td>Energy efficient building products and technologies market assessment.</td>
<td>D. Evans,</td>
</tr>
<tr>
<td></td>
<td>Energy efficient building documentation and online training.</td>
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<td></td>
<td>Utility-based clean energy programs interface and liaison.</td>
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<tr>
<td></td>
<td>Development of new business models to preserve energy savings over time.</td>
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<tr>
<td>Morgan State</td>
<td>Intensive case studies of flexible manufacturing networks</td>
<td>M. Akers</td>
</tr>
<tr>
<td></td>
<td>Applied policy development to encourage green business networks</td>
<td></td>
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<tr>
<td>Virginia Tech</td>
<td>Scalable computational models of individual behaviors and their adaptations</td>
<td>M. Marathe</td>
</tr>
<tr>
<td></td>
<td>Computational environment for decision and policy analysis</td>
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</tbody>
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3-75
3.4.4 Task Group 4: Education and Workforce Development

The goal for the education and workforce development Task Group is to assure that the new innovative energy efficiency technologies and systems are supported by a robust human capital infrastructure that will enable the diffusion of the technologies through demonstration and deployment. The workforce development efforts must also include outreach to diversify the workforce and include recruitment and training for members of communities who are underrepresented in the building trades to assure their participation in this important economic development effort. A pipeline of energy engineering will also be developed to cultivate the next generation of creative, innovative, and committed professionals who will lead the retrofit and construction of energy efficient buildings in the future.

The Greater Philadelphia Region has a rich history of education and training in supporting technology diffusion and for the building trades. These resources will be harnessed through a formal collaborative network. The network members will interact with the research and development, demonstration and deployment tasks for the HUB. The HUB Teams will inform the education and training community regarding curriculum development, educational program design, and technical training and laboratory systems. Buildings within the Navy Yard will also serve as a resource for faculty training and development.

Summary of Need

The Lawrence Berkeley Laboratory report, *Energy Efficiency Services Sector: Workforce Education and Training Needs*, identified three primary shortages in the energy efficiency services sector (EESS): trained and experienced program managers, engineers that specialize in energy efficiency and trades people trained in building and constructing integrated energy-efficient buildings. The HUB will work with all three groups but the primary concentration will be on job training and job creation for trade’s people.

Trades people are projected to constitute 65-75% of the workforce in the EESS and will undergo significant growth. Educational programs targeted at building and construction workers created through the HUB should be incorporated into existing curricula available through community colleges, technical and trades schools as well as apprenticeships.

Additionally, providing the pathways for on-the-job training, as preferred by program administrators and program implementation contractors, can augment workers skills quickly, permitting the workforce to fill the demand for technical EESS positions. Increasing the presence of mid- and senior-level managers and engineers is also a crucial step to developing the workforce. This can be done either through informal training or through programs such as those offered by the Association of Energy Services Professional and the Certified Energy Manager certificate program offered by the Association of Energy Engineers.

As the demand for more highly skilled workers in the EESS increases, there needs to be more qualified trainers to introduce them to the field. Community colleges, while more capable of adapting programs to meet the needs of the changing market landscape than four-year colleges, report high demands on their existing programs for energy efficiency. Channeling funding towards “training the trainers” will therefore become a key priority.

The EESS will introduce new professional occupations to the labor force in the forms of program administrators, energy-efficiency consulting firms, construction and installation firms, engineering and architectural firms, and energy service companies. Currently, few four-year colleges offer curricula specific to energy efficiency. Colleges and universities with start-up
programs emphasize a multi-disciplinary and systems-based approach, particularly because of the need for integrated design in energy-efficient building projects. Developing centers for engineering and policy/planning students can provide hands-on training to the future EEES professional.

**HUB Education and Workforce Development Goals and Strategy**

In response to this need, the following goals will be pursued by the HUB team: 1) Create an infrastructure that will cultivate professional and skilled workforce competencies that directly supports the commercialization and deployment of energy efficiency technologies, 2) Develop innovative new programs to attract and retain talent into the building energy fields in engineering, business, and skilled trades, 3) Capitalize on existing workforce development partnerships spanning between the manufacturing and technology industries, research institutions, community colleges, and workforce development infrastructure.

The HUB is in a unique position to integrate education and workforce development strategies seamlessly with the research activities of the HUB team. Specific strategies that will contribute to the success of the HUB education and workforce development activities include:

*Capitalize on unique existing partnerships between multiple HUB team members:* including the innovative Collegiate Consortium collaboration between Drexel University and regional community colleges to create technology channels between R&D efforts and workforce training.

*Build upon emerging DOE Energy Application and Workforce Development centers:* Penn State leads three centers headquartered at the Philadelphia Navy Yard that promote the commercialization of technology and workforce development in clean energy, solar energy, and smart grid topics.

*Expand integrative research, education and training engines* that bridge research and development, commercialization, and education to cultivate human capital needed to accelerate the growth of energy efficient building retrofits.

As described in the following subtask descriptions:

- **Subtask 1:** A regional Education and Training Board will be established to guide all efforts with a focus on the continuous assessment of education and workforce needs, program implementation and economic impacts.
- **Subtask 2:** The capacity of the educational/training infrastructure will be enhanced, with emphasis on improving the faculty and programs at the regional community colleges and the development of innovative new programs and partnerships to attract students into building energy careers.
- **Subtask 3:** Cultivate new pipelines of human capital through a faculty working group that will develop innovative new education programs, improving the capabilities of HUB members using local academic institutions, and leverage industry member/partner expertise.
- **Subtask 4:** Workforce training will be emphasized using existing partners, including a focus on recruiting, training, and supporting underrepresented individuals.

**Subtask 1: Regional Education and Training Board**

The HUB will convene an Education and Training Board. The Board will include representatives of the stakeholders organizations noted above. The purpose of the board is to identify, document and inventory education and training resources, oversee education and training program development, assure alignment to research, development, deployment and
commercialization tasks, and leverage the regional education and workforce development resources from the region’s Career and Technical Centers, Community Colleges, Universities, Workforce Boards and Building Trades Union programs. Vital to the success of this Board will be the participation of national workforce partners in the manufacturing, technology, and construction sectors.

Subtask 2 Build the Educational/Training Infrastructure

The Greater Philadelphia Region has an array of educational institutions with an existing energy education and training platform that will be leveraged to build the 21st Century Energy Workforce. The education and training providers and support organizations create a continuum of programs for entry level to advanced skills. The HUB team will organize this continuum into a comprehensive regional network to accelerate the adoption of new education and training programs into a career lattice model and provide multiple points of entry into this sector of the economy. Current education and training partners have extensive experience coordinating and integrating programs for new technologies and industry sectors in the region. Because of its unique position in the Navy Yard and the region, the Collegiate Consortium will lead this initiative for the HUB. Utilizing pooled resources and programs from HUB universities, an online educational infrastructure will also be created to 1) enable new graduate and undergraduate energy engineering opportunities that will attract students into research programs and careers in the energy efficiency sector and 2) provide an efficient infrastructure to share specialty courses and innovative educational programs between HUB universities.

The Collegiate Consortium for Workforce and Economic Development is a non-profit organization located in the Navy Yard and across the Greater Philadelphia Region and serves as the central technical education and training program provider supporting industry education and training in the region. The Consortium is a partnership of Drexel University and five area community colleges and provides a comprehensive, coordinated approach to developing a highly skilled workforce for the region. The combined efforts of the five community colleges, which emphasize advanced technical training, and a university, which offers advanced education, creates a unique model for education and training. The resources of Consortium member institutions are available to business and industry clients through the Consortium including more than 4,000 faculty supporting over 470 certificate, associate, bachelor, masters and doctoral programs, delivered at more than 60 sites throughout the region. The educational institutions also work with local high schools and vocational schools to assist them in adopting college credit courses for students seeking careers in specific fields. The objective is to encourage students to work within the region while continuing to pursue college certifications and degrees.

Since its founding in 1994, the Consortium has developed innovative programs to prepare the region’s workforce with the knowledge and skills required as a result of new innovations and technologies. As one example, the Consortium established a Veteran’s Education and Transition plan for returning veterans from Iraq and Afghanistan, funded by the U.S. Department of Defense, which enrolls nearly 300 veterans receiving scholarships at Consortium schools. As part of this project, program leaders produced a report on the transfer of skills from military service to advanced manufacturing, conducted job and career fairs, and established a regional initiative with the workforce boards and departments of veteran’s affairs in PA and NJ. More recently, the Collegiate Consortium began a “Green Academy” project to help its member colleges develop curricula and career ladders to meet the needs of emerging green industries.
The Consortium is governed by a Board of Directors of representatives from the six academic institutions as well as Philadelphia Industrial Development Corporation, a co-applicant for this proposal. It is important to note that the Consortium's offices are located at the Navy Yard itself, the venue for our initiative, thereby facilitating convenient and close cooperation between the Consortium and other project participants.73 The member community colleges provide a portfolio of programs that deliver energy sector training in combination with industry partners and the Delaware Valley Industrial Resource Center. The focus of these programs includes energy generation, power distribution, alternative energy technologies, energy conservation, facilities management, and systems maintenance.

Delaware County Community College (DCCC) has delivered, since 1993, engineering technology education and training suited for high school students, post secondary and incumbent workers. Degrees and certificates include: Automated Manufacturing/Robotics; Computer-Aided Drafting and Design; Electronics Technology; Industrial Systems Technology; Machine Tool Technology; Mechanical Technology; Nanofabrication Technology; Technical Studies; Power Generation. In addition, DCCC has developed curriculum to deliver technical training for: PV Solar Technology, Green Roof Technology, and Geothermal Systems.

Community College of Philadelphia (CCP) has established certificate and degree programs in facilities management. The Facility Management program ultimately leads to an Associate of Applied Science (A.A.S.) degree in Facility Management. Facility Managers are the people who plan and manage the buildings, grounds and systems of large businesses and institutions. The core of the Facility Management curriculum addresses gaining the basic technical knowledge of construction materials, processes and systems, as well as the business management and real estate areas. CCP is also launching a degree program in process control technology in 2010.

Buck County Community College (BCCC) has developed an industry driven public-private partnership entitled the Green Jobs Academy as a new venture that includes a variety of academic and private industry partners. The Green Jobs Academy provides both long and shorter-term training programs geared toward workers looking for new skill sets in the green and sustainability industries. Programs include a pre apprenticeship program for new entrants into the field of Green Technology. BCCC is piloting the Veteran’s Green Job Training program in the summer 2010.

Montgomery County Community College (MCCC) has focused on energy generation and has developed a Nuclear Energy Technician Program in collaboration with PECO energy. In addition, MCCC has AS degree in Engineering Science enabling transfer to a four-year college or university to earn a bachelor’s degree. AAS degree in Engineering Technology is a 63-credit degree program that prepares students for a career as a technician. AAS degree in Nuclear Engineering Technology is a 69-credit degree program that that prepares students for entry-level employment in the nuclear energy workforce.

Camden County College (CCC) students that graduate from the Engineering Science program and transfer to a four year institution, perform competitively with residential students. Locally, students can transfer to a number of institutions in the region including Drexel, Rutgers Rowan, Temple and Widener Universities and The College of New Jersey. The Engineering Technology

Programs at Camden County College are designed to provide an academic experience combined with a hands-on approach to prepare students for the workforce of the 21st century. Transferability of the technology programs is limited locally to colleges such as Temple University and New Jersey Institute of Technology (NJIT).

The HUB team will expand and enhance this powerful consortium infrastructure through the cultivation of online course modules and faculty development activities that draw upon HUB research activities to feed curriculum development and new energy technology training programs at consortium partner colleges. Coordinated by Penn State, the translation and repurposing of research results for use by diverse training programs will be performed and will build upon existing working relationships between Penn State and the electrical, mechanical, and roofing contracting industries.

**Subtask 3: Human Capital Development**

The Education and Training Board will also be charged with insuring that HUB members participate in the ongoing development of human capital for HUB members and their connections to the academic institutions in the region. The focus of this effort includes 1) the establishment of a faculty working group, 2) the leveraging of industry partners, 3) the cultivation of building energy engineering career pipelines, and 4) the growth of innovative partnerships and programs that demonstrate replicable models for developing the next generation of energy efficiency leaders.

**Faculty working group:** The faculty working group will draw from the education and training network of providers participating in HUB research and development, demonstration and deployment activities. This group will work to integrate existing education and training programs into the demonstration projects and support the development of curriculum to assure that the full vertical hierarchy contextualizes training for secondary, community college and university programs.

**Leverage industry members and partners:** Industry members will participate and support the Faculty Working group in particular with training materials, technology specifications, and in-house technical and systems experts to assure that educational programs are aligned with industry expectations in preparation of the deployment of new technologies.

**Cultivating Building Energy Career Pipelines:** The HUB team will build upon successful models at HUB partners to create innovative pipelines spanning K-12, secondary education, post-secondary education, and continuing education of both professional and skilled trade career paths. Leadership in these aspects of the HUB will be provided by Princeton University, Morgan State University, and Penn State and in a partnership with the Alliance to Save Energy.

The Princeton Plasma Physics Laboratory (PPPL) will provide a model program for the integration of HUB research activities into science education programs for broad audiences. The PPPL is a DOE national laboratory with a mission to advance the coupled fields of fusion energy and plasma physics. PPPL staff and collaborators develop the scientific understanding and key innovations needed to realize fusion as an energy source for the world. The laboratory also nurtures and supports the national research enterprise in these fields, and educates the next generation of plasma and fusion scientists. For more than 20 years, PPPL has created a portfolio of science education programs centered on energy technology. These widely recognized programs provide opportunities for students and teachers to engage in scientific inquiry in ways that enhance their understanding of science concepts and scientific ways of thinking, provide
innovative opportunities for educators to work together and with scientists and engineers to enhance science teaching and learning, and reach out to all students and teachers, particularly those previously excluded from educational opportunities. A key aspect of these programs, whether they are hands-on internships, K-12 teacher professional development workshops, or outreach to the general public, is a data-driven assessment of efficacy and an alignment with state and national best practices. Every year, PPPL provides internships for up to 60 students (high school through undergraduate), a variety of workshops on 21st century energy for middle and high school teachers, enrichment programs for underrepresented students, and outreach programs that reach thousands.

Morgan State University is a particularly important member of the HUB team and will lead the development of model programs intended to attract diverse audiences into the fields of architecture, engineering, and construction. Morgan State University Clarence M. Mitchell, Jr. School of Engineering is one of fourteen engineering schools, with an ABET accredited program, located on the campus of a Historically Black College or University (HBCU). While not exclusive, Morgan State University (MSU) has as a central mission the provision of access to higher education of minorities and women who are severely underrepresented among U.S. engineering professionals. This focus annually propels Morgan State into a national leadership role in the development of African American engineering graduates at all degree levels from the baccalaureate through the doctorate. MSU is the only HBCU offering the complement of degrees programs in Architecture, Landscape Architecture, City and Regional Planning, and Construction Management, under one academic unit. The School of Architecture and Planning, which houses these programs, is closely affiliated with the School of Engineering. The Baltimore location in the middle Atlantic region, and the mutual interest and commitment to “green technologies,” including efficient energy utilization by existing (ageing) commercial and residential buildings, make MSU a valuable contributor to the proposed HUB.

The School of Engineering will develop a model pipeline of students who are college ready, who successfully matriculate through college engineering architecture and city planning programs, who are interested in and who choose careers in energy related professions. Utilizing innovative and effective curricula and pedagogies, Saturday academies, summer camps for teachers and pre college students, competitions, internships, research opportunities and supportive student services such as tutoring, diagnostic evaluations followed by targeted academic interventions and financial support, we will increase the number of bachelor, master and doctoral level graduates who have a working knowledge of the applicable principles, and who will demonstrate skills in the application of technologies for energy-efficient building renovation, maintenance and design. Curricula will include living labs, hands-on training, policy training workshops and certificate programs for incumbent worker training. College students will conduct research with faculty who are engaged in research related to energy and energy efficient buildings.

Based in part, on prior and on-going energy/environmental (air and water quality) related research being conducted by funding from DOE, Morgan State established a Center for Advanced Energy Systems and Environmental Controls (CAESECT). In addition, it is felt that our Engineering Visualization Laboratory with its interactive 3D simulation capability, will aid in the investigation of behavioral pattern analysis. The recent completion of Morgan’s new library building (220,000 sq ft) with its automatic energy management/control system, its green roof, and other sustainability features are worthy candidates for observation. These features coupled with a state-of-the-art greenhouse in the science school where green roof plants can be
studied, is an additional asset. Ground was recently broken on a $60M LEED “Center for the Built environment and Infrastructure Studies” to be shared by faculty from the Schools of Architecture and Planning and the relevant engineering programs.

The Penn State Center for Sustainability (CfS) will lead the development and expansion of innovative programs intended to attract college students of broad disciplines into the energy efficiency and distributed energy industries. These programs will utilize proven service learning and hands-on pedagogies to respond to the interest of the millennium generation in conservation and renewable energy topics on their campuses and in their communities. Student engagement activities that will be expanded to HUB partners include a national competition titled the Green Energy Challenge in which student teams conduct energy audits for schools and non-profit organizations, and an international service program intended to cultivate clean energy solutions in developing communities in Central America. Developed through seed funding from the National Electrical Contracting Association and the National Roofing Contracting Association, and more recently the Alliance to Save Energy, these programs are poised to be expanded to a national scale through cultivation with HUB activities.

In 2009 the CfS successfully piloted an innovative program titled the National Energy Leadership Corps (N.E.L.C.). The goals of the N.E.L.C. are to 1) build credentials and interests among individuals in opportunities that exist in the energy efficiency field, 2) help reduce energy costs and greenhouse gas emissions in the residential energy sector, and 3) provide a pull mechanism for energy efficiency products and services stimulating job creation. The N.E.L.C. utilizes a unique curriculum and training program to prepare college students to conduct energy screening audits of low-income homes. Intended to compliment high cost professional energy audits, the N.E.L.C. focuses on raising awareness of homeowners of cost saving energy conservation measures spanning behavior to home improvements and appliance upgrades. Through a unique web-based software tool, the N.E.L.C. participants assist homeowners with the development of personal energy plans targeted to their preferences, beliefs, climate, and home construction features. The CfS will engage the HUB with national leaders in energy efficiency manufacturing, commercial sales, and workforce development to cultivate N.E.L.C. activities at HUB partner schools with an initial focus on the Collegiate Consortium.

The CfS is currently leading the creation of two new DOE Centers, the Northern Mid Atlantic Solar Instructor Training Center and the GridSTAR Smart Grid Education and Training Center. Both of these centers capitalize on strong partnerships between manufacturing, utilities, research laboratories, and training programs to support the adoption and deployment of new technologies. For example, a key thrust of the Solar Instructor Training Center will be the stewardship of new roof integrated photovoltaic technologies by engaging manufacturers, electrical and roofing trade associations, and workforce development partners needed to overcome barriers to BIPV deployment. Both the Solar and Smart Grid centers will serve as models for the HUB in the cultivation of vertically integrated pipelines serving the commercialization of new technologies by cultivating education and training of design professionals, contractors, skilled trades, and building inspectors/code officials in the nuances of new energy efficiency and renewable energy technologies.

The Alliance to Save Energy will support the HUB through two primary support networks that will create direct links between HUB research activities and workforce development partners. Founded in 1977, the Alliance to Save Energy (the Alliance) is a nonprofit coalition of prominent business, government, environmental and consumer leaders who promote the efficient
and clean use of energy worldwide to benefit the environment, the economy and national security. Headquartered in Washington, DC, the Alliance has an annual budget of $12,000,000, a staff of 60, and offices in New York, California, Mexico, India, South Africa and Eastern Europe. The Alliance’s efficiency activities encompass energy efficiency in buildings, education, research, utilities, policy, international development and consumer awareness. Sen. Mark Pryor (D-Ark.) currently serves as the honorary Chair of the Alliance Board. Peter Darbee, Chairman, President and CEO of Pacific Gas and Electric Corporation, serves as Co-chair. The bipartisan board includes other corporate CEOs, presidents and senior executives as well as government officials, environmental and academic leaders. The Alliance works in close partnership with more than 160 Associates – corporations, business trade associations, state energy offices, federal energy research labs, nonprofits and other entities. Current examples of efficiency collaborations in which the Alliance plays a lead role include: The Building Codes Assistance Project, in partnership with the American Council for an Energy Efficiency Economy (ACEEE) and the Natural Resources Defense Council (NRDC), and the The Zero Energy Commercial Buildings Consortium, in partnership with the National Association of State Energy Offices (NASEO).

ASE will help eliminate gaps between the supply and demand for skilled workers in the GPIC through training and education. Using highly leveraged funding, the Alliance will deliver the Green Campus Program in six institutions throughout the GPIC. The Green Campus Program is a student-led initiative that educates the campus community on energy efficiency; achieves energy savings; and encourages the next generation of energy efficiency professionals by: Research, educational campaigns, technology projects, and facilitation of retrofits; Workforce development through training, mentoring, and integrated academic curricula, internships and project-based learning; Developing and implementing campus energy efficiency policy and action; Creating partnerships within and across campuses.

ASE recruits, selects and oversees interns on each campus it funds, with Alliance supervision and input from campus staff, implements the program. The Alliance supports the interns through continuous remote consultation, regular on-campus visits and bi-annual conferences. The Green Campus Program includes dedicated modules on Student Energy Audit Training, and boasts a placement rate of >80% of program alumni with efficiency-related employers. The Alliance training programs can serve as an on-ramp for current and future student participation in the HUB. The ASE will also invite students to enroll in its Energy Internship Program, an online database that will connect students with the Alliance’s 170+ Associates who seek interns for a quarter, semester or longer of energy-efficiency projects. ASE will administer the pre-screening and application process and recruit the internship host sites. It will develop and post energy job profiles and job descriptions; the skills, training and certifications employers seek; salary ranges; and links to local employers.

**ASE will support the formation of partnerships designed to promote the growth of the cluster:** The Alliance will organize quarterly networking events for the GPIC. These general networking events will leverage existing Alliance to Save Energy policy and networking events, and may again serve as an opportunity to introduce the work of the cluster to the 170 Alliance Associates. Examples of the leveraged networking events may include: The Alliance’s Great Energy Efficiency Day (GEED), a summit in Washington, DC, regularly attended by over 400 policy leaders; Existing consortia events, such as the Alliance partnership with the DOE in the
Commercial Buildings Consortium; Existing events with international partners such as the Asia Pacific Economic Co-operation (APEC) and Asia Pacific Partnership (APP); Linking with our many state and federal partners, including through the Federal Energy Management Process (FEMP). In coordination with Penn State, ASE will also support the placement of funded PhD student interns from HUB universities that will cultivate intimate industrial research and commercialization partnerships between private industry labs and commercial research and development activities in the energy efficiency technology sector.

Subtask 4: Workforce Development Partners / Underrepresented Individuals

Workforce Development Partners: The Southeastern Pennsylvania (SEPA) Regional Workforce Investment Board (WIB) Collaborative includes leadership from the workforce investment boards from Philadelphia, Montgomery, Bucks, Chester, and Delaware County Pennsylvania. The SEPA WIB Collaborative joins with the Camden County WIB to provide support for GPIC programs that affect the regional labor pool and economy. The following are among the participating workforce development partners.

The Philadelphia WIB is the largest workforce investment entity in our region and is actively involved in relevant job creation. As a workforce system partner, the Philadelphia WIB will offer expertise and leadership to align Workforce Investment Act funds and ARRA workforce development funds with the activities of the HUB and its associated education partners. As the largest workforce investment area in the Greater Philadelphia Region, the Philadelphia WIB has already attracted resources, partnered with others and developed programs to meet current and future workforce needs that are key to the growth of the energy efficiency building cluster. This effort will build on local Workforce Investment Act formula funds for dislocated workers, low-income adults and disadvantaged youth, and pipeline programs that prepare low-income, unemployed adults with the basic skills, workforce readiness and entry-level technical skills for jobs with the energy efficient building sector and the HUB’s activities.

Philadelphia received three ARRA “Pathways out of Poverty” green job training awards worth more than $3 million. The Philadelphia WIB itself is managing one of these grants, for community-based organizations to provide literacy, job readiness and skills training programs customized for energy efficiency and clean energy occupations, which will operate through January 2012. Thirteen publicly-funded green job training programs operated by non-profit organizations in Philadelphia are training adults for energy efficiency work. A more detailed mapping of the region’s green job training assets is being conducted by the Sustainable Business Network of Greater Philadelphia and will be shared with the HUB so resources can be aligned.

The Sustainable Business Network (SBN) of Greater Philadelphia is a business organization that brings together local leaders who share a common passion to grow successful businesses that are socially and environmentally responsible. SBN works with businesses from startups to older companies who want to create or maintain organizations that respect their employees, value the community and protect the earth. As the convener of Philadelphia’s Green Economy Task Force (GETF), the SBN played an integral role in the development of the region’s network of green job training programs. GETF is a coalition of green businesses, organized labor, education and training institutions, environmental policy groups, government, and community organizations. Now more than 650 stakeholders strong, GETF’s dual mission is to grow green businesses and to expand training opportunities to meet the needs of 21st century employers and the region’s workforce. SBN and GETF have convened energy efficiency businesses for the purposes of
developing training curriculum and regularly convene job training and education organizations for the purposes of planning, business recruitment, and troubleshooting. As this project will have multiple education and training institutions supporting it, SBN and GETF will conduct bi-annual meetings of these institutions and bi-annual networking events for employers. These quarterly meetings will be essential to the success of the workforce partnership. The meetings will engage the network of HUB universities and training institutions for troubleshooting and planning to improve their responsiveness to businesses and students. SBN will produce quarterly reports for meeting participants, business partners, and key stakeholders.

Educational Data Systems, Inc. (EDSI) is an ISO 9001:2000 Certified workforce development company with significant and successful experience providing comprehensive business and jobseeker services in a dual customer role. EDSI has been in the workforce development and consulting business, assisting individuals with the transition from unemployment to employment and from under-employment to self-sufficiency. Since EDSI's inception, it has remained on the cutting edge of new initiatives, providing successful business services, placement, and retention services for government programs and corporations across the country. EDSI also works with public, private, and labor sectors to research, analyze and assess workforce development needs and has helped more than 25,000 individuals in jobs since its founding in 1979.74

Delaware Valley Industrial Resource Center (DVIRC) has been instrumental in promoting the Region’s Applied Engineering Technology Career Pathway’s program initially with Delaware County Community College and now in collaboration with the Collegiate Consortium for Workforce and Economic Development. This program has been expanded to Community College of Philadelphia and Montgomery County Community College through a grant from the United States Department of Labor Employment and Training Administration (ETA). The ETA expanded the earlier work from its original collaboration and supported the expansion of the program through marketing, industry advisory activities and program design support. The HUB partnership will work with DVIRC to work with current programs in place as well as the development of new AET’s to support building efficiency technologies.

A fundamental element of the DVIRC strategy is to work with the existing educational infrastructure to support the goals of the project. As new occupations related to the EESS take shape, DVIRC will review existing programming in the region to identify institutions with “best fit” educational and training programming that could be modified or augmented to contribute to a regional educational system supporting the broad goals of GPIC HUB. DVIRC will review and catalog existing, relevant educational programming at the secondary and post-secondary levels and produce an Inventory Report that will include institution, program of study, curriculum and age of curriculum, articulation agreements, enrollment, and enrollment profile. DVIRC will serve as part of the team that convenes the stakeholder business community to clearly articulate demand for the educational requirements and skill sets for emerging occupations. This will include coordinating work with the New Jersey Manufacturing Extension Partnership (MEP) and developing a consistent approach to working with companies in the targeted NAICS Codes.

Over the past eight years, DVIRC has been working with Delaware County Community College, Montgomery County Community College, Drexel University, the School District of

Philadelphia, and area high schools to develop Applied Engineering Technology (AET) educational programs to support the human capital needs of regional advanced technology and manufacturing companies. The DVIRC goal is to have thousands of individuals enrolled in this segment of the region’s educational system in five years, creating a regional economic development asset that will give Greater Philadelphia a comparative economic advantage for many years. The certificate and degree-based programs in Applied Engineering Technology include: Machine Tool and Manufacturing Automation, Process Control, and Industrial Systems. These three educational areas will support a substantial portion of the region’s need for technically proficient, well-educated individuals, providing the market with a range of talent from diagnostics technicians and numerical control programmers, through process control and bio-technicians, and complex systems, maintenance and repair engineers and technicians. To date there has been an investment of over $7 million from state, federal, and private sources. These foundational educational programs can also readily form the basis for thinking about an emerging Building Systems Engineering program.

Recruitment of Underrepresented Individuals: To ensure that participants are a good match for the program and will gain successful employment upon graduation, a three-tiered, targeted recruitment approach will be used. For the first tier, the recruitment team will partner with the State Unemployment Insurance office to distribute customized program marketing materials to workers who have been recently laid-off from occupations with a skill set that overlaps with those required in the program, such as construction and maintenance workers. For the second tier, the recruitment team will orient staff from all 13 one-stop centers in the region on the program, helping to define entry requirements so that the staff can correctly identify and refer dislocated workers coming into the centers. For the third tier, in order to facilitate recruitment in specifically-targeted communities that have concentrations of unemployed, low-income, minority residents, we will also work closely with Delaware County CareerLink in Chester, PA;75 Workforce New Jersey, with an emphasis on Camden;76 and the Philadelphia Workforce Development Corporation (PWDC).77

The Philadelphia and Camden AFL-CIO Councils and their affiliated Building Trade unions will play an active role in recruiting participants. The recruitment team will collaborate with the unions to publicize the program to union members in related fields who are unemployed. Targeted populations will be invited to sign-up for informational sessions that will provide a group orientation to the program’s requirements and job prospects and individual pre-screening of interested candidates. Through the WorkKeys assessment systems, participants will be directed to entry point programs and tracked by EDSI as they matriculate through training.

Given the diverse skill set required for the proposed initiative, existing degree and certificate programs cannot simply be modified. The Collegiate Consortium is ideally positioned to lead the development and implementation of new training programs, curriculum and career ladder by adapting already established degree and certification programs in the related fields of Waste Water Treatment, Construction Technology, Applied Engineering Technology, Green

75 Delaware County CareerLink: http://www.co.delaware.pa.U.S./depts/oet.html
76 Workforce New Jersey: http://lwd.dol.state.nj.U.S./labor/wnjpin/wnjpin_index.html
77 PWDC: http://www.pwdc.org
Technology, and LEED & Green Advantage certification. Ultimately, these new tools can serve as a national model, especially in communities with older infrastructures and retrofit needs.

The SBN will secure input from industry partners (e.g., alternative energy firms), who can provide ongoing expertise in the pre-screening tools and development of program curriculum. SBN will continue to recruit active participation by other green employers. Individuals enrolling in the Green Construction Technician segment of the program will participate in up to 280 classroom hours over a 12 week period through three modules. Module I will provide up to 160 hours of course time and will include an introduction to the construction workplace environment, applied math and measurement techniques, construction administration, OSHA, technical reading skills and construction and green technology. Module II will cover core skills for green construction technicians, such as methods and materials of construction and an introduction to green landscaping. Module III will prepare participants to gain employment as Green Construction Supervisors (141 hours). Upon completion of the third tier of the program, participants will have the necessary competencies to manage a project site and community relations, as well as to oversee the work plan, staffing, assets, and budget. Upon completion of the program, graduates will receive industry-validated certificates of competency. An articulation model will also be developed into already existing degree granting programs for those trainees who wish to pursue an Associate’s degree and then a Bachelor’s degree in Civil Engineering, Construction Management, or other related technical fields in fully articulated programs.

To ensure successful graduation from the programs, each participant will be connected to an EDSI case manager upon enrollment who will track participants’ progress, counsel the participant, help to address any challenges that emerge, and guarantee that each participant has a plan in place to overcome barriers they may face such as those related to transportation and childcare. The case managers will also capitalize on the broad range of supportive services that are offered through regional human service agencies, thereby addressing any additional issues faced by participants that might impede participation or program completion.

Each program participant will follow a customized placement strategy that will connect them with union and nonunion employers. EDSI Job Developers will be responsible for connecting participants to nonunion employers who will have been identified and cultivated through SBN’s Emerging Industries Project and Green Business Council or listed in one-stop career center job listings. EDSI staff will coordinate with one-stop staff to either refer participants for job matching services or to contact employers directly. EDSI staff will then conduct a task analysis to match participant strengths and skills with employer needs, and schedule or help participants to schedule interviews. Once a trainee secures employment, EDSI staff will continue its case management to ensure retention.
3.4.5 Task Group 5: Demonstration, Knowledge Management and Deployment

An effective demonstration, knowledge management and commercialization effort is required to achieve the full impact of the HUB and GPIC initiative. These elements will be accomplished in Task 5 by focusing on the following efforts, which are addressed in this narrative.

- Conduct innovation demonstrations via test beds
- Actively harvest technology, regulatory and policy initiatives, ideas and IP
- Foster “out of the box” research
- Lead knowledge management
- Develop IP effective licensing
- Promote commercialization
- Sponsor outreach and communication

Goals and Deliverables

**Convert a fragmented horizontal building industry into a virtual, vertically integrated industry model focused on developing and deploying energy efficient systems for building renovations using integrated project delivery paradigms.**

Key elements to success are technology demonstrations at the HUB’s integrated RDD&D test bed facilities, management of the Commercialization and Creativity Institute (C²I) and recommendations on specific opportunity research and technology transfer projects to the HUB management. Real-time review of all projects will assure: integration of all technical development projects (Task Group 1, 2), continuous improvement of new business value propositions and business models (Task Group 3), alignment with existing and new local government policies and incentives (Task Group 3), and identification of needed workforce development, education and training programs (Task Group 4). Early and ongoing engagements, coordinated with Task Group 3 and 4 participants and co-applicants PIDC, Wharton SBDC and DVIRC, will drive the building market in the development, management, prototyping and demonstration of building RDD&D projects in the Greater Philadelphia Region. Building managers, members of the building design community, building component manufacturers, government policy officials, trade craft unions and others will be involved. Training programs will span building trades training, undergraduate and graduate degree education and summer intern programs. Task Group 5 deliverables also include the collaboration, implementation and creation of RDD&D proposals, new grant proposals knowledge management and outreach to underrepresented partners for inclusion in the RDD&D process.

Subtask 1: Technology Demonstration via HUB Test Bed Sites

The HUB RDD&D team is to conduct the scientific, engineering, public policy development, education and training and business case model research required to realize the systems approach to establishing highly efficient, excellent indoor environments in the building stock via retrofits of existing buildings and application of practices to new construction.

*The Philadelphia Navy Yard Clean Energy Campus:* The Philadelphia Navy Yard will be the primary test bed for technology demonstrations. The site contains 282 existing buildings of which 233 are historic structures, presenting an outstanding opportunity for demonstrating innovative technologies and processes for building retrofits. The Navy Yard has its own non-regulated electric distribution system servicing the entire campus, currently managed by PIDC. This non-regulated grid allows for the rapid deployment and innovative testing of Smart Grid...
approaches to electric energy demand management. Direct connections from the Navy Yard to the interstate highway system (both I-95 and I-76), the regional labor pool, the national rail network, and the Port of Philadelphia, in addition to close proximity to a regionally important professional sports stadium complex, ensure both excellent accessibility and high visibility of projects at this historic site.

A comprehensive Master Plan, published in September 2004, guides development at the Navy Yard. The plan proposes a dynamic, mixed-use development designed to accommodate 12 to 15 million square feet of office, R&D, and industrial real estate and over 30,000 workers in a vibrant, 24-hour community based on the principles of smart growth, historic preservation, expanded mass transit and sound sustainable practices. Ultimately, the development will leverage more than $2 billion of private investment and will substantially diversify and expand the employment, productivity, and tax base of the city and region.

In 2004, the Navy Yard was designated a Keystone Innovation Zone a program of the Commonwealth of Pennsylvania designed to foster unique public-private partnerships and to support entrepreneurship in economically challenged geographic areas. Founding KIZ sponsors included Pennsylvania State University, Ben Franklin Technology Partners of Southeastern Pennsylvania (BFTP), the City of Philadelphia, the Delaware Valley Industrial Resource Center (the regional NIST-MEP), PIDC, private industry, and the Navy’s NAVSEA Warfare Center - Carderock Division (NSWCCD). The KIZ designation provided the catalyst for a thorough assessment of the regional strengths in research and technology as drivers of economic development, and led to the formation of the Navy Yard Power Group. This consortia group of public and private partners focused on creating economic opportunity by leveraging the complementary activities of education, research and development, and technology commercialization, and company formation, specifically targeted to the power and energy industry. Navy Yard Power Group members conceived of the Navy Yard Clean Energy Campus to serve as a unique national model for sustainable development and clean energy technology demonstration. The Building 100 Innovation Center at the Navy Yard houses BFTP and DVIRC.

The Pennsylvania State University has recently been awarded three United State Department of Energy (DOE) grants to establish the following centers at the Navy Yard, which will complement the GPIC HUB:

- In July 2009, the DOE established the Mid-Atlantic Clean Energy Application Center (CEAC) at The Navy Yard. The CEAC is operated by the Penn State College of Engineering at the Navy Yard with the mission of promoting the adoption of clean energy technology by industry and government in the six Mid-Atlantic states through education and technical assistance, with an emphasis on net-zero building technologies, combined heat and power (CHP), district energy management, and smart grid technology. The Mid-Atlantic CEAC at the Navy Yard will be a key asset for disseminating technologies in these and other areas to energy producers, distributors, and users in the Mid-Atlantic region and across the nation.

- A second 2009 DOE grant that was awarded provides $3.5 million to establish the Mid-Atlantic Solar Resource and Training Center, aimed at developing the solar energy industry in the Mid-Atlantic region through technical assistance and workforce development. The center is part of a national network of solar education and training centers newly established in 2009 through the DOE Solar Energy Technologies Program, and is supported by American Recovery and Reinvestment Act (ARRA) funds.
• A third DOE grant that has recently been awarded provides $5 million to establish a new Grid Smart Training Applications Resource (GridSTAR) Center to provide education and workforce training in smart grid technologies with a permanent site at the Navy Yard.

These three recent DOE awards recognize Pennsylvania State University’s Department of Architectural Engineering and its strategic focus on High Performance Green Buildings. The HUB will continue the substantial and successful investment in the programming and physical space necessary to fully realize the potential of the assets already in place at the Navy Yard. The HUB will develop a model by which the success of the Philadelphia Navy Yard Clean Energy Campus can be replicated in other regions of the country.

The City of Philadelphia was recently awarded a $25M Energy Efficiency and Conservation Block Grant Program “to deploy the most cost effective and reliable energy technologies available in renovating urban housing units in the City for the purpose of reducing associated fossil fuel emission, total energy use by the units, and create and maintain jobs via the renovation processes themselves. This application award directly relates to the specific RDD&D focus of the GPIC HUB. The HUB RDD&D team is to conduct the scientific, engineering, public policy development, education and training and business case model research required to realize the systems approach to establishing highly efficient, excellent indoor environments in the building stock via deep retrofit of existing buildings and application of practices to new construction.

Testing and Demonstration Activities at the Philadelphia Navy Yard: The first renovation at the Navy Yard will be an existing 30,000 square foot historic building (Building 661, Figure 3.1.7-1) that will house the GPIC HUB. Funding of these activities will come from the $5 million EDA grant proposed by co-applicant PIDC. This facility will host research and development, conferencing, office, and training programs. The facility’s renovation will serve as a best practices model for commercial building design, historic adaptive re-use, and energy efficiency innovation through continuous retrofit.

There are three principles that will drive this renovation:

• An innovative and commercially relevant building retrofit process, which incorporates integrated design and sustainable strategies. The process and strategies will be adaptable to multiple building morphologies and eras, and replicable to a commercial industry standard. Consortium members selected a historic structure as the test bed renovation site because of the more stringent regulatory and physical requirements demanded for these types of structures. This renovation will provide knowledge and skills transferable to commercial and multi-family residential building retrofits in the region and nationally

• The collocation of research, education, and commercialization activities focused on clean and efficient energy requiring a multi-use facility design. The building will house researchers from multiple institutions and private companies possessing diverse research specialties. In addition: the building will host economic development organizations, education providers in science, technology, engineering, and math (STEM) at the K-12, university, and graduate levels, and private firms that will commercialize the technologies and implement emerging best practices.

• Adaptive building infrastructure that will enable Building 661 (the Energy Innovation Center) to be a living laboratory, whose energy sources can be varied for advanced technology demonstrations over time. Similarly, the building’s physical spatial layout will be reconfigurable to maximize energy efficiency opportunities and space utilization.
Energy efficiency strategies and implementation across existing base of 66 businesses within the Philadelphia Navy Yard: As the HUB identifies economically viable technologies and applications they will be shared and tested at buildings at the Navy Yard. PIDC, the Navy Base landlord will work with their tenants to install and test devices and systems. Additionally, three significant divisions of the United States Navy continue to be housed at the Navy Yard and perform a number of research and energy related functions which lend themselves to the research and implementation strategies that will continue to develop through the HUB activities, thus providing another avenue of potential test bed activity. The application of Combined Heat and Power Systems with on-site energy storage and distributed throughout the Navy Yard Complex will be investigated in the Task Group 2 efforts.

In addition, a new state-of-the art energy efficient commercial building will be constructed at the Navy Yard employing integrated systems approaches and demonstrating how methods developed through the retrofit RDD&D efforts can be readily applied to new construction projects. This building project will be funded with $30 million from the Commonwealth of Pennsylvania and private financing and will be part of the Clean Energy Campus at the Navy Yard.

The Ray W. Herrick High Performance Building Laboratories at Purdue University: The Ray W. Herrick Laboratories have a long history of performing research on many topics related to buildings, including high performance equipment, intelligent controls and diagnostics, indoor environments, and high performance building envelopes. Of particular interest is the development, validation, and application of models useful for design, analysis and optimization, including modeling of components (compressors, flow control devices, heat exchangers, building envelopes), subsystems (packaged AC and heat pumps, chillers, air handling equipment, integrated envelop subsystems), indoor environments, and whole-building systems. The laboratories contain a variety of test facilities, including psychrometric chambers for testing HVAC&R equipment, a reconfigurable indoor air quality facility for evaluating air distribution systems and indoor climates, a specialized wind-tunnel for testing heat exchanges, compressor calorimeters and load stands, specialized acoustic facilities (anechoic, semi-anechoic and reverberation chambers), and a quiet room for sound evaluation. The laboratories host three parallel conferences that attract building and equipment researchers from all over the world: International Compressor Engineering Conference, International Refrigeration and Air Conditioning Conference, and International High Performance Buildings Conference. These conferences are a unique forum for academia and industry to interact and are considered to be some of the best in the field.

The new Architectural Engineering Laboratories at Purdue consist of five different building structures: four full-scale office spaces (20 ft. x 20 ft. x 12 ft. high) placed side-by-side and a similar size two-story building (24 ft. high). All the facilities are fully reconfigurable (floor, walls, windows, roof, ceiling) so that different products, technologies and developed controls could be tested and then detached. Two of the single story buildings are used for research in commercial (office) buildings and the other two for residential construction. The office spaces have a front curtain wall façade consisting of several movable parts with different glazing materials, shading attachments, openings for natural ventilation and photovoltaic panels, and the walls are made of metal insulated panels. The buildings, which are equipped with extensive systems and testing equipment, will be used to study and evaluate a range of building systems and equipment technologies. (See Figure 3.1.7-5).
Other HUB research facilities include: the new NIST sponsored High Performance Building Research Center at Purdue University; the Virginia Tech URI Center for Optimal Design And Control; the supercomputing center at the University of Pittsburgh; the Lawrence Livermore National Laboratory Computational Department; the buildings and energy research and development at the United Technologies Research Center; and the buildings and energy research at IBM Laboratories. In addition to face-to-face meetings at the Navy Yard, all research facilities will be linked by state-of-the-art, Cisco TelePresence video conferencing (acquired with the Commonwealth capital funding) to effectively expand the HUB research capabilities.

Subtask 2: Knowledge Management and Deployment
The HUB enjoys the major advantage of location to promote communication. This occurs for both the co-located HUB team and GPIC co-applicants that are all in the greater Philadelphia region. The Operating Committee and the co-located investigators are spherically integrated to continuously confront all project interdependencies. The Executive Board and Advisory Committee meet quarterly, and will address the HUB and GPIC on strategic direction and emerging issues pertinent to the program objective. The HUB has a clear plan for the use of state-of-the-art technology to support frequent virtual (video conference) meetings to promote meaningful long distance collaboration. It is expected that HUB communications plan will greatly enhance the Knowledge Management process.

Nevertheless, HUB team experience, as well as, scientific research, reveals that many good ideas are not vetted or even discovered because researchers themselves do not recognize the value beyond their particular purview. To overcome this historical innovation and deployment gap, the HUB has developed an active engagement infrastructure for the innovation and deployment process.

Knowledge generated from the HUB activities (Internal Engagement) will be captured during the course of the project and housed in a repository along with contributed data from HUB Members, with the intent to create a unique database that will inform other building researcher, architects, designers, developers and construction personnel throughout the industry. A scientific information system (SIS) developed and operated by Morgan State University to collect, catalogue, and store information on the RDD&D projects and activities will be used. The GPIC IP management plan (Appendix 3) has been approved in principle by the all GPIC and HUB members and provides an unprecedented IP/information sharing platform.

The HUB commercialization, communications and outreach plans (External Engagement) leverage the extensive and well established networks of the HUB and GPIC members and partners touching multiple times every aspect of building design, engineering, construction, operation, maintenance and retrofit. The HUB and GPIC members and partners networks are also deeply engaged with the regulatory, public policy, economic development and small and disadvantaged business community. These networks will be a strategic focus of the HUB outreach program.

The Commercialization and Creativity Institute (C2I) will be created to facilitate and manage the internal and external active engagement process (see Figure 3.4.5-1).
Specific C₂I metrics will be developed focusing on:

1. Internal engagement (Knowledge Management)
   a. Actively harvest technology, regulatory and policy initiatives, ideas and IP
   b. Foster “out of the box” research
   c. Lead knowledge management
   d. Develop IP licensing

2. External engagement (Deployment)
   a. Promote commercialization
   b. Sponsor outreach and communication

**Management: Ben Franklin Technology Partners of Southeastern Pennsylvania (BFTP):** C₂I leadership and coordination will be provided by BFTP, a nationally recognized leader in technology based economic development. BFTP functions as an innovation integrator and seed investor, linking public and private resources to create new systems to support technology development and commercialization, spawning new enterprises and growing existing ones. BFTP has a 27-year track record of successfully creating commercialization pathways, and catalyzing and developing cluster-based strategies and collaborations in the region. BFTP has invested over $37 million since 2001 and $130 million since 1982 in 1,600 companies. In the last six years, these investments have returned over $650 million in follow-on capital. BFTP’s statewide partnership was awarded the U.S. Department of Commerce Technology-Led Economic Development Award in 2008. As part of its regional energy strategy focused at the Navy Yard, BFTP is engaging corporate partners for energy demonstration projects. BFTP has actively supported the creation of several regional innovation centers.

**Internal engagement:**

1. Actively harvest technology, best-practices, regulatory and policy initiatives, ideas and IP: An effective knowledge management effort is required to achieve the full impact of the HUB and GPIC initiative. These results will not be achieved by conducting business as usual. Since World War II, the United States science policy paradigm has assumed a linear model of technological innovation, analogous to the conventional building design, construction, and delivery process. This linear model of innovation assumes that discoveries from basic research will “spin-off” to industry where they are commercially produced through a sequence of discreet steps including applied research, development, and design. This model does not accommodate that knowledge generated through basic research is in fact utilized at all stages of the innovation process, or that

![Figure 3.4.5-1 Active Engagement](image-url)
feedback from the later stages helps determine basic research directions. Kline and Rosenberg were among the first scholars to understand the innovation process as an iterative and interactive feedback process, and used the term “chain link” to describe this model of innovation as shown in Figure 3.4.5-2.

Considerable scholarly work over the past 25 years has focused on improving the understanding of the innovation process. One insight from the Deshpande Center at MIT is particularly relevant. The Center found that the vast majority of potentially valuable discoveries being made by the MIT scientists were not being disclosed to the Institution. Thus, in addition to an understanding of the innovation process as non-linear, iterative, and interactive, an effective demonstration, deployment, and commercialization effort requires continuous, proactive interaction between technology transfer staff and researchers. The HUB team recognizes that active attention must be paid to the demonstration, knowledge management and deployment of the innovations identified through the HUB initiative.

The C2I will create a single repository for HUB and GPIC’s knowledge and IP, and will be an attractive starting place for interested companies to search for and license technologies. As such, C2I will engage all HUB members and GPIC co-applicants with the intent of actively harvesting all relevant knowledge. C2I will participate in all Operating Committee and Executive Board meetings to report on knowledge management and licensing, as well as, to actively harvest ideas.

2. Fostering “out of the box” Research - HUB members recognize the scope and complexity achieving a 50% energy efficiency reduction goal demands rethinking every approach and solution set. HUB members also recognize that to solve such an immense problem in the accelerated timeframe sought by the FOA, innovation must be cultivated. Therefore, the C2I will create and manage a $10M Opportunity Research Fund (ORF) formulated to provide a competitive platform for innovative ideas for HUB member researchers. The ORF adds to the culture of innovation the HUB is fostering by providing creative means of developing good ideas. The C2I will accelerate HUB program innovation in the building industry by identifying and recommending to the HUB Operating Committee research projects to be funded from the ORF. C2I will periodically provide opportunities for member led teams including partners to offer proposals that include 50% co-funding from external sources. The HUB Operating Committee will have authority to fund projects up to $100,000; larger projects will require the approval of the GPIC Executive Board. The C2I will provide the HUB Operating Committee with periodic reviews of all funded projects.

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3. Knowledge Management - Knowledge generated from the HUB activities will be captured during the course of the project, to be housed in a repository as described in Task 3 along with contributed data from HUB members. The intent is to create a unique database that will inform other building researchers, architects, designers, developers and construction personnel throughout the industry.

C2I will also monitor the application, implementation and impacts of all projects with the various organizational sector targets – designers, materials suppliers, labor unions, policy formulators, venture capital and business models, etc. C2I will also establish and manage a database of metrics on building industry transformation traceable to HUB programs and projects, indices of innovation and degree of spherical integration.

The C2I will employ a scientific information system (SIS) developed and operated by Morgan State University to collect, catalogue, and store information on the RDD&D projects and activities to be undertaken by the HUB and across the GPIC. The SIS was developed at Morgan State in collaboration with Johns Hopkins University through research supported by the NSF Engineering Research Center (ERC) on Computer Integrated Surgical Systems Technology (CISST). Four key subsystems will be developed, integrated, and operated to establish a SIS for HUB and GPIC RDD&D: 1) the static object-oriented model; 2) scientific poster pattern methodology; 3) the communication and collaboration process; and 4) a SIS website. The SIS will provide the HUB with a state-of-the-art method for understanding and communicating both internally and externally the array of RDD&D activities underway, and will also contribute to the body of knowledge on the management of scientific information.

The success of the HUB/GPIC integrated RDD&D program will be enabled by a comprehensive and integrated Intellectual Property management program and innovation management process, detailed in the HUB IP Management Plan (Appendix 3). All HUB participants plan to adhere to a number of principles that will guide IP management, which will be incorporated into a comprehensive Collaboration Agreement to be executed by all members and partners. These principles include:

- All Foreground IP will be subject to any rights agreed to with the U.S. Government for the HUB activity.
- The C2I is the conduit for the HUB’s IP. Background IP may be donated by organizations at their sole discretion. GPIC has no ownership rights to IP either contributed as Background Intellectual Property or IP developed as a result of GPIC funding, Foreground Inventions. The inventors and their assigns retain ownership of any GPIC-generated IP.
- Members agree to participate in C2I activities through the execution of the GPIC Collaboration Agreement and provide staffing in kind, in the form of Technology Transfer or Licensing Officers plus their associated administrative costs, to support these activities.
- The GPIC Collaboration Agreement (CA) will clearly delineate ownership rights for sole or jointly developed intellectual property for both member institutions and companies.

4. Effective IP Licensing - C2I will create an Intellectual Property Team (IPT) which will serve as the conduit for the HUB’s IP management and commercialization. The IPT will perform the critical late-stage mechanisms for the HUB, accelerating an integrated pathway to successful technology IP management and commercialization. The IPT will be comprised of technology transfer officers and licensing professionals from the partners and members led by BFTP. The
C2I will coordinate their activities and programs with the members and partners across all HUB and GPIC areas as an active participant in the overall management process and specific project stage-gate processes. This coordination role will focus on ensuring comprehensive demonstration, deployment, commercialization and IP connectivity between and among the ongoing task research and their stage-gated project management activities.

The C2I will identify IP pools and packages that may benefit from test bed funding opportunities. The C2I will provide corporations with a single point contact for license negotiation, independent of the number of institutions with ownership of that IP. In addition, the centralized service from within the CI will offer more resources to be dedicated to energy efficient building technology, to support the development of greater expertise in that field. The C2I will facilitate the establishment of new companies or licensing of IP to existing companies. More specifically, the C2I will provide the following IP services:

- Manage IP disclosures, IP evaluation and patenting
- Identify and market all technology-specific IP among CI members
- Increase the impact of IP
  - Identify IP packages resulting in increased potential value
  - Includes limited due-diligence
  - Refer specific IP pools to the GPIC Executive Board for proof-of-concept funding
- Help institutional investigators engage with industry partners
- Help industry partners engage with institutional investigators
- “One-stop shopping” for license agreements

External Engagement:

1. Commercialization - The C2I will offer the resources of its partners to assist HUB members, partners, and start-up companies in establishing sound commercialization pathways. This will include 1) utilizing the services of Wharton’s Small Business Development Centers (SBDC) program to help create and validate an effective business model, 2) Delaware Valley Industrial Resource Center (DVIRC), the Region’s MEP, to identify small manufacturing companies to serve as manufacturing sites and 3) BFTP to identify and provide complementary technologies, emerging and established technology partner companies, and investment and business development resources. The organizational and legal structure underlying the C2I is designed to accelerate commercialization of C2I generated technology solutions. C2I provides the pathway for IP and innovative technology commercialization by both institutions or corporations.

Active participation in the Greater Philadelphia region is critical to the success of the GPIC, and focused efforts will be undertaken to engage the regional business community. These efforts will be led by the BFTP in partnership with the DVIRC, the Wharton SBDC, PSU, and others. Activities will include broad based marketing and communications via meetings and presentations to individual companies and groups of companies through industry associations and focused outreach efforts.

In support of the commercialization processes, supporting market research analysis will occur throughout the continuum of product development, from idea to commercialization. C2I will leverage the extensive marketing knowledge and market research and market analysis capabilities of the HUB members, including corporations, economic development groups, SBDC’s and universities. Key areas of market research will include market size, building economics, competitors and competitive response to help assess market penetration and its value.
proposition, as well as, it’s possible impediments to adoption and use by the market. The analysis will go beyond the product’s general viability to also look at workforce issues, building and zoning code limitations, and integration in the marketplace with existing products and services that would be related to components in building retrofits.

DVIRC, in collaboration with New Jersey Manufacturing Extension Partnership (NJMEP) and the Commercialization Acceleration Program (CAP) will identify and work with regional Small and Medium Enterprises (SMEs) possessing the interest for participation in C2I research projects and technology licensing as well as manufacturing capacity that can address technology focus areas of the HUB such as advanced lighting, heating, ventilating and air conditioning (HVAC) systems, construction materials, power management, electrical and systems, environmental technologies. DVIRC will work with these firms to participate in GPIC research, education and training, and technology development, and to position them as preferred suppliers to original equipment suppliers in key building energy efficiency sectors.

DVIRC will work with the Wharton SBDC to articulate and overcome the barriers to technology development and commercialization inherent in smaller firms, most of which are unfamiliar with the nuances of intellectual property disclosure and management, technology validation, and multi-party collaborations.

The CAP will provide research on potential market size; value of the potential technology to users along the value chain in terms of energy and environmental performance as well as cost and profitability, challenges to technology adoption and buying decisions throughout the value chain; competing technologies, evaluation of options for first applications of the technology and demonstrations; competitive analysis of technologies; and strategies for funding. CAP will support C2I decision making including conducting research on value chain to confirm the project’s value proposition to likely users based on monitored data and user behavior patterns. This may lead to refining financial models based on manufacturer supply chain data developed by DVIRC and other MEPs. As the CAP gains in-depth knowledge of industry market practices, needs and drivers, it will provide briefings to the C2I providing a positive market feedback loop.

2. Outreach and Communication - C2I will develop a proactive outreach strategy to the GPIC members and partners, and the building industry stakeholders – from owners, architects, engineers, building materials companies, and contractors, to device/software manufacturers, and the building trades. The HUB outreach program will establish an interactive website including an Energy Asset Map to track and analyze GPIC building and asset data. HUB and other program announcements will be issued and partner collaborations can be developed. The HUB will issue newsletters, marketing materials, press releases, and brochures.

The HUB will leverage ongoing public, private and institutional energy programs and initiatives and expand and strengthen partnerships with regional and national organizations (e.g. DVIRC, Wharton SBDC, Temple SBDC, Rutgers-Camden SBDC, EMAP of Pennsylvania SBDCs, Eastern Technology Council, NJ Technology Council, MAC Alliance, Greater Philadelphia Chamber of Commerce, Select Greater Philadelphia, Economy League of Greater Philadelphia, KIZ, NTI, ECI, the Pennsylvania Environmental Technologies for the Pharmaceutical Industry (PEPTI), the Water and Environmental and Technology Center (WET, an NSF I/UCRC), and regional capital providers).
The HUB will develop an outreach program to building industry organizations such as the Building Owners and Management Association (BOMA), Delaware Valley Green Building Council, Institute of Real Estate Management (IREM), Greater Philadelphia Building Council, Green Growth Partnership, (national: American Institute of Architects (AIA), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), U.S. Green Building Council, and more globally with the World Business Council for Sustainable Development (WBCSD). The HUB will sponsor industry symposia and conferences to present recent findings and advances, and challenge market participants to engage in the development of new design, construction and behavioral models.

C2I will actively seek minorities and females for internship and business development activities opportunities. The C2I will work with the GPIC members, partners and co-applicants and their networks to identify and work with underrepresented partners. The C2I will also establish a university-based intern program (as discussed in Task 4) to support activities and provide a rich learning experience in the technology innovation management field.

The SBDCs client are self identified as being over 30% minority and over 50% women owned. These groups include a significant number of construction, building, and building design businesses. The C2I will leverage the extensive partnerships of the SBDCs to promote and provide programs to the larger community of underrepresented small business owners. These established partnerships include: Sustainable Business Network of Greater Philadelphia, National Association of Women Business Owners, Greater Philadelphia Urban Affairs Coalition, Urban League, Philadelphia Development Partnership, Women’s Opportunities Resources Center.

DVIRC has recently been awarded an SBA contract to develop a program that serves SME’s in the category of 1-20 employees. We will focus on the inclusion of females and minorities in the GPIC program. In addition DVIRC participates in the Department of Defense - National Defense Education Program (NDEP), which is focused on females and minorities in distressed communities in the region.

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GPIC | Greater Philadelphia Innovation Cluster for Energy Efficient Buildings

Proposal to: U.S. Department of Commerce – Economic Development Administration
U.S. Department of Commerce – National Institute of Standards and Technology
U.S. Department of Energy
U.S. Small Business Administration

Date: May 6, 2010

FOA: Fiscal Year 2010 Energy Efficient Building Systems Regional Innovation Cluster Initiative

APPENDICES TO DOE HUB CO-APPLICATION
# Appendices

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Secretary of Energy Dr. Steven Chu, House Science Committee Testimony. March 17, 2009.


Appendix 2: Budget Summary
Lead Institution:
The Pennsylvania State University

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## Appendix 2: Budget Summary

**Lead Institution:**

- The Pennsylvania State University
- Carnegie Mellon University

### Year-by-Year Budget Summary

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4-7
## Appendix 2: Budget Summary

**Lead Institution:**
The Pennsylvania State University

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## Appendix 2: Budget Summary

**Lead Institution:**

**The Pennsylvania State University**

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The Pennsylvania State University

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## Appendix 2: Budget Summary

**Lead Institution:**

The Pennsylvania State University

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## Appendix 2: Budget Summary

**Lead Institution:**
The Pennsylvania State University

### University of Pittsburgh

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### PPG Insutries Glass Technology Center - Glass R & D

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## Appendix 2: Budget Summary

**Lead Institution:**
The Pennsylvania State University

### Princeton Plasma Physics Laboratory

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### Princeton University
## Appendix 2: Budget Summary

**Lead Institution:**

**The Pennsylvania State University**

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4-14
## Appendix 2: Budget Summary
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The Pennsylvania State University

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## Appendix 2: Budget Summary

**Lead Institution:**
The Pennsylvania State University

### Virginia Polytechnic Institute & State University

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Appendix 3  
HUB IP Management Plan

IP Management and Technology Commercialization

The Commercialization and Creativity Institute (C\textsubscript{2}I) will perform the critical late-stage mechanisms for the HUB, accelerating an integrated pathway to successful technology IP management and commercialization. The C\textsubscript{2}I will be designed to meet the DOE’s overall goals of addressing market driven, cost effective, clean energy technology solutions through a systematic, integrated and accelerated approach to the demonstration, deployment and commercialization of innovative and transformational technologies from Tasks 1 and 2 and supported by the policy, market, social, behavior and educational aspects of Tasks 3 and 4. The C\textsubscript{2}I will utilize a structure that encourages close collaborations between and among all of its stakeholders: research institutions, corporations, policy developers, buildings systems market experts from the entire market, economic development organizations and capital providers.

The GPIC participants plan to adhere to a number of principles that will guide Intellectual Property management, which will be incorporated into a comprehensive Collaboration Agreement to be executed by all members and partners subject to negotiation. These principles include:

- All Foreground Intellectual Property will be subject to any rights agreed to with the U.S. Government for the HUB activity.
- GPIC will create the C\textsubscript{2}I and the IP Team (IPT) as the conduit for the HUB’s IP. Background IP may be donated by organizations at their sole discretion. GPIC has no ownership rights to IP either contributed as Background Intellectual Property or IP developed as a result of GPIC funding, Foreground Inventions. The inventors and their assigns retain ownership of any GPIC-generated IP.
- Members agree to participate in C\textsubscript{2}I activities through the execution of the GPIC Collaboration Agreement and provide staffing in kind, in the form of Technology Transfer or Licensing Officers plus their associated administrative costs, to support these activities. These personnel plus a fully funded BFTP/SEP professional will form the Intellectual Property Team (IPT).
- The GPIC Collaboration Agreement (CA) will clearly delineate ownership rights for sole or jointly developed intellectual property for both member institutions and companies. The CA includes the following elements:
  - GPIC members shall retain all rights to their Background Intellectual Property. No licenses or rights are granted to any member’s Background Intellectual Property except as agreed to by the owner of such Background Intellectual Property.
  - Each member shall retain ownership of their singly and jointly owned Foreground Intellectual Properties.
  - HUB members will be granted a royalty free worldwide license to all HUB Foreground IP for research purposes for HUB related activities only.
Under the terms of the Collaboration Agreement, C2I shall have the right to negotiate a license to GPIC-generated IP, consisting of Background Intellectual Property and/or Foreground Inventions or bundles as appropriate.

Under the terms of the Collaboration Agreement, C2I and IPT will determine revenue distribution and revenue return to GPIC from the licensing of the Foreground Inventions, Background Intellectual Property or any bundles identified by IPT as agreed to by the members with ownership rights to the IP for other than HUB related activities.

Reporting on the registration or protection of Foreground Inventions will be coordinated by C2I, as agreed to by the members in advance. Funding for the registration or protection of joint Foreground Inventions shall be agreed to by the members with ownership rights to the IP.

In addition to the Technology Transfer/Licensing specialists resident at Member Institutions, the IPT will be directed by a full-time employee at BFTP/SEP with technical expertise and commercialization experience. It is the intent of Partner and Member companies to evaluate and work to bring products generated through the C2I to market. The C2I will facilitate technology transfer and commercialization as follows:

- The C2I will incorporate a novel proven IP management structure with a proven track record of accelerating technology development and commercialization adapted from The Nanotechnology Institute™ (NTI) and the Energy Commercialization Institute™ (ECI).
- The C2I will create a management approach by combining IP management with a technology commercialization processes.
- Pilot demonstrations will provide tangible results towards developing or contributing to open standards and help to expand the market opportunity. Corporate partners and members will have the ability to inform the technology selection and maturation process and successfully pull these technology innovations through to commercial impact and jobs creation.
- Existing and future facilities at The Navy Yard provide an installation and commercialization base and functionality for the region. These facilities provide a commercial “jump start” to energy efficient buildings in the region.

**Outcomes**

The outcomes from C2I will be the following:

- An accelerating stream of IP disclosures, patents, start- up companies spin offs and licenses, through resulting from the multi-institution collaboration and integrated innovation process described in this proposal.
- Expand the region’s innovation-promotion for technology commercialization and provide entrepreneurial support in the energy efficient building retrofit and building construction markets.
- Enhanced assistance to small and mid-sized companies to rapidly implement new E-RIC derived technologies; which will encourage and accelerate technology adoption, commercialization and jobs creation.
- Actively build the regional industry cluster by forming new stakeholder groups and supporting new grant proposals and access to capital.
- Build a sustainable community of innovation and economic growth.
Deliverables/Metrics

The commercialization of HUB generated IP will be manifest through license agreements and company start-ups or spin-outs. The increased activity in years 4 and 5 represent the accrued activities of the resident IP at the initiation of the HUB combined with the increased activity resulting from direct HUB-funded projects.

Table 3: C2I Subtask Goals and Metrics

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Table 4: MEP DVIRC Goals

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Table 5: SBDC Goals

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The C2I will build upon, advance and expand on a proven management model, the Nanotechnology Institute™ (NTI) model, created by the Commonwealth of Pennsylvania, Ben Franklin Technology Partners of Southeastern Pennsylvania (BFTP/SEP) and regional institutions within Southeastern Pennsylvania. The NTI is a nationally recognized multi-institutional entity whose mission is to accelerate nanotechnology commercialization through interdisciplinary translational research that flows from academic laboratories to company formation and product development. Formed in 2000 by the University of Pennsylvania, Drexel University, and BFTP/SEP, the NTI was the first nanotechnology commercialization Partnership of its kind in the nation and continues to serve as an innovative model with an unprecedented level of cooperation, collaboration, and strategic coordination between its 12 academic institutions and an economic development agency, leveraging the enormous resources of the research community in the region.

The NTI’s efforts in increasing the research enterprise, linking research institutions, creating new intellectual property, fostering a vibrant environment for new ventures, and marketing the region nationally and internationally have been highly successful. This model is being replicated in the Pennsylvania funded ECI, and is recognized as a national model for innovation.
**Intellectual Property, Deployment and Commercialization**

IP deployment and commercialization will be enabled through the ability of the HUB member and partner companies to take innovations from full scale demonstration (TRL6) through commercialization and facilitated through the high level of cooperation and coordination between researchers, policy experts, and commercial companies through the earlier stages of technology maturation.

As outlined in the O&M section, well established companies employ structured product development processes to ensure quality, coordinate activities, plan resources, benchmark, and improve the development and insertion into market of new products and solutions. Typically the phases of a product development process are: 1) Feasibility, 2) Planning and Specification, 3) Development, 4) Qualification and Release Preparation, 5) Customer Pilots or Field Trials, and 6) Full Release. Each phase of the process is followed by a gate review in which business assumptions, intellectual property management, readiness, and external factors such as regulations and policy are evaluated and updated. In some cases the assumptions may change enough to necessitate a redirect for the program.

The C2I approach will be to tightly integrate into the later-stage phases (see Figure 1) for Energy Efficient Building Systems products or services and deal with the unique challenges it poses:

- The Intellectual Property Management process starts in the earliest stages of development where concept exploration and synthesis is established and the IP strategy is explored and carried through to the later stages of the innovation process. The majority of the technology development is done prior to the commercialization phases (Phase 3 and 4) to ensure that all technologies are ready for product qualification and customer field trials or pilots. Given the integrated nature of building systems, the ability to demonstrate prototypes of the technology at building scale is essential in proving the necessary technology readiness.
• Once the major risks inherent with the technologies are reduced the process calls for the creation of company-made (manufacturing) samples and preparing customer field trials during Phase 3 of the Development process. New integrated building systems developed in Tasks 1 and 2, will require different commissioning, testing, qualification, and verification technologies and methods to ensure successful execution of field trials Task 4 of the HUB is to ensure that these technologies are developed such that installers, commissioning engineers and technicians, building operators, and building owners have sufficient knowledge to install, operate, and evaluate the real benefits of integration. Capabilities in the HUB such as relevant building test-beds where technologies can be tested and performance verified and where various members of the buildings workforce become familiar with the technology and its benefits is a key integrating element of the GPIC objectives.

• The execution of the Field Trials or commercial customer pilots (Phase 3) provides real life validation of the technologies in various locations and under a variety of use cases and is a core supporting role of the C2I. Field trails can range from deployment of several systems to hundreds. Companies use key information gained during these real world deployments in their decision process to launch new products and services. Importantly, the HUB will leverage critical information regarding performance during the field trials to inform and influence energy, comfort, and indoor air quality policy makers. The key information created will be focused on actual performance, cost drivers and barriers encountered to the creation of cost-effective high value end customer solutions.

• The last phase of the Project (Phase 4) is focused on collecting data leading to action plans to improve the product. C2I will play a central role in ensuring that general lessons learned are communicated throughout industry so that insertion of key new technologies can be accelerated.
Appendix 4
HUB Site Acquisition, Design, and Development Plan

DOE HUB facilities will include both a retrofitted energy efficient building and a new energy efficient building at the Navy Yard in Philadelphia which will house the HUB personnel. These facilities will function as living laboratories from design, through construction, commissioning and operation for developing tools and methods to transform the industry’s current fragmented serial process into system performance driven, integrated, parallel, team processes. The Commonwealth of Pennsylvania has committed $30 million of new capital funding to support these facilities.

The Philadelphia Authority for Industrial Development (PAID) acquired approximately 1,200 acres at the site of the former U.S. Navy Yard from the federal government in March 2000. The Philadelphia Industrial Development Corporation (PIDC) manages the planning, development and operation of these real estate assets on behalf of PAID.

The 1,200 acre site contains 282 existing buildings of which 233 are historic structures, over six miles of waterfront open to a broad reach of the Delaware and Schuylkill rivers, and an active Navy Reserve Basin. Direct connections from The Navy Yard to the interstate highway system (both I-95 and I-76), the regional labor pool, the national rail network, and the Port of Philadelphia, in addition to close proximity to a regionally important professional sports stadium complex, ensure both excellent accessibility and high visibility of projects at this historic site.

A comprehensive Master Plan, published in September 2004, guides development at The Navy Yard. The plan proposes a dynamic, mixed-use development designed to accommodate 12 to 15 million square feet of office, R&D, and industrial real estate and over 30,000 workers in a vibrant, 24-hour community based on the principles of smart growth, historic preservation, expanded mass transit and sound sustainable practices. Ultimately, the development will leverage more than $2 billion of private investment; and will substantially diversify and expand the employment, productivity, and tax base of the city and region.

Stage one of HUB site development will the renovation of a historic building to a sustainably designed, highly energy efficient facility called the GPIC Energy Efficient Buildings Headquarters. This facility, to be located in an existing, now defunct, brick gymnasium building constructed in 1942, will house teaching, office, and research and development activities centered on building energy efficiency, and will be the physical home of the DOE HUB Energy Efficient Buildings headquarters. This project will be carried out with a combination of DOE HUB, EDA, and other funds.

In the second stage of HUB/GPIC’s development, the Commonwealth of Pennsylvania in conjunction with PIDC is committed to construct a new research laboratory and education facility in the Navy Yard to accommodate HUB personnel and the planned growth in GPIC-associated endeavors beyond the initial investment by federal funding agencies and GPIC founding members. The Commonwealth of Pennsylvania has committed $30 million of new capital funding to support this facility. This site development plan for the DOE HUB, however, focuses on the GPIC Energy Efficient Buildings Headquarters retrofit project. There are three main principles driving this site development:

1. The demonstration of an integrated design process and sustainable strategies for building retrofits that is both innovative and commercially relevant. The process and strategies will
be adaptable to multiple building morphologies and replicable as a commercial industry standard. Consortium members have deliberately selected a historic structure as the primary renovation base for the project because of the more stringent regulatory and physical requirements that exist in historic structures.

(2) The development of a physical space that houses the research, education, and commercialization activities focused on clean and efficient energy technologies related to high-performance building renovation and construction. The building itself will convene researchers from a spectrum of research institutions and private companies and a diverse group of research specialties, in addition to economic development organizations, education providers in science, technology and math (STEM) at the K-12, university, and graduate levels.

(3) Build a living laboratory with a base infrastructure whose energy sources and end use heating, cooling, lighting, and air treatment technologies and dynamic controls can be advanced and updated for technology demonstration over time - as can the building’s external interaction with a local smart grid infrastructure. While the first iteration and major retrofit will draw on cutting-edge technologies in energy efficiency and management and leading principals in sustainable design, the building design will allow for future technology advances. Like the ideal commercial building of the future, which will be increasingly adaptable, the Energy Innovation Center will be adaptable in its energy infrastructure systems as well as its tenant programs.

Despite an increasing number of LEED certified buildings in the United States, buildings still account for 40% of natural resource consumption and 76% of electricity consumption.1 The process by which this facility’s renovation will be planned and executed will serve as a living laboratory for best practices in commercial building design, historic adaptive re-use, and energy efficiency innovation. Finally, driving innovation toward commercial application to promote investment, jobs and economic recovery will also be a primary objective for the facility and its collaborating partners.

Ultimately, it is expected that some of the diverse manufacturing, commercial and industrial tenants present today in the Navy Yard will benefit from the research and commercial activity through commercialization of the more promising technologies and processes.

**Project Scope and Requirements**

The Energy Innovation Center is conceived as an ongoing, integrated demonstration of replicable building strategies for future commercial renovations. The specific process elements that will facilitate the project concept are:

- Allowing for a documented, fully integrated approach to building sciences design and research through intentional and intelligent collaboration including the traditional design team, the building owners, the researchers and the commercial users,
- Designing for flexibility and sustainability to inhibit physical and functional obsolescence
- Integrating multiple energy system strategies to provide a broader spectrum of tested strategies for future commercial endeavors

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• Creating an environmentally sensitive workplace with improved indoor air quality, enhanced natural light, and thermal comfort

• Delivering to industry research results, cost/benefit analysis, education and training through the specific design features,

• Affording real-time results though case studies, white papers and online building performance of the HUB facility from design, construction, commissioning and continuing operation of the facility as a fully instrumented test bed,

• Providing as a key urban design element of the HUB facility an “energy park integration feature”. This would allow for simple integration of the facility’s energy and water systems into the Navy Yard’s planned utility systems in the future,

• Integrating DOE’s and EPA’s Laboratories for the 21st Century (Labs21) Environmental Performance Criteria (EPC) regarding design, construction, and operation of specific technologies that contribute toward sustainability in the laboratory portions of the building, and

• Achieving USGBC’s LEED-EB certification, targeting Platinum.

Finally, driving innovation toward commercial application to promote investment, jobs and economic recovery will also be a primary objective for the facility and its collaborating partners. Given the existing building energy related DOE projects at the site noted above and the recent EECBG program awarded to the City of Philadelphia that focused on urban housing renovation, The Navy Yard site for the HUB is unique in the opportunities it presents to transform the building industry in this economic region.

Figure 1 Aerial View of Proposed Facility
Facility Program

The new HUB/GPIC Energy Innovation Headquarters is expected to include general office space, research labs and a high bay testing lab with supporting offices, and meeting facilities. The facility will be located in an existing 2-story, 30,000 square foot building that was once a gymnasium. The project has been designed to accommodate the following areas:

**General Office Space (10,000 ft²)** – The two story portion of the existing building is optimal for this use given the narrow floor plate, multiple window openings and floor to floor heights. These offices will initially be used for housing researchers from Penn State and other research institutions with the future intention to lease to private, commercial entities whose emphasis is related to building and energy efficiency. The facility will house offices for the Director, Deputy Director and the interdisciplinary set of Associate Directors and researchers from each of the HUB Member organizations. To encourage frequent informal and spontaneous discussions among the researchers, the internal office space areas will be arranged to include open work spaces and “water cooler/coffee/brown bag lunch room” areas that are easily accessible from the private offices. The facility itself is located next to a planned green space that will encourage researchers to gather informally for discussion in the park-like setting next to the facility. The office layouts and construction will be re-configurable to test various sustainable strategies and allow for flexibility of future occupants. The remainder of the facility is located in the existing high ceiling spaces that use natural day lighting from above to best support lab and conference room needs.

**Lab, Lab Support and Lab Office Space (4,000 ft²)** - The development of robust, reliable, cost-effective, dynamic control technologies – sensors, actuators, embedded microprocessors - are seen as critical to energy efficient buildings. The laboratories are to be configured to do environmentally controlled testing of these technologies on an on-going basis.

**High Bay Testing Labs and Office Support (4,400 ft²)** - The high bay areas will be designed to implement large scale experimental assemblies. This facility area will have high power electrical and natural gas connections to allow advanced testing and characterization of heating, cooling and air filtration equipment as well as small scale, distributed power systems applicable in combined heat and power applications. Fan facilitated combustion system exhaust capability will be required, but it is anticipated that the bay area will be used for characterization of advanced distributed power technology for buildings of all types.
Part of the high bay area will be configured to develop and test advanced building lighting systems such as LED, daylight integrated LED, daylight + automatic shading + LED systems and the associated dynamic controls (see above) required to optimize performance. This space will have a designed external wall with a high degree of re-configurable fenestration area to allow change out of different glazing materials. Situated next to the HVAC equipment testing facility, the development of advanced, dynamically optimized cooling and lighting technology strategies could be developed using the two facilities in a coupled manner.
Conference/Symposium Space (5,400 ft²) – The common areas create opportunities for testing, monitoring and training energy principles within the nearby research community already housed at the Navy Yard. This space will be the outlet to the research, design, and construction industry for theories and technologies being developed within the building. It will provide high end conferencing capabilities including video conference space and multi-configurable seminar rooms.

Formal conference rooms will be equipped with the latest in telecommunications and display equipment for live streamed interactions with research colleagues around the world. The HUB will have frequent technical interactions with the Lund University energy efforts in Sweden and the Tsinghai University Building Energy Efficiency Center in China (as noted in the HUB application).

The Design Methodology: Maximizing Energy Efficiency
Recognizing that there is a lack of a quantitative and science based design methodology for sustainable buildings, particularly for existing building renovations, part of the assembled project team’s approach will be to apply and document an integrated design process. In addition the project focuses on renovating a building whose framework and systems support the concept of a “living laboratory” with particular emphasis on energy-efficient building strategies, research and applied projects of the institutions within the space initially. This effort also concentrates on monitoring the facilities’ energy use, educating the users on their essential role in energy performance, and integrating emerging technologies and strategies for improvements. An emphasis of the process will be to create and document strategies that are scalable and replicable in terms of both the technology applied and the methodologies used for designing and constructing the renovation project.
Drawing from best practices for energy efficiency in existing facilities and historic renovations, the methodology for project delivery takes a holistic approach to facility design that includes an integrated design process, energy load reduction, renewable energy sources and integrated systems, user interface including monitoring and education, and other sustainability considerations beyond those related specifically to energy. The details of this layered approach are outlined below.

1. Integrated Renovation Design Process and Documentation:

The integrated design process will include the following components; a building design charrette, an integrated project team, and implementation of sustainable laboratory guidelines from Labs 21/EPC, LEED-NC and existing case studies.

As defined by the US Department of Energy, integrated design is a “process of design in which multiple disciplines and seemingly unrelated aspects of design are integrated in a manner that permits synergistic benefits to be realized.” Integrated design reinvents the traditional linear design process in which individuals work in isolation on discrete project parts. In the design and development world, the standard process begins with a planner or architect interfacing with a client or owner’s representative and then creating conceptual designs which are handed off to a series of sub-consultants (mechanical, electrical, plumbing, structural, civil, landscape, etc) to “make it work.” This model suffers from two main problems: 1) a breakdown of communication akin to the child’s game of “whisper down the lane”; 2) treating a building or community as a sum of parts rather than a complex and inter-connected system. The result is that team members end up working in isolation and are more likely to create project components that work cross-purposes. Understanding entire systems and their opportunities for change requires many perspectives and technical areas of expertise.

A specific design methodology used to tap into an interdisciplinary team’s collective intelligence is the Integrated Design Charrette. An Integrated Design Charrette is a facilitated, multi-day design event that involves all of the project consultants and key stakeholders in generating preliminary designs so that decisions reflect the expertise brought by many disciplines. Cross-pollination of ideas and expertise is key to achieving quality designs in a condensed timeframe. Team members in an Integrated Design Charrette work in small, interdisciplinary teams to generate concepts. By having the team and project stakeholders design together in real-time, the building is treated as a system instead of a kit of unrelated parts.

Decades of change theory and learning research strongly support the value of integrated design approaches in fostering better coordination and interdisciplinary-learning which leads to increased efficiency, higher performance at a lower cost, improved sustainability outcomes and other significant breakthroughs during project design and implementation.

“Siloing” rather than integrating information is cited as one of seven common “sustainability blunders” by Bob Doppelt in *Leading Change Toward Sustainability* (2003). The integrated design charrette breaks down information silos that impede high-performance, cost-effective projects. As a specific example, a typical process tasks a lighting designer with providing a certain lumen/ ft² so they specify artificial lighting that generates an enormous amount of heat, causing the mechanical engineer to increase the size of the cooling system. By working together

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in the integrated design charrette, the architect, mechanical engineer, and lighting designer could greatly reduce the project’s artificial lighting and cooling through early decisions about building orientation and massing.

As part of the training on integrated design best practices, the participants in this process will not only include the design team (architect, lab consultant, mechanical engineer, structural engineer, civil engineer), the developer and non-profit developing agency, and the occupants (researchers) but also representatives from the architectural and engineering departments of the relevant research institutions. The documentation will include a pre-charrette workbook and a post-charrette publication for reference use by the building team and the greater design community.

2. Energy Minimization and Management Strategies:
The design process will first test options for minimizing utility loads through passive strategies, particularly those which limit east and west exposure and allow for greater, controlled southern exposure. This approach also allows for the greatest amount of natural day light which then reduces the demand for artificial lighting. Additional daylighting strategies will be assessed as well, such as the size of glazed openings and control of the exiting clerestory lighting. Daylight and solar gain will be passively controlled with external and internal solar shading devices. Synergies among strategies will be given greater consideration. One such example would be to install shutters that provide sun shading during the day and thermal insulation when the building is closed up at night.

The project design will seek to aggressively limit un-wanted envelope loads in order to have a significant impact on reducing the building’s demand for energy. Beyond the insulating materials of the individual materials and reducing infiltration, the building design process will allow for integration of energy efficient wall systems.

The key to minimizing lab energy will be in keeping exhaust air flow to the bare minimum and using non-air, low energy systems to handle the majority of room sensible loads. Typically, lab air flows are over designed and minimum air change rates are set too high. This ends up requiring more make-up air which requires significant reheat and uses a lot of energy. The goal is to limit air flow and reheat as much as possible but still protect the health and safety of the occupants. Some strategies for consideration will include: locating heat producing equipment in centralized locations where rejected heat can be captured by exhaust air rather than allowing it to enter conditioned room; utilizing shared support equipment across multiple labs where possible to limit the quantity required; setting minimum air change rates as low as possible and utilizing VAV fume hood systems to limit the amount of exhaust and make-up air; using low-flow, laminar type hoods where feasible to reduce exhaust and make-up requirements; handling room sensible loads by low-energy systems such as chilled beams rather than air systems thereby limiting the amount of reheat needed; sizing exhaust and supply air ductwork and systems to limit system losses due to friction and fitting losses and keep transport energy needs to a minimum; and using heat recovery to pre-condition outside air brought in for ventilation and make-up.

For the non-lab spaces there is more latitude on strategies to limit internal loads given program and code requirements. Some strategies for consideration will include: investigating mixed mode (natural / mechanical) ventilation with operable windows, good air flow pathways and possibly low energy ceiling fans to expand the comfort zone by providing air movement; earth tube preconditioning; limiting the resistance and pressure drop in the air pathways to limit
transport energy needs as with the lab systems; looking at low-energy systems such as chilled beams or radiant systems with dedicated outside air; and utilizing heat recovery for capturing heat from code required exhaust systems such as toilet rooms.

Controls and sensors in all program spaces will also be key factors in optimal energy use minimization. Approaches for investigation will include: daylight sensors and time clocks; occupancy sensors to control light levels but also to reset air flow minimums if the lab is unoccupied; occupancy sensors at work stations to cut power to all devices (monitor, task light, etc.) except the computer when the work station is not occupied; demand control ventilation using IAQ sensors, CO₂ sensors and / or occupancy sensors.

The inter-relationships between various construction details will be evaluated through building energy and daylight models. The daylight model will evaluate the qualitative and quantitative performance of the daylighting systems to optimize beneficial daylight to the spaces served and to establish the contribution of the daylighting schemes to overall building energy use optimization. The building energy model will be used to test the performance and impact of various design strategies and system alternatives with the goal of minimizing annual energy use. The model results will also be used to establish targets for annual renewable energy harvesting and will help inform the size and scope of energy harvesting systems. An integral part of modeling building energy use will be predicting occupant use and behavior in the building. Occupant behavior will be the major factor in annual energy use and much effort will be put into gaining an understanding of how this will occur in the finished building.

Figure 4 Section Perspective of Proposed Facility

3. Potential Energy Sources and Systems for Building Integration:
The theoretical results of both the daylighting analysis and energy modeling will be verified against actual building energy use and performance. Assumptions made in the building modeling will be back checked against actual operations. The energy model will be calibrated to
the actual building use on a continuing basis based on feedback from the building energy monitoring and measurement systems. The model will be maintained and will continue to serve as a predictive tool to project energy use of varying operating strategies. In this way, the energy model will become an operational tool in addition to being a design phase tool. Similarly, daylighting factors will be evaluated post-construction and compared to predicted values in order to determine whether the researchers recommend changes to the modeling tools for improved accuracy. This facility project will also contribute to a larger body of work about sustainable building design and predictive modeling tools in particular. The intent is that this on-going research can be shared with institutions and industries engaged in energy efficiency technologies.

The process for finalizing source and system options will include the building charrette coupled with technical research on emerging technologies and systems. In particular, the project will prioritize technologies that have potential for mass replicability. In order to achieve broad data results of the performance data and the determination of best practice for similar, future renovation projects, the inclusion of multiple system types will be considered. System designs that accommodate on-going research and advances in technology, particularly as related to energy sources, will also be considered.

**Figure 7: Site Plan Diagram**

The following are some of the sources and systems optimal for inclusion in the project:

- **Photovoltaics (PV):** Some opportunities will include roof top installation of varied panel types and building integrated PV on south façade (wall and external shading devices) that’s detachable to allow for testing new systems.

- **Ground Source Heat Pumps (GSHP):** The site is optimal for GSHP because of the high water table and the hydrology of the site. Ground source heat pumps provide ducted heating and cooling for lower ceiling office spaces. Wells for GSHP system can be located under the terrace & parking lot.
- Solar Thermal Coupled with Absorption Chiller: The solar thermal can provide radiant heating for the high ceiling spaces (in-floor, ceiling panels and wall radiators). An innovative approach couples solar thermal heating with an absorption chiller in order to turn heat (energy) into cooling then distributed through ducts. Historically, absorption chillers have been effectively used on very large scales and this project would be used to test, evaluate, and demonstrate their viability on a small-scale. This technology is especially appropriate for the HUB project because the building will have a high cooling load and has the capacity to generate more solar hot water than demand will require.

- Wind: Small scale wind turbines integrated with light fixtures are shown on the site plan.

- Ventilation: Mixed mode allowing for maximizing natural ventilation strategies, to minimize energy demand, in conjunction with ERVs for mechanical displacement (low-velocity) ventilation for improved air quality.

- Rainwater re-use/stormwater management: The project plans to take advantage of the existing pool to store rainwater and reuse it for sewage conveyance, thus reducing the use of potable water. The remainder of the stormwater, including the parking lot, the water will be directed to on-site bio-swales planted with native / adapted native vegetation.

- Envelope: Minimizing infiltration while maximizing thermal insulation is the best first strategy in energy use reduction. This project will implement different options at various locations, particularly at the High Bay Lab and Offices, and will study its effectiveness through on-going blower tests and wall monitors. Opportunities for studying shading and varied window glazing types are included as well.

- Other Energy Systems for Consideration: Co-generation, Flywheel Energy Storage and Thermal Storage Systems (ice and mass) in conjunction with radiant cooling and/or chilled beams, Earth Tubes to passively temper ventilation air.
Appendix 5
Funding Plan

The funding plan for the DOE Hub and the GPIC for Energy Efficient Buildings is embedded in a going concern, which is the Clean Energy Campus at the Navy Yard, which dates to the closure of the Navy Yard in Philadelphia by the federal government in 1996 and the emergence of the Clean Energy Campus concept as a centerpiece of the Navy Yard redevelopment strategy. The aim of the Clean Energy Campus is to make the Navy Yard a national center of excellence for energy research, education, and commercialization. The core elements of this effort are the combined education, research and commercialization strengths of government, industry, and universities in the southeastern Pennsylvania region and beyond relating to power production and management. These include:

- Ben Franklin Technology Partners of Southeastern Pennsylvania
- Delaware Valley Industrial Resource Center
- NAVSEA Warfare Center Carderock Division Philadelphia Component
- Philadelphia Department of Commerce
- Philadelphia Industrial Development Corporation
- Penn State
- Drexel University
- Collegiate Consortium for Workforce and Economic Development

As a result of these ongoing efforts, the Clean Energy Campus currently houses the DOE Mid Atlantic Clean Energy Applications Center, the DOE Northern Mid Atlantic Solar Training Center, and the DOE Grid Smart Training Applications Resource (GridSTAR) Center. Thus, the GPIC for Energy Efficient Buildings will be one element, albeit the major element to date, of the ongoing development of the Clean Energy Campus at the Navy Yard.

The GPIC at the Navy Yard will involve significant non-DOE Hub resources both during the five-year period of DOE Hub funding period and beyond. In addition to $7.7 million of non-DOE federal funding requested from EDA, NIST, and SBA to support activities during the five-year award period, DOE Hub members and GPIC partners have committed more than $50 million of co-funding to support the DOE Hub/GPIC. This includes $30 million of new capital funding committed by the Commonwealth of Pennsylvania to support DOE Hub/GPIC test bed facilities at the Navy Yard.

Beyond the initial public and private funding for the GPIC described above, DOE Hub members and GPIC partners will work together aggressively to pursue funding support from other federal agencies including the Department of Education, the Department of Labor, and the NSF, as well as philanthropic foundations, private industry, and others both during and after the GPIC award period. The broad-based collaborative effort that has guided the development of the Clean Energy Campus at the Navy Yard to date will guide the operation of the GPIC for Energy Efficient Buildings through the award period and will sustain these efforts beyond the GPIC award period and for decades to come.
## Appendix 6: Project Timetable

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Appendix 7
Biographical Sketches

PI – Foley, Henry C., Penn State
Akers, Mary Ann Alabanza, Morgan State
Akinci, Burcu H., CMU
Alur, Rajeev, Penn
Amaba, Ben, IBM
Andrews, Clinton, Rutgers
Anumba, Chimay J., Penn State
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Bahnfleth, William P., Penn State
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Bales, Erv, NJIT
Barton, William, Turner
Bilec, Melissa, Pitt
Birch, Eugenie, Penn
Birnie, Dunbar, Rutgers
Blumsack, Seth A., Penn State
Borggaard, Jeff, Virginia Tech
Bose, Mallika, Penn State
Both, Arend-Jan, Rutgers
Braun, James, Purdue
Brennan-Tonetta, Margaret, Rutgers
Bronner, Lee Roy, Morgan State
Brownson, Jeffrey, Penn State
Burkardt, John Vetter, Virginia Tech
Burns, John Allen, Virginia Tech
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Chen, Qingyan, Purdue
Clark, William, Pitt
Cliff, Eugene Matthew, Virginia Tech
Cohen, Adam, Princeton
Cole, Daniel, Pitt
D’Amora, Bruce D., IBM
Dickens, Corey, Morgan State
Echols, Stuart, Penn State
Evans, Deane, NJIT
Felder, Frank, Rutgers
Finn, Alan, UTC
Fisher, Amit, IBM
Frase, Katharine G., IBM
Freihaut, James, Penn State
Gambino, James, BFTP
Garrett, James H., CMU
Girifalco, Anthony, DVIRC
Grady, John, PIDC
Green, Anthony, BFTP
Grosh, John, LLNL
Gugercin, Serkan, Virginia Tech
Gurian, Patrick, Drexel
Hallacher, Paul, Penn State
Hamann, Hendrik F., IBM
Harasin, Steve, Bayer
Hartkopf, Volker, CMU
Hayes, John, Bayer
Henshaw, William, LLNL
Herdman, Terry L., Virginia Tech
Horton, Travis, Purdue
Houldin, Joseph J., DVIRC
Houser, Kevin W., Penn State
Hu, Jianghai, Purdue
Hughes, Mark Alan, Penn
Hunter, James, Morgan State
Iliescu, Traian, Virginia Tech
Isom, Joshua, UTC
Jadbabaie, Ali, Penn
Jafari, Mohsen, Rutgers
Jha, Niraj, Princeton
Jiao, Yu, PPG
Jurbergs, David, Bayer
Kalagnanam, Jayant, IBM
Karava, Panagiota, Purdue
Kimber, Mark, Pitt
Klein, Levente J., IBM
Kleit, Andrew N., Penn State
Klingler, Jeffrey, Turner
Krogh, Bruce H., CMU
Kunreuther, Howard, Penn
Kuntz, Michael, Turner
Lam, Khee Poh, CMU
Landis, Amy Elaine, Pitt
Lee, Seong, Morgan State
Lee, Stephen R., CMU
Lee, Young M., IBM
Lenchner, Jonathan, IBM
Liaukus, Christine, NJIT
Loftness, Vivian, CMU
Malkawi, Ali, Penn
Mangharam, Rahul, Penn
Marathe, Madhav V., Virginia Tech
Mashkif, Nir, IBM
Masin, Michael, IBM
Mazurek, Monica, Rutgers
Memari, Ali M., Penn State
Messner, John I., Penn State
Michel-Kerjan, Erwann, Penn
Miller, Barry W., DVIRC
Mistrick, Richard, Penn State
Napade, Milind R., IBM
Narayanan, Satish, UTC
Nyarko, Kofil, Morgan State
Oggianu, Stella Maris, UTC
Oliva, Ralph, Penn State
O'Neill, Zheng D., UTC
Orland, Brian, Penn State
Orts, Eric, Penn
Pappas, George J., Penn
Pekarek, Steven, Purdue
Radcliff, Thomas, UTC
Rangaswamy, Arvind, Penn State
Ransom, Avis, Morgan State
Rashid, Ali, PPG
Riley, David, Penn State
Romano, Paul, NJIT
Saeedifard, Maryam, Purdue
Schaefer, Laura A., Pitt
Sexton, James C., IBM
Shwom, Rachael, Rutgers
Sisson, William, UTC
Sliwinski, Martin, Penn State
Smith, Gregory, Turner
Snowdon, Jane L., IBM
Srebric, Jelena, Penn State
Sturm, James, Princeton
Sunderland, Nicolas, Bayer
Tong, Charles L., LLNL
Treado, Stephen, Penn State
Tzempelikos, Athanasios, Purdue
Verma, Naveen, Princeton
Vipperman, Jeffrey S., Pitt
Wachter, Susan, Penn
Wagner, Sigurd, Princeton
Wagner, Timothy, UTC
Walker, Craig, UTC
Waring, Micheal, Drexel
Watkins, Damian, Morgan State
Weiland, Lisa Mauck, Pitt
Welsh, Joseph, Collegiate Consortium
Wen, Jin, Drexel
Willis, Daniel E., Penn State
Witman, Mark, Bayer
Yen, John, Penn State
Zietsman, Lizette, Virginia Tech
Zwicker, Andrew, Princeton
Henry C. Foley
Vice President for Research and Dean of the Graduate School
The Pennsylvania State University
304 Old Main
University Park, PA 16802

<table>
<thead>
<tr>
<th>INSTITUTION AND LOCATION</th>
<th>DEGREE</th>
<th>YEAR(s)</th>
<th>FIELD OF STUDY</th>
</tr>
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<tbody>
<tr>
<td>Providence College</td>
<td>B.S.</td>
<td>1977</td>
<td>Chemistry</td>
</tr>
<tr>
<td>Purdue University</td>
<td>M.S.</td>
<td>1979</td>
<td>Chemistry</td>
</tr>
<tr>
<td>The Pennsylvania State University</td>
<td>Ph.D.</td>
<td>1982</td>
<td>Physical Chemistry</td>
</tr>
</tbody>
</table>

Positions and Employment

(The Pennsylvania State University)
2000- Professor of Chemical Engineering
2000- Professor of Chemistry
2000-04 Department Head of Chemical Engineering and Walter L. Robb Family Endowed Chair
2004-06 Associate Vice President for Research and Director of Strategic Initiatives
2006-09 Dean, College of Information Sciences and Technology
2010- Vice President for Research and Dean of the Graduate School

(The University of Delaware)
1986-91 Assistant Professor of Chemical Engineering
1987-91 Associate Director, Center for Catalytic Science and Technology
1991-96 Associate Professor of Chemical Engineering
1991-96 Director, Center for Catalytic Science and Technology
1996-00 Professor of Chemical Engineering
1997-98 Visiting Scientist, Reaction Engineering Group, CRD, DuPont Co
1999 Visiting Scholar, Wolfram Research Inc., Champaign-Urbana, IL

(The American Cyanamid Corporation)
1981-82 Postdoctoral Fellow, Center for Catalytic Science and Technology, Department of Chemical Engineering
1982-84 Research Chemist, American Cyanamid Co., Inc.
1984-85 Senior Research Chemist and Principal Investigator of DE-AC22-84PC7003
1985-86 Group Leader–Inorganic Technology

Honors and Recognition
1987 Presidential Young Investigator Award, National Science Foundation
1994-95 Research Innovation Recognition Award, Union Carbide Corporation
1995 Leo C. Friend Award, IEC Division, American Chemical Society
1995 Ernest W. Thiele Lectureship in Chemical Engineering, University of Notre Dame
1997 Du Pont Lecture in Reaction Engineering, Engineering Foundation
2000 Walter L. Robb Chair of Chemical Engineering, The Pennsylvania State University
2000 Philadelphia Catalysis Club Annual Award, Philadelphia Catalysis Club
2000 New York Metropolitan Catalysis Society, Excellence in Catalysis Award
2004 Distinguished Lecturer in Chemical Engineering, The University of Utah
Selected peer-reviewed publications (selected from 104 peer-reviewed publications)


Mary Anne Alabanza Akers
Dean and Professor
School of Architecture and Planning
Morgan State University

Education:

▪ Michigan State University, Ph.D. in Social Science (Urban Planning and Community Organization), 1991
▪ University of the Philippines, M.A. in Urban and Regional Planning, 1984
▪ University of the Philippines, A.B. in Sociology, 1979

Selected Publications Relevant to the Proposed Project:

1992  Alabanza, Mary Anne. Firm Size and Quality of Jobs in Rural Georgia. Athens, Georgia: Division of Applied Research, Institute of Community and Area Development, The University of Georgia.

Current Activities Relevant to the Project:

▪ A national study of LEED projects to find out a niche for microenterprises in the green economy (funded by the U.S. Small Business Administration).
Burcu H. Akinci

Professor voice: 412/268-2959
Civil and Environmental Engineering fax: 412/268-7813
Carnegie Mellon University e-mail: bakinci@cmu.edu
5000 Forbes Avenue http://www.ce.cmu.edu/~bakinci
Pittsburgh, PA 15213-3890

A. Professional Preparation
Middle East Technical University (Turkey), Civil Engineering, BS, 1991
Bilkent University (Turkey), Graduate School of Business, MBA, 1993
Stanford University, Civil and Environmental Engineering, MS, 1995
Stanford University, Civil and Environmental Engineering, PhD, 2000

B. Appointments

07/2009 - Professor, Dept. of Civil and Environmental Eng., CMU
07/2006 – 2009 Assoc. Professor, Dept. of Civil and Environmental Eng., CMU
07/ 2000–2006   Assist. Professor, Dept. of Civil and Environmental Eng., CMU
1996-2000 Research and Teaching Assistant, Stanford University
07-10, 1998 Summer Intern, Production Analyst, Pacific Contracting, San Francisco
07-09, 1997    Summer Intern, Project Eng., Kutlutas Construction, Ankara, Turkey
06-09, 1989-88  Summer Intern, Assist. Project Eng., Kutlutas Construction, Turkey

C. Honors
- Steven J. Fenves Award, Inst. For Complex Engineered Systems, CMU, 2010.
- ACE Award to Recognize Innovative Use of Technology to Promote Internationalism, ACE 2010
- CETI, Outstanding Early Career Researcher, FIATECH 2008
- CAREER Award Recipient, National Science Foundation, 2005-2010.
- George Tallman Ladd Research Award, Carnegie Institute of Technology , CMU, 2003.
- Lieberman Fellowship, School of Engineering, Stanford University (1999-2000)
- NATO doctoral student scholarship through Turkish National Science Foundation, 1997.

D. Publications

Five publications related to the project:

Five other publications

E. Synergistic Activities
Education:

Outreach:
2008/2007 Developed a three-day industry course on Building Information Models

Editorial:
2007-Present Specialty Editor Journal of Computing in Civil Engineering
2002–Present Editorial Board Member, Journal of Advanced Engineering Informatics
2006-Present Editorial Board Member, Automation in Construction
2009-Present Board Member, International Association for Automation and Robotics in Construction
2002–Present Reviewer to many national and international journals and conferences.

F. Collaborators and Other Affiliations
(i) Collaborators: Jim Garrett (CMU), Martial Hebert (CMU), Ramesh Krishnamurti (CMU), Carl Haas (University of Waterloo), Carlos Caldas (UT), Hassan Karimi (Univ. of Pittsburgh), Daniel Huber (CMU).

(ii) Graduate and Postdoctoral Advisors:
Martin Fischer, Stanford University

(iii) Thesis Advisees and Postgraduate-Scholar
DeWitt Tal Latimer (MS, 2002), Kevin Tantisevi (PhD, 2006), Jan Reinhardt (PhD, 2003), Frank Boukamp (PhD, 2006), Esin Ergen (PhD, 2006), Christopher Gordon (PhD 2006), Hongjun Wang (PhD 2006), Subhash Tuladhar (MS, 2003), Semilha Kiziltas (PhD 2008), Anu Pradhan (PhD 2009), Pingbo Tang (PhD 2009), Fernanda Leite (PhD 2009), Asli Akcamete (PhD Student), Guzide Atasoy (PhD Student), Saurabh Taneja (PhD Student), Salih Demir (PhD Student), Pine Liu (PhD Student), Xingchen Wang (PhD Student)
Biographical Sketch: Rajeev Alur
Department of Computer and Information Science Tel: (215) 573-7483
3330 Walnut Street, University of Pennsylvania Email: alur@cis.upenn.edu
Philadelphia, PA 19104 URL: http://www.cis.upenn.edu/~alur/

Research Interests
Formal methods in system design; Model checking; Software analysis; Embedded software systems;
Hybrid systems; Modeling languages; Logic in computer science; Automata theory; Concurrency theory

Education
Ph.D. in Computer Science (1991), Stanford University, Stanford.
Bachelor of Technology (1987), Indian Institute of Technology, Kanpur, India.

Employment
7/03 onwards: Zisman Family Professor of Computer and Information Science, University of Pennsylvania, Philadelphia.
7/01 onwards: Professor, Computer and Information Science, University of Pennsylvania, Philadelphia.
8/97 – 6/97: Member of Technical Staff, Computing Sciences Research Center, Bell Labs, Murray Hill.

Publications

Synergistic Activities
1. Graduate Group Chair in Department of Computer and Information Science for the past four years, overseeing the PhD as well as different Masters programs in the department.
2. The PI recently organized an NSF workshop titled Symbolic Computation for Constraint Satisfaction Problems bringing together computer science researchers in diverse areas such as program analysis, formal verification, AI planning, optimization, and hybrid systems.
3. Served as the Chair of ACM SIGBED (Special Interest Group on Embedded Systems) 05-07, helped to bring together researchers and practitioners from diverse areas related to embedded systems.
4. Will serve as the General Chair of IEEE Logic in Computer Science from 2009 to 2012, a group dedicated to promote the use of logic and formal reasoning in computer science.

Recent Collaborators (outside Penn)
K. Etessami (U Edinburgh, UK), N. Immerman (U Massachusetts), L. Libkin (U Edinburgh, UK), and M. Viswanathan (UIUC).

Former PhD and Post-doctoral Students
S. Burckhardt (Microsoft Research), S. Chaudhuri (Penn State), T. Dang (CNRS, France), F. Ivancic (NEC Labs), R. Grosu (Stony Brook), S. La Torre (U Salerno, Italy), P. Madhusudan (U Illinois, Urbana-Champaign), M. McDougall (GrammaTech Inc.), S. Mukhopadhyay (Utah State), G. Pappas (Penn), B. Wang (Academia Sinica, Taiwan), Z. Yang (Western Michigan U).

PhD Advisors
D. Dill and Z. Manna (Stanford)
BEN AMABA, PhD, PE, CPIM, LEED® AP
IBM Sales and Distribution Worldwide Software Sales Executive

Dr. Ben Amaba’s focus and research is systems and software engineering in the industrial and public sectors. He is well known in applying engineering analytical skills in operations and technology challenges on a global level.

EDUCATION


B.S. in Electrical Engineering, Christian Brothers University in Memphis, Tennessee graduated Cum Laude.

LICENSE AND CERTIFICATIONS
• Registered Professional Engineer, State of Florida.
• LEED © AP, Leadership in Energy & Environmental Design Accredited Professional.
• Certified in Corporate Strategy by Massachusetts Institute of Technology.
• Certified in Production and Inventory Management for Operations and Manufacturing by APICS. Distinguished marks in Supply Chain Management.

SELECTED MEMBERSHIPS
• Vice President and committee Chair (IAMOT) International Association of Management of Technology.
• Editorial Board of The Open Cybernetics and Systemics Journal.
• Executive Board Member of Applied Human Factors and Ergonomics (AHFE).
• Member, Institute for Operations Research and Management Sciences (INFORMS), Institute of Industrial Engineers (IIE), Institute of Electrical and Electronics Engineers (IEEE), National Society of Professional Engineers (NSPE), International Council on Systems Engineering (INCOSE), Florida Engineering Society.

SELECTED PUBLICATIONS
Clinton J. Andrews  
Center for Green Buildings  
Edward J. Bloustein School of Planning and Public Policy  
Rutgers University, 33 Livingston Avenue, New Brunswick, NJ 08901  
Tel: (732)932-3822 x721 email: cjaj@rci.rutgers.edu

Education
1978 Brown University, Providence, RI  
Sc.B. Engineering (Honors)
1985 MIT, Cambridge, MA  
S.M. Technology & Policy
1990 MIT, Cambridge, MA  
Ph.D. Urban & Regional Planning

Positions and Employment
2009- Professor of Urban Planning and Policy Development, Rutgers University, New Brunswick, NJ
2006- Director, Rutgers Center for Green Building, New Brunswick, NJ
2003-2009 Director, Program in Urban Planning and Policy Development, Rutgers University, New Brunswick, NJ
2002-2009 Associate Professor of Urban Planning and Policy Development, Rutgers University, New Brunswick, NJ
1999- Member, Environmental & Occupational Health Sciences Institute, Rutgers/UMDNJ, Piscataway, NJ
1997-2002 Assistant Professor of Urban Planning and Policy Development, Edward J. Bloustein School, Rutgers University, New Brunswick, NJ

Relevant Publications

Synergistic Activities
2008-2011 Board of Directors, American Collegiate Schools of Planning
2005-2006 Board of Directors, Institute for Electrical and Electronics Engineers

Collaborators and Co-editors (last 4 years):
Robert Axtell, George Mason Univ.; Dunbar Birnie, Rutgers University; David DeVault, USC; Henry Jonas, Rutgers University; Gregory Kiss, Kiss & Cathcart; Uta Krogmann, Rutgers University; Nancy Mantell, Rutgers University; Clare Mifflin, Kiss & Cathcart; Randall Solomon, Rutgers University; Richard Wener, Polytechnic Institute of NYU;

Graduate and Post-doctoral Advisees (last 5 years):
Ana Baptista, Ironbound Community Corp.; Jun Bi, Nanjing University; Mookhan Kim, unknown in Korea; John Posey, St. Louis, MO MPO; Brian Schilling, Rutgers University; Bing Zhang, Nanjing University.
CHIMAY J. ANUMBA, PROFESSOR & DEPARTMENT HEAD

B.Sc. (Hons), Ph.D., D.Sc., Dr.h.c., PGCE, C.Eng/P.E., FIstructE, FICE, FCIOB, FASCE

Dept of Architectural Engineering, Penn State University, 104 Engineering Unit A, University Park PA 16802

PROFESSIONAL PREPARATION

Delft University of Technology, The Netherlands, Honorary Doctorate Dr.h.c. 2007
Loughborough University, UK, Construction Engineering & Informatics
(Higher Doctorate – equivalent to Distinguished Professor status) D.Sc. - 2006
The University of Jos, Nigeria Building (1st Class Honours) B.Sc. - 1984.

APPOINTMENTS

2008 – Present   Professor & Department Head, Dept of Architectural Engineering, Penn State University
2000 – 2007   Professor of Construction Engineering and Informatics, and Director, Centre for Innovative & Collaborative Engineering, Loughborough University, UK
1998 – 2000   Reader (Research Professor), Dept of Civil & Building Engineering, Loughborough University, UK.
1993 – 1998   Reader/Senior Lecturer, School of Science & Technology, University of Teesside, Middlesbrough, UK
1989 – 1993   Engineer/ Senior Engineer, Curtins Consulting Engineers plc, Leeds, UK
1986 – 1989   Research & Teaching Assistant, Dept. of Civil Engineering, The University of Leeds, UK

PUBLICATIONS

Over 400 technical publications including 11 books, technical reports, book chapters, 140 refereed journal papers and numerous refereed conference papers (list available on request).

EXAMPLES OF BOOKS:


EDITORSHIPS

- Co-Editor, International Journal of Information Technology in Construction (ITCon)
- Associate/Specialty Editor:
  - ASCE Journal of Computing in Civil Engineering
  - International Journal of Agile Manufacturing Systems (IJAMS)
  - International e-Journal of Construction (IeJC)
- Editorial Board Memberships:
  - Advanced Engineering Informatics (Formerly ‘AI in Engineering’)
  - Industrial Management and Data Systems (IMDS)
  - Construction Innovation
- **Innovation and Research Focus**
- **Automation in Construction**
- **Concurrent Engineering: Research and Applications**
- **Built and Human Environment Review**

- **Reviewer** for over 30 international academic journals, numerous publishers, several learned institutions and over 50 international conferences.

**SYNERGISTIC ACTIVITIES**

2. Member of Council, Institution of Civil Engineers (1999-2002).
3. Member, European Society of Concurrent Engineering (ESoCE)
6. International Scientific Committee Member for over 50 international conferences.
7. Keynote/Invited Speaker, numerous international conferences.
9. Member, EPSRC Peer Review College (1998-Date).
10. Visiting Professor, Hanyang University, Korea (1997)
11. Visiting Professor/Scholar, Massachusetts Institute of Technology (MIT), USA: 1999-2000
12. Visiting Professor/Scholar, Stanford University, USA : July - September 2001
13. Visiting Professor, Hong Kong Polytechnic University, China: Nov-Dec 2002
14. Visiting Professor, Universiti Teknologi Malaysia, UTM: 2003-Date
15. Visiting Professor, Chongqing University, China: 2003-Date
16. Visiting Professor, Universiti Tun Hussein Onn, Malaysia, UTHM: 2003 – Date
17. Visiting Scholar/Professor, University of Florida, USA: 2006 - 2007

**RESEARCH SUPERVISION**

**Thesis/Research Advisees**


**Current Postdoctoral Researchers** (2): Dr T.Bulbul; Dr S. Lee.

**Masters Students** – too numerous to list.
David I. August
Princeton University
Department of Computer Science
35 Olden Street
Princeton, NJ 08540
Phone: 609-258-2085
Fax: 609-258-2085
E-mail: august@cs.princeton.edu
Web: http://www.princeton.edu/~august

Professional Preparation
- University of Illinois at Urbana/Champaign, Electrical Engineering, M.S. 1996.
- University of Illinois at Urbana/Champaign, Electrical Engineering, Ph.D. 2000.

Appointments
- 7/06-present Associate Professor of Computer Science, Princeton University.
- 7/00-6/06 Assistant Professor of Computer Science, Princeton University.

Significant Publications

Synergistic Activities
2. Faculty participant in Princeton University’s undergraduate and graduate program “Greening Princeton”, http://www.princeton.edu/~greening
3. Active member of Community Green, a local all-volunteer environmental organization.

Conflicts
Advisor: W. W. Hwu (UIUC)
Collaborators: S. A. Mahlker (U. Michigan), V. Pai (Purdue), S. S. Mukherjee (Intel)
Graduate Students: M. Vachharajani (U. Colorado), J. Blome (U. Michigan), S. Triantafyllis (D.E. Shaw), M. Ibrahim (IBM), D. Penry (BYU), R. Rangan (IBM), B. Guo (J.P. Morgan), M. Bridges (Google), N. Vachharajani (Google), E. Raman (Google), G. Ottoni (Intel), G. A. Reis (Google)
Azizan Aziz
Research Faculty
Center for Building Performance and Diagnostics
School of Architecture
Carnegie Mellon University
Pittsburgh, PA 15213

phone: 412.268.6882
e-mail: azizan@cmu.edu

A. Professional Preparation
Carnegie Mellon University  B. Architecture  1990

B. Appointments
Carnegie Mellon University  Senior Research Architect  1992-95, 97-present
Carnegie Mellon University  Adjunct Assistant Professor  2000-present

C. i. Related Publications
Choi, J. Loftness, V. Aziz, A. "20 commercial office building analyses of IEQ and occupant satisfaction to impact future design standards and guidelines". Proceedings of 26th Conference on Passive and Low Energy Architecture, Quebec City, Canada, June 2009
C. ii. Other Significant Publications

D. Synergistic Activities
• Teaches sustainable design principles and systems integration in architecture design studios and masters and upperclassmen courses.
• Advises masters of sustainable design students for their capstone theses and PhD students’ independent projects
• Conceptualizes, designs and develops sustainable products, ranging from portable structures to indoor environmental controls interface for Terradime, LLC, a sustainable development and innovation company.
• Consults for federal and corporate clients on integration of sustainable strategies and high performance building technologies for increased occupant comfort and satisfaction while reducing energy consumption through evidence-based post-occupancy evaluation (POE).
• Presents a white paper to the Government of Malaysia on green buildings and sustainable development.

E. i. Collaborators
Osman Ahmed, Global Head of Research and Innovation for the Building Technologies Division, Buffalo Grove, IL
Edo Rocha, President and CEO, Espacos Corporativos, Sao Paolo, Brazil
Serge Neuman, Application and Strategy Manager, Somfy, Paris, France
George Mongell, President and CEO, Terradime, LLC, Pittsburgh PA

E. iii. Graduate Advisee (Phd and Masters Independent Studies)
Christopher Leininger (Spring 2009) Yuchang Hu (Fall 2007, Fall 2008, Spring 2009), Ying Hua (Fall 2005), Sean Hay Kim (Fall 2004, Fall 2005), Janet Klosky (Summer 2006), Sunayana Mozumder (Fall 2003), Viraj Srivastava (Fall 2003, Spring 2005), Sheng Kai Tang (Summer 2008), Maffee Wan (Fall 2005, Spring 2007)
Biographical Sketch
William P. Bahnfleth

Education and Training
University of Illinois at Urbana-Champaign Mechanical Engineering B.S., 1979
University of Illinois at Urbana-Champaign Mechanical Engineering M.S., 1980
University of Illinois at Urbana-Champaign Mechanical Engineering Ph.D. 1989

Research and Professional Experience
2002-present Director, Indoor Environment Center, Penn State University, University Park, PA
1995-present Professor of Architectural Engineering, Penn State University, University Park, PA
2000-2005 Associate Professor of Architectural Engineering, Penn State University, University Park, PA
1994-2000 Assistant Professor of Architectural Engineering, Penn State University, University Park, PA
1989-1994 Senior Consultant, ZBA Inc., Cincinnati, OH
1985-1989 Principal Investigator, U.S. Army Construction Engineering Research Laboratory, Champaign, IL

Publications (*Student co-author)
Synergistic Activities

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers

Collaborators & Co-editors
John Cimbala, Penn State Department of Mechanical and Nuclear Engineering
James D. Freihaut, Penn State Department of Architectural Engineering
Richard Mistrick, Penn State Department of Architectural Engineering
Martin Moeck Penn State Department of Architectural Engineering (currently with Siemens)
Amy Musser, Vandemusser Design, LLC
T. Agami Reddy, Drexel University Department of Civil, Architectural, and Environmental Engineering (currently with Arizona State University Department of Architecture)

Graduate and Postdoctoral Advisors.
M.S. Advisor: Michael M. Chen, Professor of Mechanical Engineering, University of Illinois at Urbana-Champaign. (Currently Professor Emeritus of Mechanical Engineering, University of Michigan)
PhD Advisor: Curtis O. Pederson, Professor Emeritus of Mechanical Engineering, University of Illinois at Urbana-Champaign.
Postdoctoral Advisor: N/A

Thesis Advisor and Postgraduate-Scholar Sponsor
Jing Song, PhD 2004, Arup, Boston, MA
Edward Clements, MS 2004, HGA, Minneapolis, MN
Joseph Firrantello, MS 2007, James Posey Associates, Baltimore, MD
Justin Bem, MS 2008, James Posey Associates, Baltimore, MD
Jae-Weon Jeong, Post-doc, Sejong University, Seoul Korea
Josephine Lau, PhD 2009, University of Nebraska, Omaha NE
Trevor E. Bailey  
Principal Research Engineer  
United Technologies Research Center

Education and Training

**Ph.D Mechanical Engineering**, McMaster University, Hamilton, Ontario, Canada. 2000  
**M.Eng Mechanical Engineering**, McMaster University, Hamilton, Ontario, Canada. 1996  
**B.Eng, Mechanical Engineering**, McMaster University, Hamilton, Ontario, Canada, 1993

Research and Professional Experience

**Project Leader**  
United Technologies Research Center, Carrier Program Office, Mar. 2004-Present  
Develop direction and rationale for Carrier technology projects ranging from advanced HVAC component/systems designs to building HVAC architecture design  

**Group Leader**  
United Technologies Research Center, Systems Engineering Group, Feb 2006- Sep 2006  
Supervised a diverse staff of 14 individual contributors spanning capabilities ranging from product system design to building systems design.

Publications

- Product Family Commonality Selection Through Interactive Visualization, ASME DETC, New York City, 2008.  

Synergistic Activities

- Professional Engineers of Ontario (PEO), 1996 – present  
- ASME member, 1996 – present

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers: None
Erv Bales, PhD
NJIT Center for Building Knowledge, Senior Research Fellow

**Education and Training:**
PhD Mechanical Engineering, Doctor of Philosophy, University of Illinois, 1967
MS Mechanical Engineering, Bradley University, 1962
BS Mechanical Engineering, University of South Carolina, 1957

**Research and Professional Experience:**
New Jersey Institute of Technology, 1984 – Present
Research Professor, joint appointment Architecture and Mechanical Engineering,

U.S. Environmental Protection Agency, 1995 - 2006
Special technical consultant to the Climate Protection Partnership and Energy Star Homes programs.

US Green Building Council, NJ School of Architecture & New Jersey Chapter, Member
American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
Fellow and Life member
American Solar Energy Society, Life Member
American Society of Materials and Testing, member since 1977

**Publications (patents, copyrights, and software systems):**

**Synergistic Activities:**
Mr. Bales’ experience that is particularly relevant to E-RIC activities includes:
- Created and taught the Four Course Certificate and Master of Science in Sustainable Design program at NJIT since 2003 – the first and one of the few adult-learning programs in the country focused on sustainable, energy efficient building design.
- Senior Consultant to the US Environmental Protection Agency’s Energy Star Homes Program for 11 years, which he helped initiate and which currently promotes higher levels of energy efficiency in new and existing homes. In this position, he coordinated with industry stakeholders, building scientists and public interest groups; trained in-house EPA staff on emerging issues relevant to the program; and helped EPA staff continue to develop the program and communicate it to the public.
- Helped initiate and was Chief of the Building Systems Branch of the US Department of Energy. He was with Department for January 1977 through January 1982. The Branch created the government energy efficiency in buildings program and initiated program at three national laboratories.

**Collaborators and Co-editors/Graduate and Post-doctoral Advisors and Advisees:** NA
Biographical Sketches– William Barton /Operations Manager/Turner Construction

Education and Training:
BS, Civil Engineering with emphasis on Construction Management and Structural Design, Drexel University
- 30-Hour OSHA Certified
- ASHE Certified

Research and Professional Experience:
Shriners Hospital for Children Revitalization, Philadelphia PA - Turner is providing construction management services for a space reutilization project in the Shriners Hospital for Children facility. The renovations will include a new O & P Lab on the first floor, and a new same day surgery with robotic and invasive surgery area on the third floor. The fourth floor will have a new Digital Radiology Room and a new outpatient clinic area. The fifth floor will consists of a renovated EPAC area and the seventh floor will consist of a new research area and new medical records area.

School of Veterinary Medicine, University of Pennsylvania, Philadelphia, PA – Turner provided construction management services for the five-story, 122,400 SF vet school. This state-of-the-art facility includes small seminar rooms, library space, research laboratories, a vivarium, lecture halls, and a conference center. The challenging site lies on a brownfield site amidst roads, a subway tunnel and the operating veterinary hospital. Before building could occur, roads and intersections had to be relocated and the site had to be dewatered and waterproofed. The interior includes all new finishes, architectural millwork, terrazzo floors, acoustical ceilings and laboratory equipment. The mechanical and electrical systems include new AHUs, ductwork, mechanical piping, glycol system, laboratory gas distribution equipment, water processing equipment, new electrical distribution equipment, emergency power system and fixtures.

Cancer Treatment Centers of America, Philadelphia, PA – Turner is performing the conversion of the former Parkview Hospital in Northeast Philadelphia into a comprehensive cancer treatment facility. Work includes interior demolition of the 185,000 SF facility, as well as interior and mechanical fit-out, including the renovation of 104,000 SF to be turned into radiology suites, a tomotherapy unit, linear accelerator, surgical suite, and ICU units, with the additional 81,000 SF being converted to shell space.

Camden School District “Abbott Schools”, Camden, NJ – This project includes the design and construction of 14 new schools as part of the statewide initiative under the State of New Jersey Economic Development Authority’s Schools Construction Corporation. This program is a $9 Billion, 10-year program to improve the quality of education. Turner is the Agency Program/Construction Manager responsible for design/constructability review, preconstruction planning, phasing and logistics, bidding and overall construction management for 14 new schools worth over $220 Million. This program consists of early childhood development centers, Vocational/ Technical Schools, Elementary Schools, and Junior and Senior High Schools. Turner is coordinating the program with the school district, board of education, New Jersey Treasury Division, Department of Community Affairs (DCA), and community and parent groups. The program also includes emergency health and safety improvements to 21 existing and occupied
schools including life safety, electrical, exterior envelope, egress, and interior improvements.

*Alvernia College, New Science Wing, Reading, PA* – Turner provided construction services for this two-story, 33,000 SF teaching laboratory facility featuring labs dedicated to environmental botany, anatomy and physiology, microbiology, physical and analytical

*Liberal Arts Center, Villanova University, Villanova, PA* - Construction of a four-story, 91,900 SF liberal arts center consisting of faculty and staff offices and seminar rooms, as well as a two-story, 86,200 SF parking garage which has been structurally designed for future expansion. This project also includes extensive sitework and site utilities including a 350,000 cubic foot retention pond.

Publications: (including patents, copyrights, and software systems)
None

Synergistic Activities: n/a

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers: n/a

Collaborators and Co-Editors: n/a

Graduate Advisors: n/a

Thesis Advisor for: n/a

Postgraduate-Scholar Sponsor: n/a
Melissa M. Bilec  
Assistant Professor, Civil and Environmental Engineering  
University of Pittsburgh

Education and Training:
University of Pittsburgh Civil and Environmental Engineering B.S., 1997  
University of Pittsburgh Civil and Environmental Engineering M.S., 1999  
University of Pittsburgh Civil and Environmental Engineering Ph.D., 2007

Research and Professional Experience:
Assistant Professor, University of Pittsburgh, Department of Civil and Environmental Engineering, since 2008.  
Assistant Director for Education and Outreach, Mascaro Sustainability Initiative, University of Pittsburgh, since September 2007.  
Co-director, Center for Sustainable Transportation Infrastructure, University of Pittsburgh, Department of Civil and Environmental Engineering, since July 2007.  
Graduate Research Assistant, University of Pittsburgh, Department of Civil and Environmental Engineering, 2003-2007.  
Senior Project Engineer, Urban Redevelopment Authority of Pittsburgh, 1999 – 2007.

Related Publications:

Synergistic Activities:
Dr. Bilec is the assistant director of the Mascaro Center for Sustainable Innovation with the mission of initiating and nurturing research and education in the research thrust areas of green construction and sustainable water use.

Recent Collaborators, Advisors, and Advisees:
H. Scott Matthews (Carnegie Mellon University), Matthew Mehalik (Sustainable Pittsburgh), Kim Needy (University of Arkansas), Robert Ries (University of Florida), John Brigham (University of Pittsburgh), Joe Marriott (University of Pittsburgh), Richard Piaccenti (Phipps Conservatory), Chris Minnerly (The Design Alliance), Kent Harries (University of Pittsburgh), Graduate Advisors: Robert J. Ries (University of Florida), H. Scott Matthew (Carnegie Mellon University), Kim Needy (University of Arkansas); Advisees: Can Aktas, PhD expected 2010; Abdulaziz Benawi, PhD expected 2012; Neethi Rajagopalan, PhD expected 2010; Cassandra Thiel, PhD expected 2013; Alex Dale, PhD expected 2013
Eugenie L. Birch, Lawrence C. Nussdorf Professor of Urban Research, University of Pennsylvania
Philadelphia, PA 19104

**Education and Training**

Bryn Mawr College   A.B. History
Columbia University   M.U.P.  Urban Planning
Columbia University   Ph.D Urban Planning

**Research and Professional Experience**

2008-present  Chair, Graduate Group in City and Regional Planning   UPENN
1998-present  Professor, Department of City and Regional Planning    UPENN
2003-present  Co-Director, Penn Institute for Urban Research       UPENN
1998-2008  Chair, Department of City and Regional Planning     UPENN

**Publications**


**Synergistic Activities**

Co-Project Director (with Susan Wachter and Afaf Meleis) Urban Planning, Economic Development and Health in the Global South, Rockefeller Foundation 2008-2010 ($400,000).

Co-Project Director (with Gary Hack), Urban Design After Peak Oil, Rockefeller Foundation,2008-2009 ($450,000).

Co-Project Director (with Gary Hack, Richard Baron, Susan Wachter, Center for Urban Redevelopment Excellence at Penn (CURE@Penn) 2003-2006, Knight Foundation ($2,400,000).

**Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers**

**Collaborators and other affiliations**

Associate Editor, *Journal of the American Planning Association* 2008 to present
Member, Editorial Board, *Journal of Planning Education and Research* 2004 to present
Member, Editorial Board, *Journal of Planning History* 2002 to present
Chair, Planning Accreditation Board, 2004 to present.
Member, Planning Accreditation Board, 2003 to present.
Dunbar P. Birnie, III  
Dept. of Materials Science and Engineering  
Rutgers, the State University of New Jersey  
607 Taylor Road, Piscataway, NJ 08854  
Phone: 732-445-5605 email: dunbar.birnie@rutgers.edu

Education
Massachusetts Institute of Technology B.S. 1981 Materials Science and Engineering  
Massachusetts Institute of Technology Ph.D. 1986 Materials Science and Engineering

Employment
7/2006 to Present Department Chairman, Dept. of Materials Science and Engineering, Rutgers  
1/2004 to 7/2004 Visiting Scientist (Sabbatical), Australian Nuclear Science and Technology Organisation (ANSTO), NSW, Australia.  
7/03 to Present Professor and Corning/Saint-Gobain/Malcolm G. McLaren Distinguished Chair in Ceramic Engineering, Rutgers MSE.  
9/86 to 6/03 Dept. of Materials Sci. and Engineering University of Arizona, (beginning as Assistant Professor, rising to Full Professor in August ’99)  
7/95 to 8/97 Visiting Scientist (Sabbatical), Institute for New Materials, Saarbrücken, Germany.

Selected Publications (from over 120 total):

Synergistic Activities:  
Associate Director, Rutgers Energy Institute (www.rei.rutgers.edu); Faculty advisor to the Rutgers solar racing team (www.solarcar.rutgers.edu); Key participant in the Rutgers/NJIT bid to win the 2010 US DOE Solar Decathlon (recently chosen to be one of the 20 finalist teams); Collaborative research within the Rutgers Nanotech institute (iamdn.rutgers.edu).

Recent Collaborators (within the last 48 Months): C. Liddell (Cornell)

Graduate Students and PostDocs Supervised (within last 5 years): J. D. Sorge – on Nanowires for Dye Solar Cells (now at NewVision Inc., NJ), L. Qi – on Fabrication of Dye Solar Cells (now starting in B-School at UT Austin), S. Phadke – on Emulsion Templating of Solar Cells (now working in India at a national lab), S. Hussain – on nanoparticle alignment during coating (now returning to grad school for PhD.)
Seth A. Blumsack
Energy and Mineral Engineering
Pennsylvania State University
University Park, PA 16802
Phone: (814) 863-7597,
Fax: (814) 863-3248
Email: sab51@psu.edu

Professional Preparation
Reed College    Mathematics and Economics    B.A., 1998

Professional Appointments
Assistant Professor of Energy and Mineral Engineering (EME), The Pennsylvania State University, 2007-present.

Five relevant publications

Synergistic Activities:
1. Relevant appointments: Adjunct Research Professor, Carnegie Mellon Electricity Industry Center; Adjunct Researcher, Centre for Energy and Mineral Economics, Curtin University of Technology (Australia); Affiliate, Alfred P. Sloan Foundation Industry Studies Program.
2. Advisory: Advisory board member for the program in Energy and Sustainability Policy, Penn State University.

Collaborators Outside of Penn State (past four years)
Jay Apt (Carnegie-Mellon U.); Scott Brown (Exelon); Greg Characklis (U. No. Carolina); Michael Chertkov (LANL); Jason Hill (U. Minnesota); Paul Hines (U. Vermont); Marija Ilic (Carnegie-Mellon U.); Paulina Jaramillo (Carnegie-Mellon U.); David Kittelson (U. Minnesota); Lester B. Lave (Carnegie-Mellon U.); Ye Li (NREL); H. Scott Matthews (Carnegie-Mellon U.); M. Granger Morgan (Carnegie-Mellon U.); Adam Newcomer (Exelon); Mahendra Patel (PJM Interconnection); Dmitri Perekhotsev (LECG); Constantinos Samaras (RAND); Leigh Tesfatsion (Iowa State); Rahul Walawalkar (CES, Ltd.); Jianhui Wang (ANL); Jianhua Xu (Peking U.)

Graduate and Postdoctoral Advisees (past four years)
Adam Newcomer (Exelon); Kathleen Spees (Brattle Group); Clayton Barrows (Penn State, EME Dept.); Steven McGuenegle (Penn State, Geography Dept.); Eric Wertz (MDA Federal); Alisha Fernandez (Penn State, EME Dept.); Mostafa Sahraei-Ardakani (Penn State, EME Dept.); Paras Choudhary (Penn State, EME Dept.); Evan Frye (Penn State, EME Dept.); Jason Wiegle (Penn State, Rural Sociology Dept.); Stephen McLaughlin (Penn State, Computer Science Dept.)
Jeff Borggaard

Professor of Mathematics
Interdisciplinary Center for Applied Mathematics
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061-0531
jborggaard@vt.edu

Education
1986  B.S., Mechanical Engineering, Worcester Polytechnic Institute
1988  M.S., Mechanical Engineering, Worcester Polytechnic Institute
1990  M.S., Applied Mathematics, Worcester Polytechnic Institute
1995  Ph.D., Mathematics, Virginia Polytechnic Institute and State University

Research and Professional Experience:
Jeff Borggaard is a Professor of Mathematics at Virginia Tech. He has published over 100 research papers in the areas of control, optimization, and modeling distributed parameter systems with an emphasis on the Navier-Stokes equations. He has directed 6 Ph. D. students, 8 M.S. students and 3 postdocs. He has work experience as a Mechanical Engineer at the Naval Underwater Systems Center (currently NUWC) and a consultant at Cadkey, Inc. He is currently on the editorial board for Optimization and Engineering and a member of the IEEE technical committee on control of distributed parameter systems. In 2000, Dr. Borggaard was awarded the Presidential Early Career Award for Scientists and Engineers for his work on sensitivity analysis for complex fluid flows. Dr. Borggaard’s primary interests are novel methods for building reduced-order models of complex fluid flows as well as computational tools for control, optimization, and modeling distributed parameter systems (esp. Navier-Stokes equations). He has a long history of collaboration with large and small-scale research projects. These collaborations include Aerosoft Corporation, Air Force Research Laboratories (Control Science Center of Excellence and Arnold Engineering Development Center), BEAM Technologies, Clear Science Corporation, the Industrial Materials Institute, Science and Technology Associates, and United Technologies Research Center. He is currently working with UTRC on a DoD funded project to apply reduced-order modeling and control to address sensor/actuator placement questions as well as the influence of geometric configuration on the airflow quality in buildings.

Employment For Past Five Years
2006-Present:  Professor of Mathematics, Virginia Polytechnic Institute and State University, Blacksburg, VA.
2002-2006:    Associate Professor of Mathematics, Virginia Polytechnic Institute and State University, Blacksburg, VA.
2007-Present: Graduate Program Director, Department of Mathematics, Virginia Polytechnic Institute and State University, Blacksburg, VA.
2007:       Summer Faculty Fellow, Control Science Center of Excellence, Air Force Research Lab, Wright-Patterson Air Force Base, OH.

Ten Selected Publications:

**Synergistic Activities:**


**Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:**

**Graduate Ph. D. Dissertations Directed During the Past Five Years**

Biographical Sketch

Mallika Bose/ Associate Professor of Landscape Architecture and
Director - Hamer Center for Community Design/ The Pennsylvania State University

Education and Training:
Jadavpur University, Calcutta, India/ Architecture/ BArch, 1986
School of Planning and Architecture, New Delhi, India/ Bldg. Eng & Mngmnt./ MBE&M, 1988
Kansas State University, Manhattan, KS/ Architecture (Environment Behavior Studies)/ MArch, 1992
University of Wisconsin, Milwaukee, WI/ Architecture (Environment Behavior Studies)/ Ph.D., 1997
Georgia Institute of Technology, Atlanta, GA/ Architecture (Env Beh Studies)/ Post-doc, 1997-1999

Research and Professional Experience:
Jan 08 – present : Interim Director/Director, Hamer Center for Community Design, Penn State University
May 08 – present: Assoc. Professor, Department of Landscape Architecture, Penn State University
Aug 02 – April 08: Asst. Professor, Department of Landscape Architecture, Penn State University
Aug 01 – Aug 02: Research Associate, College of Architecture, Georgia Institute of Technology
Aug 99 – May 02: Asst. Professor, Department of Urban Planning, Ball State University
March 98 – July 99: Planner, Rosser International, Atlanta

Publications: (including patents, copyrights, and software systems)
Development Planning Review, 29(3), 271-298
Architecture and Planning Research, 24(4), 308-324.
in Harrisburg, PA. Environmental Design Research Association. Sacramento, CA
Bose, M. (2007). Exploring the Role of Physical Activity in the Lives of Female Public Housing Residents in
Harrisburg, PA. Active Living Research Conference, Coronado, CA
Harrisburg, PA: An Ongoing Study. World Planning Schools Congress, Mexico City.
Proceedings: CARDO International Conference on Housing, Work and Development: The Role of Home
Based Enterprises, Newcastle Upon Tyne, UK., 64-77.
International, 23(1), 5-18.
C. Dandekar (Ed.), City, Space, and Globalization: An International Perspective, Ann Arbor, MI: College of

Collaborators and Co-editors
Debajyoti Pati, HKS Clinical Solutions and Research
Craig Zimring, Georgia Tech University

Graduate and Post-doctoral Advisors and Advisees:
2006, Madhur Gurjar, MLA, Private Consulting, London, UK
2010, Jessica Cook, BLA/MLA, University of Colorado – Denver (doctoral student)
AREND-JAN (A.J.) BOTH
Associate Professor and Extension Specialist, Controlled Environment Engineering
Bioenvironmental Engineering, Department of Environmental Sciences
Rutgers, The State University of New Jersey, 20 Ag Extension Way, New Brunswick, NJ 08901
E-mail: both@aesop.rutgers.edu; Web site: http://www.aesop.rutgers.edu/~horteng

Education and Training:
Wageningen Agr. Univ., Netherlands  BS  1986  Agricultural Engineering
Cornell University, Ithaca, NY  PhD  1989-1994  Agricultural Engineering
Cornell University, Ithaca, NY  Post-Doc  1995-1996  Agricultural Engineering

Research and Professional Experience:
2008- present  Associate Professor and Extension Specialist, Rutgers University
2000-2007  Assistant Professor and Extension Specialist, Rutgers University
1997-1999  Research Associate, Cornell University, Ithaca, NY

Selected Publications:

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:
Collaborators and Co-editors: Albright, L.D. (Cornell University), Auge, R. (University of Tennessee), Cavazzoni, J. (self employed), deVilliers, D. (Cornell University), Fang, W. (National Taiwan University), Faust, J. (Clemson University), Fleisher, D.H. (USDA-ARS), Fisher, P. (University of Florida), Garrison, S. (Rutgers University, retired), Gent, M. (Connecticut Agricultural Experiment Station, retired), Gianfagna, T. (Rutgers University), Holmstrom, K. (Rutgers University), Janes, H. (Rutgers University), Kang, S. (Korea, self employed), Kline, W. (Rutgers University), Lam, E. (Rutgers University), Langhans, R. (Cornell University, retired), Lee, T-C. (Rutgers University), Levine, L. (Dynamac Corporation), Ling, P. (Ohio State University), Linker, R. (Israel, Technion), Logendra, L. (Rutgers University), Kopsell, D. (University of Tennessee), Manning, T.O. (Rutgers University), Mears, D. (Rutgers University, retired), Mitchell, C. (Purdue University), Moraru, C. (self employed), Rabin, J. (Rutgers University), Runkle, E. (Michigan State University), Spanswick, R. (Cornell University), Sudal, J. (Rutgers University), Ting, K.C. (University of Illinois), Wheeler, E. (Penn State University), Wheeler, R. (KSC, NASA), Wulster, G. (Rutgers University), Wyenandt, C. (Rutgers University).
Graduate and Post-doctoral Advisors and Advisees: Babson, D. (Rutgers University), Blanchard, M. (Michigan State University), Goudarzi, S. (New York University, self employed), Lefsrud, M. (McGill University), Martin, A. (Rutgers University), Mathieu, J. (The Mitre Corporation), Reiss, E. (Fraunhofer USA), Rodriguez, L.F. (University of Illinois), Speca, D. (Rutgers University), Wartell, B. (self employed).
BIOGRAPHICAL SKETCH

James (Jim) Braun
Professor of Mechanical Engineering
Purdue University
585 Purdue Mall
West Lafayette, IN 47907-2040
Phone: (765)494-9157
Fax: (765)494-0787
Email: jbraun@purdue.edu

(i) Professional Preparation

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<tr>
<th>University</th>
<th>Major</th>
<th>Degree &amp; Year</th>
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<tbody>
<tr>
<td>University of Massachusetts</td>
<td>Mechanical Engineering</td>
<td>B.Sc. 1976</td>
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<tr>
<td>University of Wisconsin</td>
<td>Mechanical Engineering</td>
<td>M.Sc. 1980</td>
</tr>
<tr>
<td>University of Wisconsin</td>
<td>Mechanical Engineering</td>
<td>Ph.D. 1988</td>
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</table>

(ii) Appointments

<table>
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<tr>
<th>Period</th>
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<th>Position</th>
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<tbody>
<tr>
<td>08/01-date</td>
<td>Purdue University, USA</td>
<td>Professor</td>
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<tr>
<td>08/96-07/01</td>
<td>Purdue University, USA</td>
<td>Associate Professor</td>
</tr>
<tr>
<td>08/91-07/96</td>
<td>Purdue University, USA</td>
<td>Assistant Professor</td>
</tr>
<tr>
<td>5/88-7/91</td>
<td>Johnson Controls, USA</td>
<td>Senior Research Engineer</td>
</tr>
<tr>
<td>9/84 – 4/88</td>
<td>Univ. of Wisconsin, USA</td>
<td>Research Assistant</td>
</tr>
<tr>
<td>1/84 – 7/84</td>
<td>Univ. of Liege, Belgium</td>
<td>Research Scientist</td>
</tr>
<tr>
<td>1/80 – 12/83</td>
<td>Univ. of Wisconsin, USA</td>
<td>Research Staff</td>
</tr>
<tr>
<td>9/78 – 12/79</td>
<td>Univ. of Wisconsin, USA</td>
<td>Research Assistant</td>
</tr>
<tr>
<td>8/76 – 7/78</td>
<td>Carrier Transicold, USA</td>
<td>Development Engineer</td>
</tr>
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</table>

(iii) Publications

Five publications most related to the project

Five other major significant publications
SYNERGISTIC ACTIVITIES

Dr. Braun has worked in the field of air conditioning and refrigeration for over 30 years in both university and industrial settings. His practical experience includes working as a development engineer for advanced cooling equipment, a software developer for simulation tools in modeling buildings and large-scale heating and cooling plants, and a developer of intelligent control algorithms for large commercial energy management and control systems. He has been awarded four patents. His research combines the use of computer modeling, optimization, and experiments to study and improve the performance of thermal systems. Overall, Dr. Braun has led or been involved with proposals leading to research awards totaling over $10 million and has over 200 papers published or in review, five of which received best paper awards. Within ASHRAE, Dr. Braun has been chairman of technical committees on “Smart Building Systems” and “Building Operation Dynamics” and is currently Vice-Chair for the Research Administration Committee. He is an Associate Editor for the International Journal of HVAC&R Research. He is a Fellow within ASHRAE and has received the ASHRAE Distinguished Service Award, the E.K. Campbell Award of Merit, in recognition of outstanding service and achievement in teaching and/or research in subjects relating to the industry and professions represented by ASHRAE, and the Early Achievement Award from the International Building Performance Simulation Association.

COLLABORATORS & OTHER AFFILIATIONS

(a) Collaborators and Co-Editors
Y. Chen, S. Frankel, E. Groll, J. Mitchell, L. Mongeau, W. Soedel, D. Tree (Purdue University), P. Bansal (University of Auckland, New Zealand), M. Brandemuehl (University of Colorado), A. Dexter (Oxford University, England), S. Klein and J. Mitchell (University of Wisconsin), B.C. Pak (Chonbuk National University, Korea), R. Radermacher (University of Maryland).

(b) List of names of graduate and postdoctoral advisors
W.A. Beckman, J.A. Duffie, S.A. Klein, J.W. Mitchell (University of Wisconsin).

(c) List of names of graduate students advised and postgraduate-scholars sponsored
F. Morris (unknown), M. Wolochuk (Hunt Air), K. Drees (Johnson Controls), K. Keeney (GH Michaels Associates LLC), T. Rossi (Field Diagnostic Services), J. Douglas (Trane), B. Minner (Owens Corning), J. West (Johnson Controls), J. Leroy (Trane), M. Breuker (Service Resources), N. Halm (Germany), K. Montgomery (Ford), M. Comstock (Lexmark), Y. Chen (United Technologies Research Center), B. Chen (Johnson Controls), N. Chaturvedi (I2 Technologies), G. Li (Haywood Pool Products), T. Harms (Owens Corning), K. Mercer (Trane), T. Lawrence (University of Georgia), L. Yang (Carrier), S. Bendapudi (United Technologies Research Center), H. Li (University of Nebraska), I. Paek (Kangwon National University, Korea), X. Zhou (Carrier), Z. Zhong (Steven Winter Associates), B. Shen (Trane), M. Jovane (Technival University of Panama), J. Hugeneroth (InvenTherm), K. Lee (KEPRI, Korea), R. Chervil (York), J. Kim (University of Alabama), D. Hegenveld (Purdue), M. Mathison (Purdue), A. Wichman (PSEG Nuclear), I. Bell (Purdue), L. Ma (Purdue), V. Lemort (Purdue), M. Paredes (unknown), S. Goebel (unknown), G. Rieder (unknown), N. Schmidt (unknown), Z. Wang (unknown), F. Yi, (Nanjing Aotecar Refrigerating Company, China), Woohyun Kim (Purdue)

Total number of graduate students advised: 36
Total number of postgraduate scholars sponsored: 6
Margaret F. Brennan-Tonetta  
*Rutgers, the State University of New Jersey*  
88 Lipman Drive Rm 113, New Brunswick, NJ 08901-8520.  
(732)932-1000 x 569.  brennan@aesop.rutgers.edu

**Education and Training:**

Rutgers University, NJ  
**BS**  1994  Economics

Rutgers University, NJ  
**MS**  1996  Applied Economics

Rutgers University, NJ  
**PhD**  2010 (Oct.)  Energy Policy

**Professional Experience:**

**2006- Present**  *Associate Director*, Rutgers New Jersey Agricultural Experiment Station

**2002 – 2006**  *Associate Dean of Research*, Cook College, Rutgers University

**2000 - 2003**  *Director*, Rutgers Food Innovation Center, Rutgers University

**2001 - 2002**  *Associate Director for Program Development*, Cook College, Rutgers University

**1999 - 2001**  *Special Initiatives Coordinator*, Cook College, Rutgers University

**1996 - 1999**  *Research Economist*, Dept. of Agricultural, Food and Resource Economics, Cook College, Rutgers University

**Synergistic Activities:** Chair of Outreach Committee, Rutgers Energy Institute; Founder and Chair, NJAES Sustainable Energy Working Group; Member, Statewide Bioenergy Committee; Board of Directors, Northeast Center for Rural Development; Member, State Energy Sector Partnership Council.

**Selected Publications:**


**Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:**

*Collaborators and Co-authors:* David Specca (Rutgers), Brian Schilling (Rutgers), David Tulloch (Rutgers), Steven Paul (Princeton), Kevin Sullivan (Rutgers), Zane Helsel (Rutgers), Priscilla Hayes (Rutgers), A.J. Both (Rutgers), Donna Fennell (Rutgers), Stacy Bonos (Rutgers), Mike Westendorf (Rutgers) Rhea Brekke (NJ-BPU), Fred Hitzhusen (Ohio State University), Daniel Ciolek (Penn State), Bruce Miller (Penn State), Jonathan Rubin (University of Maine), Aaron Weiskittel (University of Maine), Ray Miller (Michigan State), Larry Leefer (Michigan State), David MacFarlane (Michigan State), Marc McDill (PSU), Chris Recchia (VT Biomass Energy Resource Center), Tim Rooney (Antares Group, Inc.), Peter Woodbury (Cornell).

**Professional Recognition:**

- PlanSmart NJ – Excellence in Economic Development – Rutgers Food Innovation Center (2009)
- Rutgers Presidential Award for Research in Service to New Jersey for “Contributions to the health and economic well-being of communities across New Jersey” (2008).
- National Business Incubation Association, “ Incubator of the Year”, Rutgers Food Innovation Center (2007)
- USDA Partnership Award , “Innovative Program Model”, Rutgers Food Innovation Center (2007)

**Grants:**

2000-2010: $9,285,000 in federal and state grants
Lee Roy Bronner, Ph.D., P.E.
Research Associate Professor
Morgan State University
Industrial and Systems Engineering Department

Education

B.S.E.E., University of Akron, Year of Graduation – 1963, Akron, Ohio
M.S.E.E., Northeastern University, Year of Graduation – 1966, Boston, Massachusetts
Ph.D., Systems Engineering, Case Western Reserve University, Year of Graduation – 1973, Cleveland, Ohio

Professional Engineer
Certification - State of Ohio, 1963

Private Sector Experience
1. 25 Years International Business Machines (IBM) Corporation
   a. Systems Engineering in direct support of customers
      1. Systems Analysis, Design, Programming, Implementation
   b. IBM Thomas J. Watson Research Center
      1. Research - Operating Systems (VM/370)
   c. IBM Washington Systems Center
      1. Systems Application - Analysis, Design, Implementation
      2. Large System Capacity Planning
   d. Advanced Software Development
      1. Artificial Intelligence - Expert Systems/Natural Language Processing
   e. Desktop Software Development
      1. Advanced Word Processing Software

Academic Experience
1. Howard University - Washington, D. C. (1 Year)
2. Morgan State University - Baltimore, Maryland (11 Years)

Publications:
Jeffrey R. S. Brownson  Assistant Prof. of Energy & Mineral Engineering
Dept of Energy & Mineral Engr.  Phone: (814) 865-8473
224 MRL Building  Fax: (814) 865-3248
The Pennsylvania State University  Email: nanomech@psu.edu
University Park, PA  16802  http://www.eme.psu.edu/faculty/brownson.html

Education and Training

Research and Professional Experience

Publications. Electronic copies of these publications can be obtained from: http://nanomech.ems.psu.edu/.


Synergistic Activities:


4. Transdisciplinary Course Development: Living with Sustainable Energy in a Global Society. Leading collaboration with engineering, science, design and policy faculty and students for a yearlong course sequence that included summer voyage to experience sustainable energy in Germany and France. (2008-09)


Collaborators (past 48 months)
Marc Anderson (UW—Madison) Lisa Iulo (PSU)
Seth Blumsack (PSU) Allen Kimel (PSU)
Claude Lévy Clément (CNRS) David Riley (PSU)

Graduate and Postdoctoral Advisors
Graduate: Marc A. Anderson (Ph.D.) and Jillian F. Banfield (M.S.): UW—Madison.
Postdoctoral: Claude Lévy Clément (CNRS) and Marc Anderson (UW—Madison)

Graduate Advisees
Mr. Ramprasad Chandrasekharan (PhD student)
Mr. Lucas Witmer (MS/PhD candidate)
Mr. Oladipo Ositelu (MS candidate)
Mr. Charith Tamineedi (MS candidate)
Ms. Mesude Bayrakci (PhD candidate)
(all affiliated with Penn State, Department of Energy & Mineral Engineering)
John Vetter Burkardt

Computational Scientist

Interdisciplinary Center for Applied Mathematics/Information Technology Department
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061-0531
burkardt@vt.edu

Education
1995 Ph.D., Mathematics, Virginia Tech
1978 M.A., Mathematics, The University of Pittsburgh
1975 BS, Science and Humanities, MIT

Research and Professional Experience:
John Burkardt is a computational scientist working for Virginia Tech's Advanced Research Computing (ARC) facility. He also maintains a close relationship with the researchers at ICAM. In that role, he has participated in a number of projects, generally providing support for computation, algorithms, computer visualization, and parallelization. He has presented numerous seminars for faculty and graduate students on parallel programming on HPC systems using OpenMP, MPI and parallel MATLAB. He has held similar positions that combine research and computing at Florida State University's Department of Scientific Computing, at Iowa State, and at the Pittsburgh Supercomputing Center.

He has published 23 research papers on computational methods for clustering, flow optimization, mesh generation, continuation methods, and various applications of sparse grids for high dimensional collocation of PDE's with stochastic parameters. He is currently the principal investigator in a grant from Sandia National Laboratories whose purpose is the development, implementation and extension of sparse grid techniques to a variety of probabilistic distributions, with an emphasis on dimensional anisotropy. Sparse grids are a natural and efficient approach to the simulation and analysis of problems in which a deterministic model has been augmented by stochastic components, for which it is desired to estimate statistics on various quantities of interest.

Employment For Past Five Years
2007-Present: Computational Scientist, Virginia Tech, Blacksburg, VA.
2002-2007: Associate in Research, Florida State University, Tallahassee, FL.

Ten Selected Publications:

Synergistic Activities:

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:
I. Akhtar (Virginia Tech), Jeff Borggaard (Virginia Tech), Gene Cliff (Virginia Tech), Q. Du (Penn State), Max Gunzburger (Florida State), T. L. Herdman (Virginia Tech), L. Ju (University of South Carolina), H.C. Lee (Ajou University).
John Allen Burns
Hatcher Professor of Mathematics
Interdisciplinary Center for Applied Mathematics
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061-0531
jaburns@math.vt.edu

Education
1967  B.S.E., Mathematics, Arkansas State University
1968  M.S.E., Mathematics, Arkansas State University
1970  M.A., Mathematics, The University of Oklahoma
1973  Ph.D., Mathematics, The University of Oklahoma

Research and Professional Experience:
John Burns is the Hatcher Professor of Mathematics at Virginia Tech and the Director of the Center for Optimal Design and Control. He has published over 150 research papers on computational methods for identification, design, optimization and control of systems governed by partial and functional differential equations. He has directed over twenty Ph.D. students and 10 MS thesis. He has served on more than 12 editorial boards and he was the founding Editor of the SIAM Book Series on Advances in Design and Control. He served as Vice President of SIAM, is the past Chair of the SIAM Activity Group on Systems and Control and is a Fellow of the IEEE. Dr. Burns was recently named as the winner of the 2010 Reid Prize for his fundamental contributions in computational methods for and applications in control, design and optimization of infinite dimensional dynamical systems.

Dr. Burns’ primary interests concern the development of rigorous and practical computational algorithms for model reduction, design and optimization and sensitivity analysis of engineering and biological systems. He has applied his research to a wide variety of areas including fluid dynamics, smart materials, large space structures, nano-devices, aerodynamics, mathematical biology and control of energy efficient buildings. Dr. Burns has been a consultant and advisor to Booz Allen & Hamilton, NASA Langley Research Center, The Air Force Research Labs, DARPA, The Babcock and Wilcox Company, Solers Inc., United Technologies and has held several visiting positions in the USA, Europe and Asia. Dr. Burns currently is working with UTRC on several DoD funded projects concerning reduced order modeling and control of energy efficient buildings.

Employment For Past Five Years
1995-Present:  Hatcher Professor of Mathematics, Virginia Polytechnic Institute and State University, Blacksburg, VA.
1993-Present:  Director, Center for Optimal Design and Control, Virginia Polytechnic Institute and State University, Blacksburg, VA.
1987-Present:  Technical Director, Interdisciplinary Center for Applied Mathematics, Virginia Polytechnic Institute and State University, Blacksburg, VA.
2008-2009:  Visiting Research Fellow, United Technologies Research Center, Hartford, CN.

Ten Selected Publications:


**Synergistic Activities:**


2. **2007 – 2010:** Co-organized three workshops and working groups on high performance buildings and computational tools for design and optimization of energy efficient buildings.

3. **2009:** Member of DOE panel to evaluate current and proposed energy simulation software.

**Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:**

I. Akhtar (Virginia Tech), E. Allen (Texas Tech), Jeff Borggaard (Virginia Tech), Gene Cliff (Virginia Tech), Lisa Davis (Montana State), David Gilliam (Texas Tech), T. L. Herdman (Virginia Tech), Z. Liu (U. Minnesota), G. H. Peichl (U. Graz, Austria), E. W. Sachs (U. Trier, Germany), John Singler (U. Missouri), R. D. Spies (U. of Santa Fe, Argentina), A. Surana (UTRC).

**Graduate Ph. D. Dissertations Directed During the Past Five Years**


PROFESSIONAL PREPARATION:
- Masters of Business Administration, Georgetown University
- Bachelors of Science, Operations Research, Cornell University

APPOINTMENTS /HIGHLIGHTS:
December 2009 – Current: **Smart Buildings Services Manager**, IBM Global Business Services
- Manage development and productization of IBM’s Smart Building solution
- Responsible for consulting group focused on delivering Smart Building solutions.

- Led eProcurement consulting group for IBM’s Public Sector clients.
- Supported US Government eProcurement policy initiatives at the highest levels of the US Government
  - Worked directly with Deputy Secretary of Defense Paul Brinkley in effort audit and improve eProcurement practices in Baghdad.

SYNGERGISTIC ACTIVITIES
Focal point for IBM’s Smart Building initiatives
- Coordinate with IBM organizations globally to identify cutting edge Smart Building solutions and processes
- Leading effort to consolidate selected technologies into a standard solution
- Responsible for deployment of Smart Building solution to IBM facilities
- Manage IBM’s Smart Building consulting practice for public sector clients

HONORS AND AWARDS
2 Service Area Excellence Awards (2006, 2008)
IBM Academy of Technology (Member since 2007)
Industry Advisory Council (Member since 2007)
Qingyan (Yan) Chen, Ph.D.

Professor of Mechanical Engineering
Purdue University
585 Purdue Mall
West Lafayette, IN 47907

Phone: (765)496-7562
Fax: (765)494-0539
Email: yanchen@purdue.edu
http://engineering.purdue.edu/~yanchen

Education and Training

<table>
<thead>
<tr>
<th>University</th>
<th>Major</th>
<th>Degree &amp; Year</th>
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<tbody>
<tr>
<td>Tsinghua University (China)</td>
<td>Mechanical Engineering</td>
<td>B.Sc. 1983</td>
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<tr>
<td>Delft University of Tech. (Netherlands)</td>
<td>Mechanical Engineering</td>
<td>M.Sc. 1985</td>
</tr>
<tr>
<td>Delft University of Tech. (Netherlands)</td>
<td>Mechanical Engineering</td>
<td>Ph.D. 1988</td>
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Research and Professional Experience

<table>
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<tr>
<th>Period</th>
<th>Employer</th>
<th>Position</th>
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<tbody>
<tr>
<td>09/04-date</td>
<td>National Center of RITE, Purdue Univ.</td>
<td>Principal Director</td>
</tr>
<tr>
<td></td>
<td><em>A center related to air cabin environment</em></td>
<td></td>
</tr>
<tr>
<td>07/02-date</td>
<td>Purdue University, USA</td>
<td>Professor</td>
</tr>
<tr>
<td></td>
<td><em>Research and teaching related to built environment, energy-efficient buildings, and thermal systems</em></td>
<td></td>
</tr>
<tr>
<td>07/98-07/02</td>
<td>Massachusetts Institute of Technology, USA</td>
<td>Associate Professor</td>
</tr>
<tr>
<td></td>
<td><em>Research and teaching related to sustainable buildings</em></td>
<td></td>
</tr>
<tr>
<td>01/95-06/98</td>
<td>Massachusetts Institute of Technology, USA</td>
<td>Assistant Professor</td>
</tr>
<tr>
<td></td>
<td><em>Research and teaching related to sustainable buildings</em></td>
<td></td>
</tr>
<tr>
<td>04/91-01/95</td>
<td>TNO-Institute of Applied Physics, Netherlands</td>
<td>Project Manager</td>
</tr>
<tr>
<td></td>
<td><em>Research related to thermo-fluid industrial processes</em></td>
<td></td>
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<tr>
<td>01/89-04/91</td>
<td>Swiss Federal Institute of Technology (ETH)</td>
<td>Research Scientist</td>
</tr>
<tr>
<td></td>
<td><em>Research related to built environment</em></td>
<td></td>
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<tr>
<td>01/86-12/88</td>
<td>Delft University of Technology, Netherlands</td>
<td>Research Staff</td>
</tr>
<tr>
<td></td>
<td><em>Research on building energy and indoor environment</em></td>
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</table>

Ten Publications Most Related to the Project


**Synergistic Activities**

Chen is leading the National Air Transportation Center of Excellence for Research in the Intermodal Transport Environment (RITE). The ten-year, multi-million dollar center sponsored by the Federal Aviation Administration consists of faculty and students from seven universities. Chen has conducted 49 research projects with a total budget of approximately $19 million and published over 200 papers in archival journals and refereed conference proceedings in the field of indoor environment. He has developed many computer programs for research, education, and industrial applications, such as a computational fluid dynamics program, CFD0, and a building energy simulation program, ACCURACY. Chen is the Editor-in-Chief of journal “Building and Environment”. He was a co-chair of the First International Conference on Energy and Environment (COBEE 2008). Chen has received the CAREER award from the NSF, Exceptional and Distinguished Service Award, Best Paper Award, and Best Poster Awards from the ASHRAE, and Willis J. Whitfield Award from the Institute of Environmental Sciences and Technology.

**Collaborators and Co-Editors in the Past 48 Months**


**Graduate Students Advised and Postgraduate-Scholars Sponsored during the Last 5 Years**

William W. Clark  
Professor, Mechanical Engineering and Materials Science  
University of Pittsburgh

Education and Training:
Virginia Polytechnic Institute and State University  Mechanical Engineering  B.S.  1986
Virginia Polytechnic Institute and State University  Mechanical Engineering  M.S.  1988
Virginia Polytechnic Institute and State University  Mechanical Engineering  Ph.D.  1991

Research and Professional Experience:
Professor, Mechanical Engineering and Materials Science, University of Pittsburgh (2005 - )
Associate Professor, Mechanical Engineering, University of Pittsburgh (1998 – 2005)
Assistant Professor, Mechanical Engineering, University of Pittsburgh (1992 – 1998)
Instructor, Mechanical Engineering, Virginia Polytechnic Institute & State University (1989-90)

Related Publications:

Recent Collaborators, Advisors, and Advisees:
Collaborators: Christopher Bielawski (University of Texas), David Cowan (Northrup Grumman), Jay Kudva (NextGen Aeronautics), Shiv Joshi (NextGen Aeronautics), Lee Radziemski (Piezo Energy Technologies), Pete Hensel, Randy Gemmen, Jimmy Thornton (DOE National Energy Technology Laboratory, Morgantown),
Co-Editors: Dane Quinn, University of Akron, Mohammad Daqaq, Clemson University
Graduate and Post-doctoral Advisor and Advisees: Graduate Advisor: Professor Harry Robertshaw (retired), Recent Post-Doctoral Advisees: None, Recent Doctoral Students: Lawrence Corr, Westinghouse; Sung-Hwan Kim, LG Electronics, South Korea , Recent Masters Students: Elias Hilliard; Michael Hudzik; Brad Boyerinas (University of Maryland); Scott Rauscher (Army Research Lab); Ryan Knight (Army Research Lab); David Charnegie (Bechtel Plant Machinery Inc.); Tom Johnson (Westinghouse); Amanda Frederick (Bechtel Plant Machinery Inc.).
Eugene Matthew Cliff

Reynolds Metals Professor
(Emeritus)
Interdisciplinary Center for Applied Mathematics
Virginia Tech, Blacksburg, Virginia 24061-0531
Phone: (540) 231-7667, Fax: (540) 231-7079
ecliff@vt.edu

Education:
The University of Arizona, Mechanical Engineering, M.S., 1967.
The University of Arizona, Mechanical Engineering, Ph.D., 1969.

Research and Professional Experience:
Eugene Cliff is the (emeritus) Reynolds Metals Professor of Aerospace and Ocean Engineering at Virginia Tech. He has published over one hundred research papers on optimization and optimal control of systems governed by ordinary and/or partial differential equations. In the aerospace community he is known for his work on trajectory optimization; particularly the use of reduced-order models for guidance and control. He was one of the principal architects of semi-group-based computational methods for inverse problems and sensitivity analysis. He is a member of the IEEE, and SIAM and is an Associate Fellow of the AIAA. He has served as Associate Editor of the AIAA Journal of Guidance, Control, and Dynamics and as an Associate Director of the Interdisciplinary Center for Applied Mathematics (ICAM). He has directed more than thirty graduate students in engineering and in mathematics. In 2008 he received awards from NASA Langley Research Center and from DARPA for work in support of the space-based antenna technology.

Employment:
2002 - Present: Emeritus Professor of Aerospace and Ocean Engineering, Virginia Tech.
1971 – 1975: Assistant Professor of Aerospace and Ocean Engineering, Virginia Tech.
1969 – 1971: Assistant Professor of Aerospace and Mechanical Engineering, University of Arizona.

Visiting and Consulting Appointments:
2005: Consultant, SRS Technologies, Arlington, VA
1979 – 1988: Consultant, Optimization Incorporated, Blacksburg, VA

Ten Selected Publications:
4. J. A. Burns, E. M. Cliff, Z. Y. Liu, and R. Spies, Results on Transversal and Axial Motions of a


**Synergistic Activities:**


2. Associate Editor for; *J. Guidance, Control and Dynamics, SIAM Book Series on Optimal Design and Control*.

3. Reviewer for *J. of Aircraft; J. Guidance, Control and Dynamics; IEEE Conf. On Decision and Control; J. of Optimization, Theory and Applications; Optimal Control: Applications and Methods; AFOSR; NSF*.

**Identification of Potential Conflicts if Interest or Bias in Selection of Reviewers:**

J.Z. Ben_Asher (The Technion, Haifa, Israel), D. Brewer(U. Arkansas), M.D. Gunzburger (Florida State), Lisa Davis (Montana State), Z. Liu (U. Minnesota), E. W. Sachs (U. Trier, Germany), R. D. Spies (U. of Santa Fe, Argentina), K.H. Well (U. Stuttgart, Germany)

**Graduate Theses Directed in the Past Five Years:**


**BIO for Adam Cohen**

| **Name as you would like it to appear:** | Adam Cohen |
| **Title:** | Deputy Director for Operations, Princeton Plasma Physics Laboratory (PPPL)  
Chief of Staff, National Laboratory Directors’ Council (NLDC) |
| **Areas of professional expertise:** | Nuclear Energy, Energy Strategy, National Laboratories |
| **Background:** | Adam has more than 25 years experience in management of research and development, strategic planning and operations at Princeton (PPPL), Argonne National Laboratory (ANL), and the Department of Energy. As Deputy Director for Operations, he is responsible for both the engineering and operations function at PPPL, including design efforts, project management, human resources, financial activities, outreach, ES&H and applied research activities. He also serves as Chief of Staff for the DOE National Laboratory Directors’ Council, with representatives from each of the 17 DOE Laboratories including PPPL, as well as on the Operations Committee for Brookhaven Science Associates (BSA), the organization that runs Brookhaven National Laboratory (BNL). Adam formally served as senior advisor to the DOE Under Secretary for Science for nuclear energy programs, and at Argonne as COO, as the head of environment, safety and health, as a nuclear facility manager, and as a researcher/principal investigator on nuclear fuels and materials. Earlier in his career, he spent four years in the U.S. Navy as a submarine officer, and he worked at Babcock & Wilcox manufacturing nuclear fuel for research reactors. |
| **Education:** | PhD in Materials Science and Engineering, Northwestern University, 1997  
MBA, University of Chicago, 2000  
BS in Metallurgy, Columbia University, 1985 |
| **Professional:** | American Nuclear Society  
Tau Beta Pi  
Sigma Xi |
Daniel G. Cole, Ph.D., P.E.
Assistant Professor, Department of Mechanical Engineering and Materials Science
University of Pittsburgh

Education and Training:
Ph.D. Mechanical Engineering, Virginia Polytechnic Institute and State University, 1998
M.S. Mechanical Engineering, Virginia Polytechnic Institute and State University, 1992
B.S. Mechanical Engineering, Virginia Polytechnic Institute and State University, 1991

Research and Professional Experience:
2006–present Assistant Professor, Department of Mechanical Engineering and Materials Science, University of Pittsburgh.
2004–2006 Research Assistant Professor, Department of Mechanical Engineering and Materials Science, Duke University.

Related Publications:

Recent Collaborators, Advisors, and Advisees:
Collaborators: Lisa M. Weiland, University of Pittsburgh
Graduate Students Supervised and Under Supervision: Dr. Kurt D. Wulff, MIT Lincoln Laboratory; Dr. Monica Rivera, Motile Robotics, Inc.; Daniel R. McAdams (Ph.D. student); Jason G. Pickel (Ph.D. student); Nicholas A. Kirsch (M.S. student)
BRUCE D. D'AMORA
1101 Kitchawan Road Yorktown Heights, NY (914) 945-4514

PROFESSIONAL OBJECTIVE
A senior leadership position requiring a collaborative cross-team effort to develop hardware and/or software solutions that seamlessly integrate the workflow components required for complex simulations and visualization.

PROFESSIONAL EXPERIENCE

2009-present  Senior Technical Staff Member, IBM T.J. Watson Research Center, Yorktown Heights, New York
2005-2008      Senior Technical Staff Member, IBM T.J. Watson Research Center, Yorktown Heights, New York
2000-2004      Senior Software Engineer, IBM T.J. Watson Research Center, Hawthorne, New York
1996-2000      Senior Software Engineer, IBM, Austin, Texas
1995 - 1996    Senior Software Engineer, GE Medical Systems, Waukesha, WI.
1982 - 1983    Programmer Co-op, IBM, Boulder, Colorado
SUMMARY OF QUALIFICATIONS

Application/System Software Development

- 3D Geometry Pipelines and Raster Engines
- Advanced Rendering Effects
- Image and Volume Rendering
- Interactive source-level Debuggers
- Graphical User Interfaces
- Rigid- and soft-body dynamics
- Computational fluid dynamics
- Online Game development

Hardware & Operating Systems

- Linux/Cell/B.E.
- Blue Gene P
- IBM Power with AIX
- Microsoft Windows
- Palm OS
- Pocket PC & Palm Hardware
- Apache server

Languages & Tools

- C, C++, Fortran, Pascal, X86 assembly, Power PC assembly, gdb, Eclipse, MySql, Python

PATENTS

16 Patents or Patents pending

AWARDS

1995 Acceleration of Advantage Windows 2.06
1993 AWD Division Award - Overall Lead for OpenGL development
1992 GL select mode pipeline development
1985 CADwrite product development

PUBLICATIONS

2005 High Performance compute servers for next generation Online Gaming, IBM Systems Journal
2008 Exploiting High Volume Processors for e-Servers, IBM Journal of Research and Development

EDUCATION

M.S. Computer Science National Technological University - Fort Collins, CO - 1992
B.S. Applied Mathematics Metropolitan State College - Denver, CO - 1983
B.A. Biological Sciences University of Colorado - Boulder, CO - 1978
Corey Dickens, Ph.D.
Morgan State University, Schaefer Bldg. RM 347
Department of Electrical Engineering
Baltimore, MD 21251

*Professional Experience*

**Director of Energy Education and Research Development**, Morgan State University, Baltimore, MD. 9/09-Present
- Developed MSU Power and Energy Curriculum
- Infused critical thinking concepts into Power Systems, Materials and Electronics courses
- Co-Founded Maryland Energy and Education Center (MEERC)

**Center Director** (Semiconductor Center for Electronic Devices and Circuits), Morgan State University, Baltimore, MD. 8/03-8/08
- Developed vision, mission and implemented policies in relation to the daily operation for the center
- Wrote, procured and managed research contracts and grants
- Developed integrated training, research and course work program

**Assistant Professor**, Morgan State University, Baltimore, MD. 8/00-Present
- Taught Power Systems, Electronic Materials and Devices, Introduction to Electrical Laboratory, Introduction to Electrical Engineering, Semiconductor Integrated Circuit Fabrication, Power Systems, Power Electronics, and Electronic Circuits

*Relevant Projects*
- Initial Development: 1MW South Carolina Solar Energy Farm, New Energy Institute
- Hybrid Design: 300KW Solar and 300KW Wind, Solicitation by Talbot County Sewage Department
- Product Development: Intelligent Solar Grid Tie Inverter, Helios Technologies
- Product Development: Intelligent Efficient Lighting Solution, Wise Grid
- Developed Cost Effective Residential Solar Funding Model, State of Maryland
- Electric Van Renovation Project, Supported by Maryland Energy Administration

*Education and Training*
- Morgan State University, Baltimore, MD, Electrical Engineering, B.S. 1987-1991

*Professional Affiliations*
- Co-Founder: New Energy Institute
- Executive Director of Engineering and Technology: MDR Group
- Secretary: IEEE Power and Energy Society, Maryland Chapter
- Co-Founder: Maryland Energy and Education Center, Morgan State
- Co-Founder: Wise Grid Solutions, LLC
Biographical Sketch

Stuart Echols / Associate Professor  
Department of Landscape Architecture, The Pennsylvania State University

Education and Training:  
2002, PhD, Environmental Design and Planning, Virginia Polytechnic Institute & State University  
1994, M.L.A., Virginia Polytechnic Institute & State University  
1988, M.S., Land Development, Texas A&M University  
1986, B.S.L.A., Texas A&M University

Research and Professional Experience:  
2003–present, Assistant/Associate Professor – Department of Landscape Architecture, Penn State University  
2001–2003, Assistant Professor – Department of Landscape Architecture, West Virginia University  
2000–2003, Visiting Assistant Professor – Department of Landscape Architecture, Penn State University  
1994–1998, Instructor –Landscape Architecture, Virginia Polytechnic Institute & State University  
1994–1996, Project Manager, Virginia Tech – Community Design Assistance Center, Blacksburg, VA  
1988–1992, Senior Landscape Architect and Project Manager, Land Design South, West Palm Beach, FL

Publications: (including patents, copyrights, and software systems)  

Synergistic Activities:  
2003–2004, Design Consultant – Stormwater Design and implementation of Municipal Separate Storm Sewer Systems for the State College Friends School with Hayes Large Architects, LLP

Collaborators and Co-editors  
Eliza Pennypacker, Penn State University; Hala Nassar, Clemson University

Graduate and Post-doctoral Advisors:  
Dean Bork, Virginia Polytechnic Institute & State University  
Bruce Ferguson, University of Georgia
Deane M. Evans, FAIA, LEED AP
NJIT Center for Building Knowledge, Executive Director

Education and Training:
Bachelor of Arts, Magna cum Laude, Yale University, 1972
Master of Architecture, Columbia University, 1977

Research and Professional Experience:
NJIT Center for Building Knowledge, 2001-present
Executive Director. Manages all Center research and technical assistance activities.
Private Practice, 1999-2001
US Department of Housing and Urban Development, 1999
Served as the founding Director of the Partnership for Advancing Technology in Housing (PATH), a public/private partnership to accelerate the creation and use of advanced technologies in U.S. housing.
American Institute of Architects, 1990 - 1997
Served as the AIA’s first Vice President for Research and as the first, full-time Director of the AIA/ACSA Council on Architectural Research.
Senior Principal. Concentrated on applying innovative technologies and systems to the design and construction of buildings, particularly housing

Publications (patents, copyrights, and software systems):
• The Role of Architects in Advancing Technology Innovation in Housing (co-author) US Department of Housing and Urban Development, 2007
• Energy Tools: New Products for Architects from the National Energy Laboratories (editor and publisher) AIA/ACSA Council on Architectural Research, 1992

Synergistic Activities:
Mr. Evans’ experience that is particularly relevant to E-RIC activities includes:
• Content coordinator for the California Energy Commission’s Online Learning Center, a resource for training code officials on enforcement of the Title 24 Energy Standards.
• Lead technical consultant for McGraw-Hill Construction’s Continuing Education Center for building product manufacturers, architects and engineers.
• Supervisor for the development of:
  o A PSE&G Retro-Commissioning Pilot Program
  o The Clean Energy Program Online Academy
  o The Affordable Green Online Academy
  o A National Grid Core Training Program on Advanced Buildings
  o An energy efficiency online training program for NSTAR

Collaborators and Co-editors/Graduate and Post-doctoral Advisors and Advisees: NA
EDUCATION:
Massachusetts Institute of Technology  Ph.D. 2001  Technology, Management and Policy
Massachusetts Institute of Technology  S.M. 1994  Technology and Policy
Columbia College  B.A. 1987  Applied Mathematics
Columbia School of Engineering  B.S. 1987  Applied Mathematics

APPOINTMENTS:
2007 – present  Associate Research Professor
E.J. Bloustein School of Planning and Public Policy, Rutgers University
2004 - 2007  Assistant Research Professor
E.J. Bloustein School of Planning and Public Policy, Rutgers University
2002- 2004  Assistant Professor
School of Business, Manhattan College

OTHER AFFILIATIONS:
Director of the Center for Energy, Economic and Environmental Policy and Associate Director of the Rutgers Energy Institute, Rutgers University.

SELECTED PUBLICATIONS:

COLLABORATIONS & OTHER AFFILIATIONS:
D. Coit (Rutgers), M. Greenburg (Rutgers), M. Lahr (Rutgers), N. Mantell (Rutgers), H. Guirguis (Manhattan College), R. Zimmerman (NYU), Hatic Tekiner (PhD external committee member, 2007 – present), Jose Francisco Espiritu (University of Texas at El Paso).

MEMBERSHIP IN COMMITTEES AND PROFESSIONAL ORGANIZATIONS:
New Jersey State Sustainability Institute, Technical Advisory Board, (July 2006 to present)
Member Editorial Board, KIEE International Transactions on Power Engineering (2005 to date)
Referee, Energy Journal (2000 to date)
Referee, IEEE Transactions on Power Systems (2002 to date)
Member, Institute of Electrical and Electronics Engineers (1994 to date)
Member, Institute for Operations Research and the Management Sciences (August 2002 to date)
Member, U.S. Association of Energy Economics (September 2002 to date)
Alan M. Finn, Ph.D.
United Technologies Research Center

Education and Training
Cornell University Ph.D. in Electrical Engineering 1983
Cornell University M. Eng. in Electrical Engineering 1980
Rensselaer Polytechnic Institute B.S. in Electrical Engineering 1977
Rensselaer Polytechnic Institute B.S. in Mathematics 1977

Research and Professional Experience

United Technologies Research Center - August 1986 to Present

Research Fellow performing original research and consulting in digital signal processing, diagnostics and prognostics, embedded computer architecture, wireless communications, and fault-tolerance for embedded computer systems. Responsible for strategic technical planning, external resource development, program planning and management, intellectual property strategy, technology transfer, publication of research, staffing, and budgeting.


Managed Estimation and Decision group: 8 direct reports. Responsible for strategic technical planning, technical leadership and mentoring, program planning, staffing, budgeting, personnel development, and performance reviews.

Developed hands-free Cabin Communication System (CCS). CCS uses beamforming microphones, acoustic echo cancellation, and Wiener noise filtering for enhanced passenger communication in minivans, helicopters, etc. Developed DSP algorithms, performed systems-level optimization, and built hardware demonstrator. Provided demonstrations to OEMs and helped secure launch customer. Received 4th Outstanding Achievement Award.

Invented reliable remote-entry products with cryptographically secure user authentication for automotive division. Generated over $155 million in sales through 2001. Performed analysis of competitor’s products. Achieved patent protection and increased market share for division. Received 3rd Outstanding Achievement Award.

Contributed to design of next generation sonar signal processor. Established high-level simulation methodology; wrote custom simulator; developed critical hardware and software optimizations for shared memory multiprocessor. Major contributor to successful $20 million proposal and $15 million sole-source award.
Led strategic planning team for Active Noise and Vibration Control (ANVC) research. Developed long-term plan; won funding; established program; designed message passing multiprocessor laboratory controller. Designed ANVC products for helicopter division. Received 1st and 2nd Outstanding Achievement Awards.

Publications

Author or co-author of 19 externally published papers and 39 patents.


Synergistic Activities:

Technical lead on UTRC-funded capability project on mathematical foundations of closed-loop control over stochastic networks. Academic participants included Prof. Umesh Vaidya and Prof. Prashant Mehta, U. Illinois UC; Prof. Sekhar Tatikonda, Yale, and Prof. Nicola Elia, Iowa State.

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:
Pengju Jang, GE Global Research, Teja Kuruganti, ORNL
Amit Fisher - manager of the Business Transformation and Optimization group at the IBM Haifa Research Labs. His main expertise is in the areas of architecture and modelling (conceptual and formal modeling), model management, modeling tools architecture, enterprise architecture, and service oriented architecture and operation research. Mr. Fisher is involved in shaping IBM’s future Business and IT modeling tools and platforms, and leading several projects in this realm. Amit has a B.Sc. degree in Industrial Engineering and Management and a M.Sc. Degree in Information System Engineering from the Technion, Israel.
PROFESSIONAL PREPARATION
PhD, Materials Science and Engineering, University of Pennsylvania
A.B. Chemistry, Bryn Mawr College

APPOINTMENTS / HIGHLIGHTS:
Sept. 2009 to present: VP, Industry Solutions and Emerging Business, IBM Research Division, Yorktown Heights NY. Responsible for working across IBM Research on behalf of IBM clients, to create innovative industry-focused solutions.


Prior roles with IBM (since 1986) have included: corporate assignments on technology assessment and strategy, and roles in IBM Microelectronics in the management of process development, design/modeling methodology and production of chip carriers, assemblies and test.

CURRENT RESEARCH INTERESTS
No relevant publications or patents

SYNERGISTIC COLLABORATIONS
Member of the Division of Engineering and Physical Sciences board at the National Academy of Engineering. Past chairperson of the National Materials Advisory Board. Member of several review committees for the National Research Council, including materials science for the Army Research Lab, supply chain optimization for the Dept of Defense and research strategy for the Dept of Homeland Security.

HONORS AND AWARDS
Member, National Academy of Engineering

IDENTIFICATION OF POTENTIAL CONFLICTS OF INTEREST
None at a personal level. IBM has close collaborations with a number of leading players in the buildings energy space, and with most leading universities. However none of those projects specifically overlaps with the proposed Hub activities.
JAMES D. FREIHAUT  
Associate Professor  
Department of Architectural Engineering  
The Pennsylvania State University  
University Park, PA. 16802  

Educational Background  
Christian Brothers College - B.A. (1966) Philosophy/Chemistry - Summa Cum Laude; Valedictorian  
Rensselaer Polytechnic Institute - M.Sc. (1972) in Nat. Sci./Physical Chemistry- NSF Fellowship  
Pennsylvania State University - Ph.D. (1980) Fuel Science - Dept. of Interior Fellowship  

Academic:  
Associate Professor, Department of Architectural Engineering, Pennsylvania State University (Present - July, 2002)  
Co-founder of DeLaSalle Education Center, Kansas City, Missouri (1970-1975)  

Industrial:  
United Technologies Research Center/Carrier Corp.- 1980 – June 6, 2002  
• Program Leader of UTC Indoor Air Quality Program (1992- June 30, 2002)  
• Technical Area Leader of Physics Based Modeling of Combustion (1995-2000)  
• Technology Integration Manager (1998-2000) – Aeromechanical, Chemical and Fluid Systems  
• Director of UTC Building Science Program(1994-1997)  
• Combustion and Environmental Sciences Group Leader (1991-1995)  

Selected Publications and Invited Presentations  


Awards
UTC Corporate Award for Environmental Technology Innovation for Winthrope, Maine Superfund Remediation technology innovation

ASME Eugene W. Jacobson award for best all-round paper at 1991, ETCE

Educator of the Year, Chamber of Commerce, Kansas City Missouri, 1973 for work in establishing innovative, certified curriculum at alternative high school founded in 1971

Issued Patents
7 U.S. Patents including Photocatalytic Indoor Air Quality devices, CFC disposal techniques, Fuel Processing, Humidity Control via Polymer Membranes

Professional Memberships
American Chemical Society and ACS Division of Environmental Chemistry
American Society of Mechanical Engineers
American Society of Heating, Refrigeration and Air Conditioning Engineers
American Association for the Advancement of Science
Association of Energy Engineers
Risk Analysis Society
James Gambino

James Gambino is Vice President of Technology Commercialization: Physical Sciences for Ben Franklin Technology Partners of Southeastern Pennsylvania (BFTP/SEP). The Technology Commercialization Group creates pathways to commercialization for new companies, entrepreneurs and researchers by building consortia and regional initiatives with universities, government and private partners. Jim is also responsible for developing and managing Ben Franklin’s Regional Energy Strategy, seeded with funding from the Commonwealth’s Alternative Energy Development Program under the Energy Investment Act.

Jim has successfully commercialized high value disruptive technologies across multiple markets as a senior executive in multinational companies, joint ventures, and start-ups. Prior to joining Ben Franklin, Jim was Vice President and CTO at Elementis Specialties, Inc., a specialty chemical company, where he was responsible for research and development, new business development, and licensing.

Jim is a past Director of the Commercial Development and Marketing Association (CDMA), trustee of the PDMA-CDMA Educational Foundation, and 2008 winner of the CDMA Golden C award for Commercial Development Excellence. Jim is also a board member and trustee of the Chemist Club of New York, and a partner of PolySolutions Advisors LLC, a consultancy to technology start-ups and emerging companies.

Jim earned his Bachelor of Science degree in Chemical Engineering from the Polytechnic Institute of New York, and completed the Business Management Executive Program at the University of Pennsylvania’s Wharton School.

Ben Franklin Technology Partners of Southeastern Pennsylvania is the region’s catalyst for Stimulating Entrepreneurial Potential. For over 25 years, we have invested in innovative enterprises and created commercialization pathways and partnerships that generate wealth through science and technology.

Ben Franklin is part of the Commonwealth of Pennsylvania’s Ben Franklin Technology Partnership. We provide entrepreneurs and established businesses with the Capital, Knowledge and Networks to compete in the global marketplace. We have provided more than $130 million to grow more than 1,600 regional enterprises across all areas of technology.

Our partnerships with universities and others strengthen the innovative fabric of our region. We are founding partners of The Nanotechnology Institute™ (NTI), Mid-Atlantic Nanotechnology Alliance (MANA®), Pennsylvania Green Growth Partnership (PAGGP), Pennsylvania Advanced Textiles Research and Innovation Center (PATRIC), Pennsylvania Environmental Technologies for the Pharmaceutical Industry (PETPI), and the PA Biotechnology Center of Bucks County. We are founding partners of the Energy Commercialization Institute (ECI) and other partnerships emerging through our Regional Energy Strategy, funded through the Commonwealth’s Alternative Energy Development Program. Ben Franklin is also a founding partner of the Emerald Stage2 Venture Fund, the Minority Angel Investor Network, and is a partner of the Mid-Atlantic Angel Group (MAG) Fund I & II and DreamIt Ventures.

www.sep.benfranklin.org
A. Professional Preparation:

Carnegie Mellon University  Civil Engineering  B.S., 1982
Carnegie Mellon University  Civil Engineering  M.S., 1983

B. Appointments:

2006 – present  Department Head, Civil and Environmental Engineering, Carnegie Mellon
2006 – present  Co-Director, Center for Sensed Critical Infrastructure Research, Carnegie Mellon
2000 – 2006  Associate Dean, College of Engineering, Carnegie Mellon
2004 – Apr.-July  Acting Dean, College of Engineering, Carnegie Mellon
1999 – 2006  Director, Advanced Infrastructure Systems Lab, Carnegie Mellon
1996 – present  Professor of Civil and Environmental Engineering, Carnegie Mellon
1987 – 1990  Assist. Professor of Civil Engineering, U. of Illinois at Urbana-Champaign
1986 – 1987  Research Engineer, Schlumberger, Houston Downhole Sensors

C. Publications:

Relevant:


**D. Synergistic Activities:**

1. Co-Chief Editor, ASCE Journal of Computing in Civil Engineering
2. International Bridge Conference, Executive Committee Member

**E. Collaborators and Other Affiliations:**

1. Collaborators: Akin (CMU), Akinci (CMU), Bielak (CMU), Faloutsos (CMU), Fedder (CMU), Fischbeck (CMU), Kiliccote (Atoga), Klausner (Bosch), Kovacevic (CMU), Krishnamurti (CMU), Liu (UIUC), Maxion (CMU), McNeil (Delaware), Moura (CMU), Oppenheim (CMU), Paredis (GaTech), Soibelman (CMU), Sohn (CMU), Smailagic (CMU), Small (CMU), Thayer (RedZone).

2. Graduate and Postdoctoral Advisors: S. J. Fenves (for Ph.D.)

3. Former Graduate Advisees:
   R. Buchheit (PhD), C. Buergy (PhD), P. Chen (MS, PhD), T. Chmielenski (MS), V. Collins (MS), R. Ganeshan (PhD), C. Gordon (PhD), W. Guo (PhD), M. Hakim (MS, PhD), G. Hooymans (MS), N. Ivezic (MS, PhD), O. Juarez (PhD), H. Kiliccote (MS, PhD), M. Krofchik (MS), D. Latimer (MS), V.-C. Liang (MS), R. Quinn (MS), R. Ranjithan (PhD), J. Reinhardt (PhD), D. Sackin (MS), W. Seiler (PhD), V. Singhvi (PhD), D. Stasiak (MS), J. Sungho (PhD), S. Teneja (MS), C. Tsai (MS), H. Wang (PhD), J. Wright (MS), X. Wu (PhD), J. Yau (PhD). Summary: 16 M.S. students; 18 Ph.D. students
ANTHONY J. GIRIFALCO
EXECUTIVE VICE PRESIDENT
DELAWARE VALLEY INDUSTRIAL RESOURCE CENTER (DVIRC)

Education and Training:
• Bachelor of Arts Degree, Literature, University of Pennsylvania, June 1977
• Masters of Arts, Literature, Georgetown University – August 1980
• Doctoral Candidate & Teaching Fellow, University of Pennsylvania – 1980-1981

Research and Professional Experience:
• Executive VP, Delaware Valley Industrial Resource Center – 1989-Present
• Project specialist & Hearing Office, New Jersey Department of Corrections – 1986-1989
• Co-founder, President, & Editor -Information Research Institute, Inc. (IRI) – 1983-1986
• Manager, Marketing Representative/Trainer, East Coast Financial 1982-1983
• Teaching Fellow – University of Pennsylvania – 1980-1981

Publications: (including patents, copyrights, and software systems)
“Partnership for Quality –A Model for Instilling Total Quality at the Grass Roots” Quality Progress Magazine, February 1992
Current Index of computer Literature (CICL), Monthly magazine index, published 1984-1986

Synergistic Activities:
Serves as Member American management Association
Serves as Member, Council for Urban Economic Development
Serves as Member Pennsylvania Economic Development Association (PEDA)
Member Greater Philadelphia Chamber of Commerce

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:
Collaborators and Co-Editors:
N/A
Anthony P. Green, Ph.D.
Vice President, Technology Commercialization Group: Life Sciences
Ben Franklin Technology Partners of Southeastern Pennsylvania
Ben Franklin Director, The Nanotechnology and Energy Commercialization Institutes

Education and Training:
Brown University, Providence, RI Sc.B. with Honors in Immunology (1976)
Temple University School of Med. Phila, PA Ph.D. Microbiology and Immunology (1994)

Research and Professional Experience:
2009 – present Ben Franklin Director, The Energy Commercialization Institute, Philadelphia, PA
2008- present Visiting Research Professor, School of Biomedical Engineering, Science and Health Systems, Drexel University, Philadelphia, PA
2006 -present Ben Franklin Director, The Nanotechnology Institute, Philadelphia, PA
2006-present Vice President, Technology Commercialization Group, Ben Franklin Technology Partners/SEP, Philadelphia, PA
2003-06 Distinguished Scientist, Puresyn, Inc., Malvern, PA
1995-03 Vice President, Product and Business Development, Puresyn, Inc., Malvern, PA
1991-95 Director, Product Development, Puresyn, Inc., Malvern, PA
1985-89 Marketing Research Consultant, Migliara-Kaplan, Towson, MD
1985 Manager, in vitro Product Development, Centocor, Malvern, PA
1982-85 Supervisor, in vitro Product Development, Centocor, Malvern, PA
1981-82 Group Leader, Product Support, Centocor, Malvern, PA
1979-81 Immunologist, BBL Microbiology, Cockeysville, MD

Publications:


**Synergistic Activities:** List no more than five professional and scholarly activities related to the effort proposed.

Advisory Boards:
Life Sciences Congress/Philadelphia Convention Center Bureau
Coulter Foundation/Drexel University Translational Research in Biomedical Technologies Program
Fox Chase Cancer Center Innovation Fund
University City Science Center QED Fund
Co-Chairman, Chester County Keystone Innovation Zone
Y-Carbon, Inc.

**Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:** Provide the following information in this section:

**Collaborators and Co-editors** None.
**Graduate and Post-doctoral Advisors and Advisees:** None.
Biographical Sketch: John Grosh
Acting Department Head for Computing Applications and Research
Lawrence Livermore National Laboratory

Education and Training:
- M.S., Mathematics, University of Delaware, Newark, Delaware, January 1994.
- B.S., Chemical Engineering, The Pennsylvania State University, December 1983.

Research and Professional Experience:
- Oct 2009 to present: Acting Department Head, Lawrence Livermore National Laboratory, CA. Manage over 400 scientist and engineers conducting research, development, and engineering in large-scale scientific and engineering simulation, computational and computer science, software engineering, control systems, cyber security, etc.
- Apr 2006 to Sep 2009: Director, Center for Applied Scientific Computing, Lawrence Livermore National Laboratory, CA. Managed basic and applied research division of about 80 PhDs in applied math, computer and computational scientists; portfolio of about $30M per year; research focus on large-scale multi-physics / multi-scale simulation, uncertainty quantification, tools and algorithms for massively parallel computer systems, cyber security.
- Aug 1998 to Dec 2000: Program Manager, DoD High Performance Computing Modernization Office, Arlington, Virginia. Managed approx. $40M/year program in applications software development (computational fluid dynamics, computational chemistry, image processing, wargaming, etc.), computing tools, technology development and transition, training, minority programs.

Selected Publications and Patents


**Synergistic Activities:**

**Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:**

**Collaborators and Co-Editors:**
Stan Ahalt (RENCI), Charles Holland (DARPA), Fred Johnson (SAIC), Steve Ashby (PNNL), David Brown (LLNL), Lori Diachin (LLNL), James Rathkopf (LLNL), Doug Post (DoD).
Serkan Gugercin
Associate Professor of Mathematics
Interdisciplinary Center for Applied Mathematics
Virginia Tech, Blacksburg, VA  24061-0531
Phone: (540) 231-7667, Fax: (540) 231-7079
gugercin@math.vt.edu
http://www.math.vt.edu/people/gugercin/

Education
2003, Ph.D., Electrical Engineering, Rice University
2000, M.S., Electrical Engineering, Rice University
1997, B.S., Electrical and Electronics Engineering, Middle East Technical University, Turkey

Research and Professional Experience:
Serkan Gugercin is an Associate Professor of Mathematics and a member of the Interdisciplinary Center for Applied Mathematics. He has published several papers in the area of model and controller reduction for large-scale dynamical systems. In 2007, Dr. Gugercin received the National Science Foundation Early CAREER Award in Computational and Applied Mathematics for his research proposal in the area of model reduction, entitled “CAREER: Reduced-order Modeling and Controller Design for Large-scale Dynamical Systems via Rational Krylov Methods”. His Ph.D. dissertation, “Projection Methods for Model Reduction of Large-Scale Dynamical Systems” received the Ralph Budd Award for Research in Engineering from Rice University, in 2003 for the best doctoral thesis in the School of Engineering. He is also the recipient of Teaching Award from Jacobs University Bremen, in 2003. Dr. Gugercin currently serves as an Associate Editor for the IEEE Conference Editorial Board. He was one of the co-organizers of 18th International Symposium on Mathematical Theory of Networks and Systems (MTNS 2008) in Blacksburg, VA, July 2008. Dr. Gugercin also co-organized several model reduction mini-symposia at scientific conferences, the last one being the five-session Model Reduction Mini-Symposium for the SIAM Meeting on Computational Science and Engineering in Miami, FL, March 2009. A recent SIAM News article in June 2009, “CSE 2009: Theory, Algorithms, Applications: Advances in Model Reduction” by Beattie and Gugercin highlighted the mini-symposium.

Dr. Gugercin’s research focuses on developing robust, numerically effective methods to produce high-fidelity/optimal reduced-order models and controllers for simulation and control of large-scale dynamical systems. His research has a wide range of application areas involving flexible structures, fluid dynamics, circuit simulation and large-scale optimization. Dr. Gugercin has applied his research to several examples ranging from LA University Hospital building model to International Space Station Modules and to storm surge modeling of Bay St. Louis.

Employment:
2008 - Present:  Associate Professor of Mathematics, Virginia Tech., Blacksburg, VA
2009 – 2010:  Visiting Scientist, Technical University Berlin, Germany
2003-2008:  Assistant Professor of Mathematics, Virginia Tech., Blacksburg, VA
2003:  Research Instructor, Jacobs University Bremen, Germany
Ten Selected Publications Most Relevant to the Proposed Project:


Synergistic Activities


Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:

A.C. Antoulas (Rie University), U. Baur (Technical University Chemnitz), P. Benner (Technical University Chemnitz), C.A. Beattie (Virginia Tech), J. Borggaard (Virginia Tech), E. de Sturler (Virginia Tech.), Z. Drmac (University of Zagreb), T. Iliescu (Virginia Tech), J.-R. Li (INRIA), D.C. Sorensen (Rice University), T. Stykel (Technical University Berlin), K. Wilcox (MIT), A. van der Schaft (University of Groningen)

M.S. and Ph.D. Advisor:

Athanasios C. Antoulas (Rice University)
Patrick L. Gurian
Assistant Professor, Department of Civil, Architectural, and Environmental Engineering
Drexel University

Education and Training
Harvard University  Chemistry     A.B. 1989
Stanford University  Environmental Engineering   M.S. 1990
Carnegie Mellon University  Engineering & Public Policy and  Civil & Environmental Engineering  Ph.D. 2001

Research and Professional Experience
2004-present:  Assistant Professor, Civil, Arch., and Environmental Eng., Drexel University
2001-2004:  Assistant Professor, Civil Engineering, University of Texas at El Paso.
1993-1997:  Staff Engineer, McNamee, Porter, Seeley, Inc., Ann Arbor, MI.

Selected Publications

Synergistic Activities: Developed new course offerings in statistics, decision analysis, and policy analysis. Contributed to curriculum and participates in ongoing activities of Drexel summer outreach program to high school students considering engineering as a career. Research advisor to high school students in Drexel’ Summer Mentorship program and Central High School’s gifted program.

Collaborators: Elizabeth Casman, Carnegie Mellon; Yi-Chang Chiu, U of Arizona; Steve Cook, UT El Paso; Veronica Corella-Barud, UT El Paso; Julie Downs, Carnegie Mellon; Jay Graham, Johns Hopkins; Josiah Heyman, UT El Paso; John Lockwood, RAND; Kristina Mena, UT Health Sciences Center; Teresa Montoya, UT El Paso; Zuber Mulla, UT Health Sciences Center; Frank Perez, UT El Paso; Agami Reddy, Arizona State; Joan Rose, Michigan State; Gilberto Velazquez, UA Ciudad Juarez; Irene Xagoraraki, Michigan State.

Graduate advisor: Mitchell Small, Carnegie Mellon University;
Graduate students advised: Probas Adak, Barnes Ferland and Associates; Victor Martinez, CH2MHIll; Elia B. Marquez, Universidad Autonoma Metropolitana; Nicholas Dudley Ward, Pattle Delamore Partners Ltd.; Arun Kumar, MSU; Ian Solon, NBACC; Jade Blackwood, Drexel (in progress), Tao Hong, Drexel (in progress), Jingjie Teng, Drexel (in progress); no postgraduate scholars sponsored.
Paul M. Hallacher
Director, Research Program Development
The Pennsylvania State University
304 Old Main
University Park, PA 16802
Office of the Senior Vice President for Research
(814) 865-6042
hallacher@psu.edu

Professional Preparation
Kutztown University of Pennsylvania, B.S., Business Administration, 1976
Johns Hopkins University, M.A.S., Management, 1982
Pennsylvania State University, Ph.D., Public Administration, 2000

Appointments
2008-Present Managing Director, NSF Center for Nanotechnology Applications and Career Knowledge, Penn State
2006-Present Lecturer, Department of Political Science, Penn State
1993-Present Director, Research Program Development, Office of the Vice President for Research, Pennsylvania State University
1989-1993 Associate Director, Economic Development, Institute of State and Regional Affairs, Penn State Harrisburg
1986-1989 Director, Office of Enterprise Development, Pennsylvania Department of Commerce
1981-1986 Director, Federal Programs, Bureau of Appalachian Development, Pennsylvania Department of Commerce
1977-1978 Planning Assistant, City Planning Bureau, Reading, Pennsylvania

Publications Relating to the Proposed Grant
Hallacher, Paul M. Leveraging university research for industrial competitiveness and growth: final report of findings and recommendations. The Pennsylvania State University. National Science Foundation sponsored project. Project Number 0650124.


Dr. Hendrik F. Hamann
IBM T.J. Watson Research Center
1102 Kitchawan Road, PO Box 218
Yorktown Heights, NY, 10598
914-945-2430 (phone)
914-945-4006 (fax)
hendrikh@us.ibm.com

PROFESSIONAL PREPARATION:
• Ph.D. (summa cum laude), University of Göttingen, Germany
• Diploma (with special honors), Chemical Physics, University of Göttingen, Germany

APPOINTMENTS / HIGHLIGHTS:
May 2004 to present: Manager for Photonics and Thermal Physics, IBM T.J. Watson Research Center, NY
- Lead IBM's data center research with particular focus on energy management
- invention of a Mobile Measurement Tech for increasing efficiency of data centers
Jan. 2001 to May 2004: Research Staff Member, IBM T.J. Watson Research Center, NY
- development and product implementation of thermally-assisted magnetic data storage
- invention of an all-thermal phase-change memory cell
- demonstrated world record in magnetic storage density using thermal assisted-recording
- 3D finite element optical, thermal, electrical and mechanical modeling

CURRENT RESEARCH INTERESTS:
• Physical Aspects of Energy and Thermal Management of large-scale computing system
• Nanoscale heat transfer including sub-continuum effects
• Nanomechanical properties and devices for ultra-sensitive mass detection

SELECTED RELEVANT PUBLICATIONS:
Uncovering Energy Efficiency Opportunities in Data Centers

Hotspot-limited microprocessors: Direct Temperature and Power distribution measurements (invited), H.F. Hamann, A. Weger, J.A. Lacey, Z. Hu, P. Bose

Rapid 3-Dimensiona thermal characterization of large-scale computing facilities

SYNERGISTIC ACTIVITIES
Regular reviewer for: Journal of Applied Physics, Journal of Microscopy, Physical Chemistry Chemical Physics, Optics Express, Applied Physics Letters; Membership of the American Physical Society (APS), IEEE, Optical Society of America (OSA)

HONORS AND AWARDS:
1 Innovation in Industry Award Finalist of NY Academy of Sciences (2008)
4 Supplemental Outstanding Innovation Awards (7,063,127; 7,068,865; 6,757,235; 6,433,310) (2x2008,2006,2005)
2 IBM Outstanding Technical Achievement Awards (2008, 2006)
STEVE HARASIN

EDUCATION AND TRAINING

1968-1972 BS. Chemistry Duquesne University Pittsburgh, PA  
1972-1974 MS. Organic Chemistry Penn State University State College, PA

RESEARCH AND PROFESSIONAL EXPERIENCE

BAYER MaterialScience, Pittsburgh, PA, Principal Scientist 1975 - Present
Responsibilities have ranged from managing all technical development and technical service activities of a group of 9 people. Including 3 Technical Service Reps, 1 Development Leader, 1 Senior Chemist and 4 Lab Techs to Developing new polyurethane formulas for applications in a variety of markets. Product line includes all RIM elastomers, Baydur Structural Foams and Composites.
Other responsibilities have included:
• Supervise all programs to develop new or modify existing products.
• Supervise all activities of technical service group that provide technical assistance to current and potential customers.
• Assign project priorities; communicate needed information to all interested groups including Development Group.
• Update Marketing & Sales on status of technical activities.
• Assure adequate customer coverage by technical service group.
• Ensure customer satisfaction with Bayer technical service.
• Administer Performance Management Process within group, including goal setting, performance reviews, merit adjustments, salary reviews and training programs.
• Ensure monthly reports, expense reports & trip reports are issued within required deadlines.
• Ensure technical exchanges and technology transfers occur.
• Communicate priority changes, as well as needed information to ensure successful completion of programs.
• Serve as Specialty Group representative on Lab Management Team.
• Serve as Bayer industry representative to Underwriters Laboratories Industry Advisory Group.
• Ensure group participation & participate in Continuous Improvement activities.
• Ensure group compliance with all safety & environmental requirements. These include monthly safety inspections, improvements in cleanliness reports, attendance at safety meetings and incur no recordable accidents.
• Serve as main source of technical information to customers on products, process and Bayer activities.
• Monitor technical service time & cost at each customer.
• Assign accounts to tech service reps and ensure fair distribution of accounts between representatives.
• Manage Technical Budget of $1.8MM. Monitor spending, control SARE expenses.

Armstrong Cork Company, Lancaster, PA 1974 - 1975
Research Chemist responsible for development of new polymers for flooring applications.

PUBLICATIONS and PATENTS
• 8 Issued patents on new technology development for polyurethanes.
• 4 additional patents pending
Volker Hartkopf,
Professor of Architecture, Director, Center for Building Performance and Diagnostics, Carnegie Mellon University

Professional Preparation
- (1964) Vordiplom in Architecture, University of Stuttgart
- (1969) Dipl. Ing., Architect, University of Stuttgart
- (1972) M. Arch., University of Texas, Austin, TX, (Fulbright Scholar, 1970-72)
- (1989) Dr. Ing.,(Ph.D.), University of Stuttgart, Germany
- (2004) Dr. h.c., Sierra Nevada College, NV for life long dedication to sustainability

Appointments
- Chair, United Nations Environmental Programme (UNEP) Sustainable Building Construction Initiative (SCBI) Think Tank, Paris, France, September 2007 to present.
- Director, Center for Building Performance and Diagnostics, Carnegie Mellon University; 1981 to present.
- Executive Interchange Scholar, Public Works Department, Ottawa, Canada, 1981-85 (maintained university relationship).
- Director, Advanced Building Studies Program, CMU, 1975-81.

5 publications most closely related to the proposed project
  o The GSA Adaptable Workplace Laboratory, pages 12-28 (with V. Loftness, A.Aziz, J.Shankavaram)  
  o The Collaborative Building: Mediating Between Climate and Interior Quality, pages 29-44 (with V.Loftness, S.Lee, A.Mahdavi, P.Mathew, J.Shankavaram, A.Aziz)

5 other significant publications

Synergistic Activities
- (1974-81) Co-founder and director of the first multi-disciplinary graduate program in architecture engineering and urban planning funded by the NSF with $500,000 grant and co-funded by industry with $1 million. This program was the founding institutional framework which led to the multi-disciplinary PhD programs in Building Performance and Diagnostics and with Civil Engineering in Architecture Engineering Construction Management.
- (1976) Created the first passively/actively heated/cooled and ventilated house within an inner city context with funding from city of Pittsburgh, PA.
• (1978-81) Created the first urban energy effective neighborhood re-development with passive/active and energy conserving new construction and rehabiliated housing in an inner city context. This was a national demonstration and research project funded by the Departments of Energy and Housing and Urban Development ($1 million research funding).

• (1988-Present) Co-founder and Director, Advanced Building Systems Integration Consortium : development of an integrated research and development agenda for global building related corporations and US governmental agencies. This led to the first National Science Foundation, Industry University Cooperative Research Center (NSF/IUCRC) in the building industry and resulted in major breakthrough projects, including the world renowned Robert L. Preger Intelligent Workplace at Carnegie Mellon University, the first living (always adapted) and lived-in (measured, monitored and critically assessed by its faculty, students and staff) laboratory in the building industry, initiated globally fund raised and directed by Volker Hartkopf (a $7.5 million R&D and a $8.0 million demonstration effort over twelve years). Major demonstration projects resulted globally (Korea, China, Japan, Germany, and North America with CBPD leadership).

• Professor, tenured, Carnegie Mellon University, Department of Architecture, 1981-present; Chairman MS/PhD Programs 1983-1987: (Associate Professor without tenure 1976-1981; Assistant Professor 1972-1976).

Teaching in the first professional programs, B.Arch and M.Arch.: Design studio, lecture courses in Building Performance, Building Diagnostics, Third World Housing. Teaching in M.Sc./PhD Programs: MS/PhD Theory Course, Project Courses, Systems Courses (joint with School of Urban and Public Affairs), lecture courses in Building Performance and Building Diagnostics. Currently chairing nine PhD student committees benefiting from the advice of CBPD colleagues.

Collaborators International and National

• Abraham E. Haspel, Ph.D., Deputy Assistant Secretary, Energy, Environmental and Economic Policy Analysis, U.S. Department of Energy, Office of Policy and International Affairs, 1000 Independence Ave., S.W. Washington, DC 20585, and

• Yang Guoxiong, National Research Center for S&T for Development, Ministry of Science and Technology (MOST), P.R. China, P.O. Box 3814, Beijing, P.R. China 100038 to create the Beijing Energy Efficient Office Building for the MOST, as a national demonstration.

• Dr. Saadi Lahlou, EDF R&D / MTI, 1, ave du Gl. de Gaule, 92141 Clamart Cedex, France, to create the laboratory for the design of cognition.

• Dr. Jiang Yi, Professor of Tsinghua University School of Architecture, Head of Department of Building Science and Technology, Postbox 2670, Beijing, P.R. China 100084, to create the Tsinghua University Low Energy Demo Building

• Nobert A. Streitz, German National Research Center for Information Technology, Darmstadt, Germany.

• Shin’ichi Konomi, German National Research Center for Information Technology, Darmstadt, Germany.

• Heinz-Jurgen Burkhart, German National Research Center for Information Technology, Darmstadt, Germany.

• Jane Siegel, HCI Institute, Carnegie Mellon University, Pittsburgh, PA, USA.

• Dr. David Archer, Adjunct Professor of Engineering, CBPD, Carnegie Mellon University, Pittsburgh, PA, USA.

• Vivian Loftness, University Professor of Architecture, CBPD, Carnegie Mellon University, Pittsburgh, PA, USA.

• Dr. Khee Poh Lam, Professor of Architecture, CBPD, Carnegie Mellon University, Pittsburgh, PA, USA.

• David Claridge, Dan Turner, Malcolm Verdict, Energy Systems Laboratory, Texas A&M University, College Station, Texas

Graduate Advisors and Postdoctoral Sponsors

• (1985-89 Dissertation) Prof. Dr. Ing. Ewald Bubner, University of Essen, Germany together with Prof. Hans Kammerer, University of Stuttgart, Germany.

• (1970-72) Prof. and Dean of Architecture Yamaguchi, University of Texas at Austin, USA as Fulbright scholar.

• (1969) Prof. Dr. Ing. Kurt Siegel, University of Stuttgart, Germany

Thesis Advisor and Postgraduate-Scholar Sponsor


2006 - Yin, Hongxi “Absorption Chiller in Micro BCHP Model Based Design & Performance Analysis”

1999 - Seongju Chang “A Hybrid Computation Model for Building Systems Control”

1998 - Nyuk Hien Wong “Computational Airflow Modeling for Integrative Building Design”

1994 - Khee Poh Lam "Computational Design Support System for Interactive Hygro-thermal Analysis of Building Enclosures”

1991 - Chris Kesner "The Current State of Museum Exhibition Lighting"


John E. Hayes Ph.D.

EDUCATION AND TRAINING
Ph.D. Organic Chemistry, University of Delaware, Newark, Delaware 1986 Thesis: Heterocyclic Synthesis from Azines
B.S. Chemistry, Summa Cum Laude, Wagner College, S.I. New York, 1979

RESEARCH AND PROFESSIONAL EXPERIENCE
BAYER Material Science Senior Principal Scientist Composites Research, - July 2004 - Present
- Project leader of team that developed polyurethane resin formulations and processes for pultrusion applications. Lead programs that converted pultrusion customers from polyester resins to polyurethane resins as well as customers new to pultrusion. Have given presentations and demonstrations at pultrusion seminars hosted by Martin Pultrusion Group. Provided training to other Bayer application groups in Europe and Asia.

December 2003- June 2004
- Project leader for team to develop a system for Utility Trailer.
- Responsible for formulation development for foam system for refrigerated trailers.
- Member of flooring composite team to develop a product for pontoon boats.

January 2003- November 2003
- Responsible for leading the development and execution of intellectual property, idea management, and knowledge management activities for Innovation Americas.
- Manage the interface between a number of groups (INN, BD, GO, Legal/Patent) to ensure that BPO’s IP rights are protected, coordinated, communicated, and understood
- Lead a number of research projects on issues that effect the Rigid foam industry. Research areas included adhesion, flammability, flow, and blowing agent changes.

BAYER Corporation, Newtown Square PA, Manager of Step-out Research, August 2000- January 2002


PUBLICATIONS and PATENTS
Hayes, John; Snyder, Craig; “Structural, environmental, and processing advantages of polyurethane pultrusion”. JEC Composites Magazine, No. 38 pages 38- 39, (Jan –Feb 2008).

I hold over 20 US patents and patent applications that have resulted in commercial production of over one billion pounds of product including the following related to pultrusion.

Hayes, John E.; Magnotta, Albert; Barksby, Nigel “ Immiscible polyurethane pultrusion formulations and processes” US 20080090966 A1


Hayes, John E.; Magnotta, Albert; Barksby, Nigel “Polymer polyol containing polyurethane pultrusion formulations and Processing”, US 20080087373 A1.
Biographical Sketch: William Douglas Henshaw
Research staff member, Centre for Applied Scientific Computing, Lawrence Livermore National Laboratory

Education and Training:


Research and Professional Experience:

- Sept 1998 to present: Staff Member, Lawrence Livermore National Laboratory, Livermore, CA. Perform research into the numerical solution of partial differential equations, with emphasis on low-speed and high-speed reactive flows, electromagnetics, elasticity, conjugate heat transfer, fluid-structure interactions, adaptive algorithms and grid generation.
- April 1994 to 1998: Staff Member, Los Alamos National Laboratory, Los Alamos, NM. Perform research into the numerical solution of partial differential equations with emphasis on low-speed and high-speed reactive flows and grid generation.
- Sept 1986 to March 1994: Research Staff Member, IBM T.J. Watson Research Center, Yorktown Heights, NY. Perform research into the numerical solution of partial differential equations with applications to low-speed flows and turbulence.
- July 1985 to July 1986: Postdoctoral Research Fellow, California Institute of Technology.

Selected Publications:


**Identification of Potential Conflicts of Interest or Bias of Reviewers:**

**Collaborators and Co-editors**: D. A. Appelö (Caltech), J.W. Banks (LLNL), R.L. Braun (U. Delaware), K. K. Chand (LLNL), V. Eliasson (USC), A.K. Kapila (RPI), P.E. King-Smith (OSU), K.L. Maki (U. Minnesota), D.W. Schwendeman (RPI), J.N. Shadid (SNL), P. Ucciferro (U. Delaware).

**Graduate Advisor**: Professor H.-O. Kreiss (Royal Institute of Technology, Stockholm).
Terry L. Herdman
Interdisciplinary Center for Applied Mathematics
Virginia Tech, Blacksburg Virginia 24061
Phone: 540 231 7667 Fax: 540 231 7079
terry.herdman@vt.edu

Education:
1967 B.S., Mathematics, Fort Hays State University
1970 M.A., Mathematics, University of Oklahoma
1974 Ph.D., Mathematics, University Of Oklahoma

Research and Professional Experience:
Terry Herdman is the Associate Vice President for Research Computing at Virginia Tech and a Co founder and Director of the Interdisciplinary Center for Applied Mathematics (ICAM). He has produced more that 60 research publications and directed 17 thesis students. He directed Virginia Tech’s undergraduate program in applied and computational mathematics at the Blacksburg Campus and the graduate program in interdisciplinary applied mathematics at Virginia Tech’s Northern Virginia Campus. He served six years as Vice President for Education for the Society for Industrial and Applied Mathematics (SIAM) and is currently a member of the SIAM Education Committee and co – directs the SIAM Visiting Lecturers Program. He is a member of the Board of Governors for Mu Alpha Theta and a member of the SURA Board. He serves as the Virginia Tech liaison to the Oak Ridge National Laboratory and is a member of the Council and Board for Oak Ridge Associated Universities.

Dr Herdman’s research interests are in modeling, analysis, parameter identification and approximations for systems governed by complex systems of integral and differential equations. His research has been funded by the Air Force Research Laboratories (AFRL), the Air Force Office of Scientific Research (AFOSR), the FBI, NASA LARC and the Defense Advanced Research Projects Agency (DARPA). He is a member of the NASA Large Space Systems Team that was awarded the 2008 NASA Center Team Award for contributions in the development and testing of inflation deployed, rigidizable space structure and materials. He is an Associate Editor for the Journal of Integral Equations and Applications. Dr. Herdman has served as a consultant with Solers Inc. and Booz Allen and Hamilton.

Employment:
2005-present Associate Vice President for Research Computing, Virginia Tech
1988-present Professor, Mathematics, Virginia Tech
1987-present Director, Interdisciplinary Center for Applied Mathematics, Virginia Tech

Visiting and Consulting Appointments:
2003-2004 Consultant, Booz Allen and Hamilton, McLean, Virginia

Ten selected Publications:


Synergistic Activities

- Served six years as Vice President for Education for the Society for Industrial and Applied Mathematics (SIAM) and is currently a member of the SIAM Education Committee and co-directs the SIAM Visiting Lecturers Program.
- Member of the Board of Governors for Mu Alpha Theta, SURA, ORAU
- Serves as the Virginia Tech Liaison to the Oak Ridge National Laboratory
- Associate Editor for the Journal of Integral Equations and Applications.

Identification of Potential Conflicts of Interest or Bias in Selection of reviewers:

Burns, John (Virginia Tech), Cao, Yanzhao (Auburn), Cerezo, Graciela (self employed), Chiang, Shihching (Chung Hua University), Cliff, Eugene (Virginia Tech), Liu, Z. Y., (Minnesota - Duluth), Morin, P. (IMAL, CONICET-UNL, Santa Fe, Argentina), Nguyen, Hoan (CNA), Spies, R. D. (IMAL, CONICET-UNL, Santa Fe, Argentina), Temperini, K. G. (IMAL, CONICET-UNL, Santa Fe, Argentina), Turi, Janos (Univ. Texas-Dallas), Xu, Y. (Syracuse University)

Graduate Theses Directed in the past Five Years:


W. Travis Horton, Ph.D., P.E.
Assistant Professor of Architectural Engineering

Purdue University
School of Civil Engineering
550 Stadium Mall Drive
West Lafayette, Indiana 47907
Phone: (765) 494-6098
Fax: (765) 494-0395
E-mail: wthorton@purdue.edu

(i) EDUCATION AND TRAINING
05/02 Ph.D. in Mechanical Engineering
Purdue University, West Lafayette, IN
03/97 M.S. in Mechanical Engineering
Purdue University, West Lafayette, IN
08/95 B.S. in Mechanical Engineering
Utah State University, Logan, UT

(ii) RESEARCH AND PROFESSIONAL EXPERIENCE
01/09 – present Assistant Professor of Architectural Engineering, School of Civil Engineering, Purdue University, W. Lafayette, IN, USA
08/07 – 01/09 Research Assistant Professor, Mechanical Engineering, University of Maryland, College Park, MD, USA
11/04 – 08/07 Engineering Manager, Tecumseh Products Company Research Labs, Ann Arbor, MI
08/01 – 11/04 Research Engineer, Tecumseh Products Company Research Labs, Ann Arbor, MI
08/96 – 05/01 Graduate Research Assistant, School of Mechanical Engineering, Purdue University, West Lafayette, IN, USA
08/98 – 08/01 Graduate Teaching Assistant, School of Mechanical Engineering, Purdue University, West Lafayette, IN, USA
08/97 – 08/00 Adjunct Faculty Member, Ivy Tech State College, Lafayette, IN, USA
08/95 – 08/96 Graduate Research Assistant, Space Dynamics Lab, Utah State University, Logan, UT
08/95 – 08/96 Systems Engineer and Project Leader for the Unity IV Hybrid Rocket, Utah State University, Logan, UT, USA

(iii) PUBLICATIONS AND PATENTS
Dr. Horton joined the Department of Civil Engineering at Purdue University in January 2009 to participate in establishing the Architectural Engineering emphasis area. He is a registered Professional Engineer who has worked in the air conditioning and refrigeration field for over thirteen years, with six of those years spent in the corporate research and development lab of Tecumseh Products Company developing new vapor compression components, systems, and technologies. He completed his Master’s degree in Mechanical Engineering at Utah State University in 1996 and earned his Ph.D. in Mechanical Engineering in 2001 from Purdue University. He received the James Joule, Young Investigator award in 2003 from the International Institute of Refrigeration for his Ph.D. thesis work on the modeling of secondary loop refrigeration systems in supermarket applications. Prior to joining Purdue University he was a research faculty member at the University of Maryland where he directed the small autonomous energy systems consortium, and the integrated systems optimization consortium at the Center for Environmental Energy Engineering. As a faculty member in the Architectural Engineering emphasis area Dr. Horton is dedicated to improving the energy efficiency of residential, commercial, and industrial buildings and their systems. He is active in the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) and currently serves as chair of a task group on optimization. He has published over a dozen papers and has been awarded three patents related to improving the performance of vapor compression refrigeration and heat pumping systems.

(v) POTENTIAL CONFLICTS OF INTEREST

(a) Collaborators and Co-Editors
Professors James E. Braun, Professor Reinhard Radermacher, University of Maryland, Yunho Hwang, University of Maryland, Joe Orlando, University of Maryland.

(b) List of names of graduate and postdoctoral advisors and advisees
Professor J. Clair Batty, Utah State University, Professor Eckhard A. Groll, Purdue University, LT. Ethan Lust, U.S. Naval Academy, Annapolis, MD.
JOSEPH J. HOULDIN
CEO
DELAWARE VALLEY INDUSTRIAL RESOURCE CENTER (DVIRC)

Education and Training:
Bachelor of Arts Degree, Villanova University, May 1973
Masters Degree, City & Regional Planning, Catholic University of America, 1979

Research and Professional Experience:
• CEO, Delaware Valley Industrial Resource Center – 1988-Present
• Vice President, Financial Services and Program Development, Philadelphia Industrial Development Corporation (PIDC) - 1981-1988
• Teacher, St. John’s College High School, Washington DC – 1974-1979

Synergistic Activities:

Serves on Board of Directors for NACFAM (National Coalition for Advanced Manufacturing)
Serves on Technology Committee for SMART (Strengthening Mid-Atlantic Region Tomorrow)
Serves as Member IRC Network Workforce Development & Education
Serves as Member, President’s Council-NAM (National Association of Manufacturers)
Serves as Member, Philadelphia Industrial Development Corporation, Loan Committee
Past Chairman of State-wide IRC Network in Pennsylvania
Serves as a member of the Greater Philadelphia Engineering Deans Economic Development Council
Member Greater Philadelphia Chamber of Commerce

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:
Collaborators and Co-Editors:
N/A
Kevin W. Houser, PhD, PE, LC, LEED AP

Penn State University
104 Engineering Unit A
University Park, PA 16802
Phone: (814)863-3555
Email: khouser@engr.psu.edu
http://engr.psu.edu/candle

Education and Training

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<tr>
<th>University</th>
<th>Major</th>
<th>Degree &amp; Year</th>
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<tr>
<td>Penn State University (USA)</td>
<td>Architectural Engineering</td>
<td>B.A.E. 1993</td>
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<tr>
<td>Penn State University (USA)</td>
<td>Architectural Engineering</td>
<td>Ph.D. 1997</td>
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Research and Professional Experience

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<th>Period</th>
<th>Employer</th>
<th>Position</th>
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<tr>
<td>01/08-present</td>
<td>Penn State University</td>
<td>Associate Professor</td>
</tr>
<tr>
<td></td>
<td><em>Research, teaching, and service in the oldest continuously accredited Architectural Engineering program in the United States.</em></td>
<td></td>
</tr>
<tr>
<td>07/02-present</td>
<td>Loucetios LLC</td>
<td>Principal</td>
</tr>
<tr>
<td></td>
<td><em>Research, engineering, expert witnessing, and corporate education related to lighting in the built environment.</em></td>
<td></td>
</tr>
<tr>
<td>08/05-12/07</td>
<td>University of Nebraska-Lincoln</td>
<td>Associate Professor</td>
</tr>
<tr>
<td></td>
<td><em>Founding faculty member of the Architectural Engineering program. Research, teaching, and service related to building engineering with a focus on lighting.</em></td>
<td></td>
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<tr>
<td>12/98-08/05</td>
<td>University of Nebraska-Lincoln</td>
<td>Assistant Professor</td>
</tr>
<tr>
<td></td>
<td><em>Founding faculty member of the Architectural Engineering program. Research, teaching, and service related to building engineering with a focus on lighting.</em></td>
<td></td>
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<tr>
<td>06/97-11/98</td>
<td>Philips Lighting Company</td>
<td>Manager of Lighting Education</td>
</tr>
<tr>
<td></td>
<td><em>Program development, course content, and principal presenter for continuing education programs at the Philips Lighting Center.</em></td>
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Ten Publications Most Related to the Project


Synergistic Activities
Dr. Houser is a member of the Board of Directors of the Illuminating Engineering Society (IES), a technical society dedicated to advancing the state of the art in applied lighting. He is the Chair of the Board of Knowledge Committee, and in this role provides strategy and leadership for the technical direction of the Society.

Dr. Houser is the director of Project CANDLE, which is a collaboration between Penn State, the IALD Education Trust, and lighting industry partners. There are 16 industry partners and growing (for a current list, see: http://www.engr.psu.edu/candle).

Dr. Houser’s research has focused on the relationship between the spectral composition of light and human vision and has been recognized with the Taylor Technical Talent Award from IES and the Leon Gaster Award from the Chartered Institution of Building Services Engineers (United Kingdom). He is an experienced public speaker sought especially for his ability to present complex lighting ideas to audiences with diverse backgrounds. Companies and conferences where he has been an invited speaker include: California Lighting and Technology Center; Day-Brite Lighting; Elliptipar Corporation; Erco Lighting; Hyde Memorial Observatory; Illuminating Engineering Society; Lightfair International; Lightolier; Omaha Astronomical Society; Pacific Energy Center; Philips Lighting Company; Purdue University; Society of Automotive Engineers; and Steris Corporation.

Collaborators and Co-Editors in the Past 48 Months
Almeida D. (Penn State, PA), Ballentine N. (Hershey Medical Center, PA), Behr R. (Penn State, PA), Cheal C. (University of Sheffield, UK), DiLaura, D. (University of Colorado-Boulder, CO), Fotios, S. (University of Sheffield, UK), Mistrick, R. (Penn State, PA), Steffy G. (Ann Arbor, MI)

Graduate Students Advised and Postgraduate-Scholars Sponsored during the Last 5 Years
Bradley, D. (University of Nebraska-Lincoln), Eble-Hankins M. (University of Nebraska-Lincoln), Guo X. (University of Nebraska-Lincoln), Hu X. (University of Nebraska-Lincoln, NE), Ownings M. (University of Nebraska-Lincoln, NE), Pandya N. (University of Nebraska-Lincoln), Protzman J. (University of Nebraska-Lincoln, NE), Rich B. (University of Nebraska-Lincoln, NE), Rathsam J. (University of Nebraska-Lincoln), Royer M. (Penn State, PA), Sarkar A. (University of Nebraska-Lincoln), Turner J. (University of Nebraska-Lincoln, NE), Vukov, J. (University of Nebraska-Lincoln), Wilkerson A. (Penn State, PA)
Biographical Sketches of Jianghai Hu

Education and Training

- Xi’an Jiaotong University, P. R. China, Electrical Engineering, B.E., Jul. 1994
- University of California at Berkeley, Electrical Engineering, M.S., Dec. 1999
- University of California at Berkeley, Electrical Engineering, Ph.D., Oct. 2003
- Stanford University, Aeronautics and Astronautics, 2003-2004

Research and Professional Experience

- Assistant Professor, School of Electrical and Computer Engineering, Purdue University, 08/04-present
- Research Associate, Dept. of Aeronautics and Astronautics, Stanford Univ., 10/03-07/04
- Visiting Researcher, University of Brescia, Italy, 06/02-07/02
- Research Intern, Honeywell Research Center, Minneapolis, MN, 05/01-08/01
- Graduate Research Assistant, Department of Electrical and Computer Sciences, University of California at Berkeley, 05/98-07/03

Awards and Honors

- NSF Career Award, 2007
- Leon O. Chua Awards, Department of EECS, University of California at Berkeley, 2003
- Bernard Friedman Memorial Prize in Applied Mathematics, Mathematics Department, University of California at Berkeley, 2003

Publications


**Synergistic Activities**

• Finance Chair, 2010 IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM10), Montreal, Canada, Jul. 2010.

• International program committee member, 2006 and 2010 IEEE International Conference on Networking, Sensing and Control (ICNSC).

• Faculty advisor, Happy Hollow Elementary School (HHES) team of the Engineering Projects In Community Service (EPICS) program, Purdue University, Spring, 2006.

• Faculty advisor, SURF (Summer Undergraduate Research Fellowships), Purdue University, 2007 and 2009.


**Identification of Potential Conflicts of Interest**

(a) Collaborators: M. Harrison (Purdue), Y.-H. Lu (Purdue), J. Lygeros (ETH), M. Mahoney (Purdue), N. Pettis (Purdue), M. Prandini (Politecnico di Milano), J. Ridenour (Purdue), A. Rundell (Purdue), J. Shen (Univ. Maryland, Baltimore County), S. Simic (San Jose State), C. Tomlin (Stanford), W. Zhang (Purdue). No co-editors.

(b) Graduate and Postdoctoral Advisors: S. Sastry (M.S. and Ph.D. advisor, UC Berkeley), A. Weinstein (M.A. advisor, UC Berkeley), C. Tomlin (Postdoctoral advisor, Stanford).

(c) Thesis Advisor (5 Ph.D. Students) J.-Y. Chen (Purdue), W. Zhang (Purdue), M. Albatesman (Purdue), V. Putta (Purdue), G. Zhu (Purdue).
Mark Alan Hughes
School of Design, University of Pennsylvania

Education: Swarthmore College, B.A. in Art History and Religion, 1981
University of Pennsylvania, Ph.D. in Regional Science, 1986

Experience: Distinguished Senior Fellow, PennDesign and TC Chan Center, 2009-present
Chief Policy Advisor, Mayor Michael Nutter, Philadelphia, 2009
Founding Director of Sustainability, City of Philadelphia, 2008-2009
Opinion Columnist, Philadelphia Daily News, 2001-present
Distinguished Senior Fellow, Penn School of Arts & Sciences, 1999-present
Non-Resident Senior Fellow, Brookings Institution, 1998-2001
Vice President for Policy Development, Public/Private Ventures, 1993-1999
Visiting Associate Professor, Kennedy School, Harvard University, 1992-1993
Assistant Professor, Wilson School, Princeton University, 1986-1992


"Emerging Settlement Patterns and Their Implications for Inner City Poverty in the United States" in Anita A. Summers et al (eds), Urban Change in the United States and Western Europe (Washington DC: Urban Institute Press, 1993).


Activities: Greenworks designed and produced the City of Philadelphia’s comprehensive plan to meet 15 targets with 169 initiatives calibrated to achieve 5 goals by 2015

Campaign for Working Families expanded EITC participation by $15 million annually in Philadelphia, 2001-2002


National Bridges-to-Work Demonstration designed $15 million access-to-jobs program evaluation in five cities, 1992-1996

Conflicts or Bias in Reviewers: Co-authored Position Paper for COP-15 with Dr. John Byrne, University of Delaware
James G. Hunter, Ph.D.
Assistant Professor, Department of Civil Engineering
Morgan State University, Baltimore, MD 21251-0001

Education and Training
Purdue University. Civil Engineering, Environmental, Ph.D., 2006
Purdue University. Civil Engineering, M.S., 2002
Morgan State University, Civil Engineering, B.S., 2000

Research and Professional Experience
Assistant Professor – November 2009 to Present
Department of Civil Engineering, Morgan State University

Current research areas include low impact development (LID), green roofs, watershed systems design, and ecological engineering design to reduce impacts from urban and agricultural activities. Ongoing research activities includes the development of LTHIA-LID, a web-based decision support tool to assess LID practices enables decision makers to formulate effective watershed management plans to achieve desired stormwater management and water quality goals.

Postdoctoral Researcher - December 2006 to September 2009
Agricultural & Biological Engineering, Purdue University.
Web-Based GIS and Decision Support Systems (DSS) for Hydrological/Water Quality Impact Analysis: Developed Low Impact Development Decision Support and Planning Tool to evaluate urban BMPs (i.e. green roof, impervious surface reduction & disconnection) and develop/integration of other online DSS tools.

Publications

Synergistic Activities
1. Advisor to Undergraduate / Masters students working on green infrastructure and water conversation projects.
2. Working with collaborative partnership on the Louisiana Haiti Sustainable Village Project with rain water collection/harvesting and addressing infrastructure needs.
3. Faculty Advisor for the Morgan State University American Society of Civil Engineers (ASCE) Student Chapter, 2010-Present.

Collaborators / Graduate and Post-doctoral Advisors and Advisees:
Alleman J.E. (Iowa State University), Banks, M. K. (Purdue University), Chaubey, I. (Purdue University), Engel, B. (Purdue University), Farnsworth R. (Purdue University), Kang D. (University of Minnesota), Quansah, J.E. (USGS), Schwab, A.P. (Purdue University)
Traian Iliescu
Associate Professor of Mathematics
Interdisciplinary Center for Applied Mathematics
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061-0531
iliescu@vt.edu

Education
1995 B.S., Mathematics, University of Bucharest
1997 M.S., Mathematics, University of Pittsburgh
2000 Ph.D., Mathematics, University of Pittsburgh

Research and Professional Experience:
Traian Iliescu is an Associate Professor in the Department of Mathematics at Virginia Tech. He has published a research monograph and 50 research papers on mathematical modeling and numerical simulation of turbulent flows in engineering and geophysical applications. He is currently directing 4 Ph.D. students and has directed one MS student. He has advised several graduate and undergraduate summer research projects, both at Virginia Tech and Argonne National Laboratory. He was the winner of the SIAM Student Paper Prize in 1999 and was the Wilkinson Fellow at the Argonne National Laboratory from 2000 to 2002.

Dr. Iliescu’s primary research interests are in multi-scale and reduced-order modeling of complex flows, with a special emphasis on turbulent flows in engineering and geophysical settings. His current research projects target grand computational challenges that require rigorous mathematics, physical insight and numerical skills. A common theme in these projects is the accurate and efficient modeling of mixing in turbulent flows within the Boussinesq approximation. Dr. Iliescu has maintained a long-term collaboration with researchers at Argonne National Laboratory, especially with Paul Fischer in the Mathematics and Computer Science Division. This fruitful collaboration has materialized in several research publications and a summer internship for one of his students.

Employment For Past Five Years
2000-2002: Wilkinson Fellow, Argonne National Laboratory, IL
2002-2007: Assistant Professor of Mathematics, Virginia Polytechnic Institute and State University, Blacksburg, VA
2007-present: Associate Professor of Mathematics, Virginia Polytechnic Institute and State University, Blacksburg, VA

Ten Selected Publications:

Synergistic Activities:

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:

Collaborators and Co-editors:
I. Akhtar (Virginia Tech), C. Beattie (Virginia Tech), L. C. Berselli (University of Pisa), J. Borggaard (Virginia Tech), J. Duan (Illinois Institute of Technology), P. F. Fischer (Argonne National Laboratory), S. Gugercin, (Virginia Tech), W. J. Layton (University of Pittsburgh), H. Lee (Clemson University), T. Ozgokmen (University of Miami), J. P. Roop (North Carolina A & T State University).

Graduate and Postdoctoral Advisors and Advisees:
Dr. Joshua D. Isom / Principal Engineer / United Technologies Research Center

**Education and Training:**
University of Illinois at Urbana-Champaign, Ph.D. Chemical Engineering, 2009
University of Illinois at Urbana-Champaign, M.S., Chemical Engineering, 2004
Rensselaer at Hartford, M.S., Computer Science, 2002
Yale University, B.S., Chemical Engineering, 2000

**Research and Professional Experience:**
Principal Engineer, United Technologies Research Center, 2010- present
- Principal investigator for technology development projects for commercial building and aerospace systems
Technical Lead, Sikorsky Aircraft Corporation, 2007-2010
- Managed multimillion dollar annual technology investment for aircraft health management
- Led systems design effort and commercial building market studies for a new 400 kW phosphoric acid power plant
- Led systems engineering effort for an organic Rankine cycle power plant
- Directly supervised engineers working on systems and control design for fuel cell, Rankine cycle, and combined heat and power products
- Developed residential fuel cell products

**Publications (including patents, copyrights, and software systems):**


Synergistic Activities:
- Reviewer for IEEE Conference on Decision and Control
- Review for American Control Conference
- Reviewer for IEEE Journal of Controls Systems Technology
- Organizing committee, 2005 United Technologies Corporation Conference on Prognostics and Health Management
- Organizing committee, 2009 United Technologies Corporation Conference on Prognostics and Health Management

Collaborators and Co-editors
Professor Richard D. Braatz, University of Illinois at Urbana-Champaign; James P. Cycon, Sikorsky Aircraft Corporation; Mark W. Davis, Sikorsky Aircraft Corporation; Tim Flynn, Goodrich Aerospace Corporation; Dr. Robert E. LaBarre, United Technologies Research Center; Professor Sean P. Meyn, University of Illinois at Urbana-Champaign; Shawn Tayloe, Goodrich Aerospace Corporation

Graduate and Post-doctoral Advisors and Advisees:
Professor Richard D. Braatz, University of Illinois at Urbana-Champaign; Dr. Robert E. LaBarre, United Technologies Research Center; Professor Sean P. Meyn, University of Illinois at Urbana-Champaign
Biographical Sketch: Ali Jadbabaie
Skirkanich Associate Professor of Innovation
Department of Electrical & Systems Engineering, University of Pennsylvania.
Email jadbabai@seas.upenn.edu, Tel: 215-898-8105, Fax:215-573-2068

Professional Preparation
- California Institute of Technology, Control and Dynamical Systems, Ph.D., November 2000
- Sharif University of Technology, Tehran, Iran, Electrical Engineering, B.S., January 1995

Appointments
- Founding Co-director, Singh Program in Market and Social Systems Engineering University of Pennsylvania; 09/09 - present
- Skirkanich Associate Professor of Innovation in Electrical and Systems Engineering University of Pennsylvania; 02/09 - present
- Associate Professor Department of Electrical and Systems Engineering University of Pennsylvania; 07/08 - 07/09
- Assistant Professor, Department of Electrical and Systems Engineering University of Pennsylvania; 07/02 - 02-08

Publications
- A. Tahbaz-Salehi and A. Jadbabaie, Learning under social influence, IEEE Conference on Decision and Control, Shanghai, China, December 2009
- A. Jadbabaie, J. Lin, and A. S. Morse, Coordination of groups of mobile autonomous agents using nearest neighbor rules, IEEE Transactions on Automatic Control, Vol. 48, No. 6, June 03.
- A Jadbabie, A. Ozdaglar, and M. Zargham, A Distributed Newton method for network optimization, IEEE Conference on Decision and Control, Shanghai, China, December 2009

Synergistic Activities
- Current research on social learning in dynamic networked systems
- Extensive past and present research on collective behavior in networked systems
- Research on cooperative control of multiagent systems
- Research on mathematics of dynamic networks
- Major research on control of multi vehicle systems relevant to DoD
- Research on interplay of dynamical systems, optimization, control and graph theory

Collaborators
John C. Doyle, (Post Doctoral Sponsor and PhD Advisor); Richard M. Murray (Co-advisor); A. Stephen Morse (Post Doctoral Sponsor); John Hauser (Colorado); George Pappas (UPenn); Vijay Kumar (UPenn); Jonathan Smith (UPenn); Michael Kearns (UPenn); Asu Ozdaglar (MIT); S-T Yau (Harvard); Fan Chung Graham (UCSD); Mauricio Barahona (Imperial College); Herbert Tanner (Delaware); Babak Hassibi (Caltech); Steven Low (Caltech); Pablo Parrilo (MIT); Francesco Bullo (UCSB).
Mohsen A. Jafari

a. Education
   Ph.D. Industrial Engineering & OR, Syracuse University, Syracuse, 1984.
   M.Sc. Computer Science, Syracuse University, Syracuse, 1981.

b. Academic Experience
   Rutgers University, New Jersey, Industrial and Systems Engineering
   Professor (6/01 – present); Associate Professor; (93-5/01); Assistant Professor (87 – 93)
   Syracuse University (New York), Industrial Engineering and Operations Research
   Assistant Professor; 1985-1987

c. Areas of R& D Specialization
   Modeling & Optimization of complex systems; Decision Support Systems; Intelligent
   Distributed systems; Data Mining and Statistical Analysis; Logistics and Supply chain.
   Application areas: Transportation; industrial and healthcare systems.

d. Scholarly Publications
   ➢ 68 Refereed Publications in technical journals,
   ➢ Over 70 national and international invited and contributed presentations.

d. Research and Development Funding
   Project Director/Co-director and Principal Investigator/Co-investigator to research and
   development projects with funding from government agencies and industry; (Total
   budget over $12.0M)

e. Selected Sponsored Projects
   ➢ Co-Principal Investigator - “Towards Protection of Power Grids against Cyber Attacks –
   ➢ “Planning of Renewable Fuel Generating Facility for Transportation Infrastructure,”
     AEF 2009, with M. Mauzerk, $100k.
   ➢ Co-Principal Investigator - “A multi-layer web based software for traffic accident
     analysis and traffic safety planning,” 4/ 2004 – present, $400K/year; FHWA/NJ DOT.
     (with A. Maher)
   ➢ Principal Investigator – “An Int’l Multi University Research on Design and Verification
     for Enterprise Integration,” (with T.O. Boucher), The National Science Foundation,
     08/03- 08/05, $811,154.
   ➢ Principal Investigator – “Strategic Distribution Business Promotion Plan (SDBPP) of
     The PA NY/NJ,” 10/2006-12/2007, $200K, Port Authority of NY/NJ (with John
     Ricklefs – Moffatt & Nichol Engineering Co. NY)

g. Awards
   ➢ Excellence Award from the IEEE Society on Systems, Man and Cybernetics for
     contributions to service and scholarly research and development in the field, 10/2000.

i. Research Project Directorship
   ➢ Research Advisor and Project Director to 17 Ph.D. (doctoral) students; 14 already
     graduated joined US/Europe/China universities, US R&D companies.
   ➢ Research Advisor and Project Director to 9 M.S. (Master of Science) students
   ➢ Research Advisor and Project Director to 7 Post Doctoral and Research Fellows

j. Technical Consultant and Industry Experience
   ➢ Consultant to Siemens USA, Merck-Medco, General Motors, Honeywell, Schering-
     Plough, etc.)
   ➢ Consultant to government agencies (e.g., NYC Metropolitan Transit Authority)
   ➢ Consultant to international agencies (e.g., Port of Piraeus, Greece, Korea
     Telecommunication, United Nations Technology Transfer Program).
Biographical Sketches of Niraj K. Jha

Education

- **M.S.** Electrical Engineering, State University of New York at StonyBrook, 1982.
- **Ph.D.** Electrical Engineering, University of Illinois at Urbana-Champaign, 1985.

Appointments

- **1998-present** Professor of Electrical Engineering, Princeton University, Princeton.
- **1999-2005** Director, Center for System-on-a-chip Design, funded by NJ Commission on Science and Technology.
- **1993-98** Associate Professor of Electrical Engineering, Princeton University, Princeton.
- **1987-93** Assistant Professor of Electrical Engineering, Princeton University, Princeton.
- **1985-87** Assistant Professor of Electrical Engineering & Computer Science, University of Michigan, Ann Arbor.
- **1982-85** Research Assistant, Coordinated Science Laboratory, University of Illinois at Urbana-Champaign.
- **1981-82** Teaching Assistant, Electrical Engineering, S.U.N.Y. at StonyBrook.

Awards

- NEC Preceptorship Award for Research Excellence, School of Engineering and Applied Science, Princeton University, 1992.
- Princeton University Graduate Mentoring Award, 2004.
- Best Paper Awards: ICCD’93, FTCS’97, VLSID’98, DAC’99, ICPDCS’02, VLSID’03, CODES’06, ICCD’09.
- Nomination for Best Paper Awards: DAC’96, DAC’97, DATE’98, MICRO’08, ITC’09.
- Selection of two papers for IEEE MICRO Magazine’s Top Picks from 2005 and 2007 Computer Architecture Conferences.
- Selection of two papers for “The Most Influential Papers of 10 Years: Design Automation & Test in Europe Conference.”

Five Publications Most Closely Related to the Proposed Research


Five Other Significantly Related Publications

Synergistic Activities
- Books: Textbooks titled Testing of Digital Systems and Switching & Finite Automata Theory, 3rd. edition being used by universities worldwide, and two reference books on IC power analysis and optimization and CMOS testing.
- Ongoing commercialization of a low power behavioral synthesis methodology by ChipVision.

Research Interests
- Power/thermal analysis and optimization, design automation, computer architecture, nanotechnology, digital system testing, computer security.

Collaborators
- Collaborators in the last 48 months: Prof. Li-Shiuan Peh (Princeton), Prof. Ruby Lee (Princeton), Prof. Naveen Verma (Princeton), Dr. Anand Raghunathan (Purdue University), Dr. Srihari Cadambi (NEC), Dr. Franjo Ivancic (NEC), Dr. Martin Roetteler (NEC), Dr. Srimat Chakradhar (NEC), Mr. Murugan Sankaradass (NEC), Dr. Partha Kundu (Intel), Prof. Robert Dick (University of Michigan), Prof. Li Shang (University of Colorado), Dr. Srivaths Ravi (TI), Mr. Vijay Gangaram (Intel), Dr. Sreejit Chakravarty (LSI).
- Graduate Advisor: Prof. Jacob A. Abraham (University of Texas, Austin).
- Thesis Advisor in the last five years for: Prof. Lin Zhong (Rice University), Prof. Chao Huang (Virginia Tech), Dr. Fei Sun (Tensilica), Dr. Rui Zhang (Mentor Graphics), Dr. Loganathan Lingappan (Intel), Dr. Le Yan (Renaissance Technologies), Dr. Pallav Gupta (Villanova University), Dr. Divya Arora (Intel), Dr. Nachiketh Potlapally (Intel), Dr. Najwa Aaraj (Booz-Allen-Hamilton), Dr. Wei Zhang (Nanyang University).
Dr. Yu Jiao  
Principal Investigator
PPG Industries, Inc. | Glass Business & Development Center | 400 Guys Run Road | Cheswick, PA 15024  
(412) 820-8752 | jiao@ppg.com

Education and Training:
Xi’an Jiaotong University, China: B.S. - Electrical Engineering (1982)
University of Pittsburgh: M.S. - Electrical Engineering (1985)

Research and Professional Experience:
PPG Industries, Inc., Pittsburgh, PA
Manager of Process Engineering/Process Control Group, Glass R&D (2007-Present)
Currently managing a PPG Glass R&D group responsible for glass (flat glass, automotive glass, and aerospace transparencies) process technology research and development. The main responsibilities include advanced control system development, process mathematical modeling, process information system development, glass forming technology development, and other related areas for the PPG Glass Group. Technical skills include advanced control system design, process information system structure development, real time process control software development including the programming skills for various DCS control hardware platforms, working experience for electrical/magnetic field mathematical modeling development and CFD model, and project management expertise for large and complex process technology development programs.

Senior Production Engineer, Works No. 8, PPG. (1988-1991)
University of Pittsburgh, Pittsburgh, PA
Teaching Fellow and Research Associate, Electrical Engineering Department. (1984-1988)
Haushan Electrical Motor Vehicle Assembly Plant, Shanxii, China.
Production Supervisor.

Publications:
Author of PPG glass melting/forming process control system documents, which include PPG’s glass melter temperature control system, model-based glass level control system, automatic tweel control system, model-based excess oxygen control system, melter bubbler control system, batch moisture control system, and automotive glass windshield forming control system.


Ydstie, B. Erik and Yu Jiao, “Passivity Based Inventory and Flow Control in Flat Glass, Manufacture”; IEEE-CDC, Nassau, Bahamas, December 14-17, 2005.

**Synergistic Activities:**
Member of PPG Collegium (elected in 2008), Membership in the Collegium is the highest honor that PPG can bestow. Individuals eligible for election as PPG Distinguished Colleagues to the PPG Collegium must have demonstrated sustained contributions to the technical advancement of the company for over a period of not less than 10 years. Active members work with important research, development and engineering groups within the company, and the Collegium is establishing a sustained record of contributions to PPG's technical operations. Collegium membership is for life, and the organization meets biennially to elect new members.

Project Manager for PPG MSVD Coating Process Math Model.

Co-Developer for 3D MSVD Magnetic Field and Target Erosion Profile Measurement System.

Principle Developer for PPG MSVD Coating Process Control System.

**Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers**

*Collaborators and Co-editors: None*

*Graduate and Post-doctoral Advisors and Advisees:*

David Jurbergs, Ph.D

EDUCATION AND TRAINING

Ph.D. Chemistry, University of Texas, Austin, TX, 1991–1996
B.S. Chemistry, University of Texas, Austin, TX, 1987-1991

RESEARCH AND PROFESSIONAL EXPERIENCE

2007-present Bayer MaterialScience LLC., Austin, TX
Manager, Holographic Application Development
• Lead NAFTA efforts to develop new products and markets for Bayer Photopolymer.
• Created and currently run satellite lab to support development and new applications.
• Working as part of the product development team based in Germany.

2003-2006 Innovalight, Inc., Santa Clara, CA - Senior Director, Materials Development
• Managed technical team of 9 scientists & engineers.
• Developed process to produce silicon nanomaterials and proprietary “silicon ink” for low-cost, printable solar cells.
• Directed all aspects of the company’s technical effort to develop silicon nanocrystals for solid-state lighting. This resulted in silicon-based phosphors with world-record efficiency.

2001-2002 Schott Optovance, Southbridge, MA - Project Manager
• Directed technical team of 5 engineers in the development and manufacturing of custom 2D fiber arrays and 2D collimator arrays for MEMS-based telecommunications applications.
• Oversaw product development to exceed customer performance expectations, with delivery months ahead of schedule.

1998–2001 Optical Switch Corp., Richardson, TX - Product Development Engineer III
• Invented, patented and led the development of a new optical switch platform for telecommunications which generated over $20M of venture capital and successfully passed beta trials of several top-tier telecommunications customers.


PUBLICATIONS and PATENTS

WORK EXPERIENCE

[July 2003 – present] Senior Manager, Production Modeling, Mathematical Sciences Dept. IBM T.J. Watson Research Center, Yorktown Heights, NY.

- Lead and manage (with active research involvement) a team of researchers focused on applying analytics and optimization techniques to business problems in Production Design and Operations Scheduling applied to Steel Production, 300 mm Semiconductor Fab, Utilities (Smart grid)
- Manage a team of researchers focused on applying analytics and optimization techniques to business problems applied to the following areas: Supply Chain Management, and Reservoir and Operational Modeling for Oil Fields

[Jan. 96-Jun 2003] Research Staff Member, IBM T.J. Watson Research Center, Yorktown Heights, NY.

  - Researched and developed an optimization library for market clearing with multiple buyers and sellers (double auctions) for multi-attribute commodities such as steel and paper.

[Aug. 91 - Dec. 95] Research Assistant Professor, Dept. of Engineering & Public Policy, Carnegie Mellon University, Pittsburgh.

- $SO_2$ Compliance Markets [July 93 - Dec. 95]: Developed a model to simulate SO2 compliance market for electric utilities. Each utility was modeled to generate its least cost production curve for SO2 compliance over available clean coal technologies. Funded by DOE, this model was developed as part of an integrated risk framework to inform Congress on effectiveness of the Clean Air Act.

EDUCATION

Doctor of Philosophy, Dept. of Engineering & Public Policy, Carnegie Mellon University, Pittsburgh, PA.
Master of Mechanical Engineering, University of Delaware, Newark, DE.
Bachelor of Technology, Mechanical Engineering, Indian Institute of Technology, Kanpur, India.

HONORS

- Edelman Award 2002: Finalist for “Combinatorial and Quantity Discount Auctions Provide Benefits to Mars Incorporated and its Suppliers”.
- IBM Invention Plateau 2001: 3rd Plateau for filing over 12 invention disclosures.

SOME RECENT PUBLICATIONS

BIOGRAPHICAL SKETCH

Panagiota Karava
Assistant Professor of Civil Engineering (Architectural Engineering group)
Assistant Professor of Construction Engineering and Management
Purdue University
550 Stadium Mall Dr., West Lafayette, IN 47907

(i) Education and Training

<table>
<thead>
<tr>
<th>University</th>
<th>Major</th>
<th>Degree &amp; Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>National University of Athens</td>
<td>Applied Physics</td>
<td>B.Sc., 2000</td>
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<tr>
<td>Concordia University</td>
<td>Building Engineering</td>
<td>M.A.Sc., 2002</td>
</tr>
<tr>
<td>Concordia University</td>
<td>Building Engineering</td>
<td>Ph.D., 2007</td>
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</table>

(ii) Research and Professional Experience

<table>
<thead>
<tr>
<th>Period</th>
<th>Employer</th>
<th>Position</th>
</tr>
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<tbody>
<tr>
<td>08/09-date</td>
<td>Purdue University, USA</td>
<td>Assistant Professor (tenure track)</td>
</tr>
<tr>
<td>08/09-date</td>
<td>University of Western Ontario, Canada</td>
<td>Adjunct Research Professor</td>
</tr>
<tr>
<td>07/08-07/09</td>
<td>University of Western Ontario, Canada</td>
<td>Assistant Professor (tenure track)</td>
</tr>
<tr>
<td>01/08-06/08</td>
<td>Concordia University/Solar Buildings Research Network, Canada</td>
<td>Postdoctoral Fellow</td>
</tr>
<tr>
<td>09/00-12/07</td>
<td>Concordia University, Canada</td>
<td>Research Assistant</td>
</tr>
</tbody>
</table>

(iii) Publications (mostly related to the proposed project)


(iv) Synergistic Activities

1. Participation -graduate student (2005-2007), postdoctoral fellow (2008), faculty member (2008-2010) - in large-scale research projects related to energy and buildings such as the Canadian Solar Buildings Research Network (2005-2010, Strategic Research Network, $7M research funding provided by the Natural Sciences and Engineering Research Council of Canada - NSERC, government agencies, and industry) and the Insurance Research Lab for Better Homes (2008-2010; University of Western Ontario, $6M research funding provided by Canada Foundation for Innovation).

2. Most significant research contributions include the development of novel experimental and modeling techniques for integrated design and control of advanced building envelope systems (low-energy cooling systems with natural/hybrid ventilation, building-integrated Photovoltaic-Thermal systems) that perform simultaneous functions related to energy efficiency, on-site renewable energy production, and comfort delivery.

3. Contribution to the development of the new Architectural engineering emphasis area (curriculum, research facilities) within the school of Civil Engineering at Purdue University focused on high performance buildings. Development of new courses and research activities in the Division of Construction Engineering and Management related to sustainable building construction and energy management in the built environment (2008-2009).

4. Recipient of a prestigious University Faculty Award (2008) for young researchers from NSERC (Natural Sciences and Engineering Research Council of Canada) and a best paper award at the International Conference on Passive and Low Energy Cooling for the Built Environment (2005).

5. Member of ASHRAE and ASCE Technical committees, reviewer for 4 international journals, published over 25 articles in peer-reviewed journals and conference proceedings, member of scientific and organizing committee of four Solar Building conferences (2006-2009).

(v) Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers

(a) Collaborators and Co-Editors
A. Athienitis, T. Stathopoulos (Concordia University), G. Kopp, E. Savory, K. Siddiqui (University of Western Ontario), M. Lightstone (McMasters University).

(b) Graduate and postdoctoral advisors
T. Stathopoulos, A.K. Athienitis (Concordia University)
Mark L. Kimber
Assistant Professor, Department of Mechanical Engineering and Materials Science
University of Pittsburgh

Education and Training:
PhD in Mechanical Engineering (2008), Purdue University
MS in Mechanical Engineering (2004), Brigham Young University
BS in Mechanical Engineering (2002), Brigham Young University

Research and Professional Experience:
Assistant Professor, University of Pittsburgh (2008-present)
Research interests include characterizing heat and mass transport in nuclear energy generation, energy accountability and sustainability in electronic equipment, and energy efficient and biomimetic methods of propulsion.
Research Assistant, Purdue University (2004-2008)
Engineering Intern, Sony Corporation, Tokyo, Japan (2007)

Related Publications:

Recent Collaborators, Advisors, and Advisees:
Graduate Advisor
Suresh V. Garimella, School of Mechanical Engineering, Purdue University, West Lafayette, IN

Supervised Students (Thesis Advisor)
- Andrew Eastman, PhD student, Department of Mechanical Engineering, University of Pittsburgh, Pittsburgh, PA
- Ricardo Rivera-Lopez, PhD student, Department of Mechanical Engineering, University of Pittsburgh, Pittsburgh, PA
- D. Tyler Landfried, PhD student, Department of Mechanical Engineering, University of Pittsburgh, Pittsburgh, PA
EDUCATION AND TRAINING

- PhD in Condensed Matter Physics, University of Utah, Salt Lake City, Utah, 2002
- MS in Semiconductor Physics, University of Bucharest, Bucharest, Romania, 1996
- BS in Physics, University of Bucharest, Bucharest, Romania, 1995

APPOINTMENTS/HIGHLIGHTS

Research Staff Member, Jan 2008-Present IBM TJ Watson Research Center
- Investigated three dimensional air flow patterns, atmospheric contaminations and sensor interfacing with Mobile Measurement Technology sensor platform

Postdoc Researcher, Nov 2006-Jan 2008 IBM TJ Watson Research Center
- Mechanical and thermal properties of NEMS structure and their application for mass sensing and telecommunications.

University of Wisconsin-Madison, Departments of Physics and Engineering
- Single electron transistors fabrication and characterization in Si/SiGe heterostructures combined with ultra high sensitivity electrical measurement at cryogenic temperature.

Graduate Research Assistant, Sept. 1997 – Oct. 2002, Univ. of Utah, Department of Physics
- Electrical, capacitance and spectroscopy techniques for the localization and electrical characterization of the surface states on SiO₂ and HfO₂ surfaces employing a single electron.

CURRENT RESEARCH INTEREST

- Physical Aspects of Energy and Thermal Mgmt of large-scale computing system.
- Energy management of large scale Photovoltaics installation.
- Instrument, monitor, optimize and model water reservoir and water treatment plants.

REPRESENTATIVE PUBLICATIONS

Over 25 published articles in peer reviewed journals and more than 50 conference presentations


SYNERGISTIC ACTIVITIES

Andrew N. Kleit

a. Professional Preparation

<table>
<thead>
<tr>
<th>Institution</th>
<th>Degree</th>
<th>Year</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yale University, New Haven, CT</td>
<td>Ph.D.</td>
<td>1987</td>
<td>Economics</td>
</tr>
</tbody>
</table>

b. Academic Appointments

1992-1998 Assistant then Associate Professor, Department of Economics, Ourso School of Business Administration, Louisiana State University, Baton Rouge, LA
1998- Associate Professor; then Professor of Energy and Environmental Economics and MICASU Fellow, The Pennsylvania State University, University Park, PA,

c. Selected Journal Articles and Books

Electricity Restructuring: The Texas Story, (coeditor with Lynne Kiesling) 2009, American Enterprise Institute.

d. Institutional Innovations

Creator and Professor in charge of the undergraduate major in Energy Business and Finance, B.S. degree.
Director, Penn State University Electricity Markets Initiative, 2010-Present. This initiative represents a consortium of six electricity companies with initial funding of $250,000.

f. Recent grants

Biographical Sketches– Jeffrey A. Klinger /Vice President & General Manager/Turner Construction

Education and Training:
BS, Civil Engineering, Villanova University, 1978
• 30-Hour OSHA Certified

Research and Professional Experience:

School of Veterinary Medicine, University of Pennsylvania, Philadelphia, PA – Turner provided construction management services for the five-story, 122,400 SF vet school. This state-of-the-art facility includes small seminar rooms, library space, research laboratories, a vivarium, lecture halls, and a conference center. The challenging site lies on a brownfield site amidst roads, a subway tunnel and the operating veterinary hospital. Before building could occur, roads and intersections had to be relocated and the site had to be dewatered and waterproofed. The interior includes all new finishes, architectural millwork, terrazzo floors, acoustical ceilings and laboratory equipment. The mechanical and electrical systems include new AHUs, ductwork, mechanical piping, glycol system, laboratory gas distribution equipment, water processing equipment, new electrical distribution equipment, emergency power system and fixtures.

Science, Education and Technology Building, Cabrini College, Radnor, PA - The new facility consists of approximately 60,700 SF on three-and-one-half levels of the Cabrini College Campus. The steel-framed building is situated so as to complete one side of a new quadrangle adjacent to two of the original buildings on campus. The new facility provides socially interactive space in the three-story lobby area. The building houses Chemistry, Biology, Microbiology, and other laboratories, as well as classrooms and an auditorium. A partial basement includes storage, mechanical, and electrical rooms, while an astronomical observation deck is included at the penthouse level.

St. Luke’s Hospital, Allentown, PA – Preconstruction and construction phase services for a multi-phase, new construction and renovation project. The renovation work includes conversion of an existing clinic into an ambulatory surgery center, lobby/waiting area, and admissions. Other renovation phases include pharmacy, central sterile supply, and conversion of patient rooms from double to single occupancy. The renovation work also includes new chillers and mechanical and electrical upgrades.

Dod Hall Renovations, Princeton University, Princeton, NJ – Turner’s Philadelphia office completed the 41,000 SF exterior and interior renovation of historic Dod Hall. The four-story dormitory originally built in 1890 received new finishes, plumbing, fire protection, HVAC, and electrical systems. A European lift was installed in the space containing the existing monumental stair. Turner replaced the windows with custom mahogany wood windows similar to the windows found on the original building. In addition, new student bedrooms in the attic space were built that connect to existing suites on the fourth floor. A new glazed and heated vestibule was added to the west entrance. Turner Construction Company has served Princeton University as Construction Manager/General Contractor since 1948 with the construction of the Firestone Library.
Cornell University Sage Hall, Ithaca, NY - Feasibility study and preconstruction services for the renovation and repair of Sage Hall, a four-story masonry and wood structure building built in 1875.

Prudential Insurance Company, Eastern Home Office, Willow Grove, PA - Preconstruction and construction services for a three phase retrofit project. Phase I involved the renovation of approximately 400,000 SF of office space in two occupied, four-story buildings. Phase II involved the construction of a high tech, 275,000 SF West Wing Addition/Data Center. Phase III was the construction of a 12,000 SF, one-story, state-of-the-art audio/visual equipped Training Center.

Publications: (including patents, copyrights, and software systems)
None

Synergistic Activities: n/a

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers: n/a

Collaborators and Co-Editors: n/a

Graduate Advisors: n/a

Thesis Advisor for: n/a

Postgraduate-Scholar Sponsor: n/a
Bruce H. Krogh

Department of Electrical and Computer Engineering voice: (412) 268-2472
Carnegie Mellon University fax: (412) 268-3890
Pittsburgh, PA 15213 e-mail: krogh@ece.cmu.edu

Professional Preparation

Wheaton College (Illinois) Mathematics and Physics B.S., 1975
University of Illinois, Urbana Electrical Engineering M.S., 1978
University of Illinois, Urbana Electrical Engineering Ph.D., 1982

Appointments

1992– Professor, Dept. ECE, Carnegie Mellon University
1991–1992 Visiting Research Professor, Univ. of Dortmund, Germany
1988–1992 Associate Professor, Dept. ECE, Carnegie Mellon University
1983–1988 Assistant Professor, Dept. ECE, Carnegie Mellon University

Publications Related to Proposed Project


Five Other Significant Publications

Synergistic Activities

1. Co-Chair of the National Workshop on Beyond SCADA: Networked Embedded Control for Cyber Physical Systems, for the National Coordination Office for Networking and Information Technology Research and Development (NITRD) and NSF, November 2006.

2. General Chair, 2001 American Control Conference, the annual conference of the Joint Automatic Control Council representing control engineers in eight professional societies.

3. Steering Committee Chair, Hybrid Systems: Computation and Control, an annual interdisciplinary international workshop.

4. Co-developer of CheckMate, a MATLAB-Simulink-based verification tool for hybrid dynamic systems with nonlinear continuous dynamics. Available at www.ece.cmu.edu/webk/checkmate.


Collaborators

2. James Buffington, Lockheed-Martin Aerospace
3. Edmund M. Clarke, Carnegie Mellon University
4. Darren Cofer, Rockwell-Collins
5. Alexandre Donze, Verimag, Grenoble, France
6. Peter Feiler, Software Engineering Institute
7. James Freudenberg, University of Michigan
8. David Garlan, Carnegie Mellon University
10. Bill Milam, Ford Research Laboratories
11. Jose Moura, Carnegie Mellon University
12. Michael Whalen, Rockwell-Collins
14. Haotian Zhang (LSI Corporation)

Ph.D. Thesis Advisees and Post-graduate Scholars

1. A. Bhave (current)
2. E. Blood (current)
3. X. Cheng (Westinghouse Process Control)
4. A. Chutinan (The MathWorks)
5. A. Donze (Verimag, Grenoble, France)
6. E. Ferreira (Universidad de la Republica, Uruguay)
7. G. Freshe (Verimag, Grenoble, France)
8. J. Fan (Honeywell Corporation)
9. A. Fehnker (National ICT, Australia)
10. Z. Han (The MathWorks)
11. S. Ivol (current)
12. D. Jai (The MathWorks)
13. J. Kapinski (independent consultant)
14. S. Kovalewski (TU Aachen)
15. R. Kumar (United Technologies)
16. J. Li (Hewlett Packard)
17. J. Lui (current)
18. H. Pei (South China University of Technology, Guangzhou, China)
19. A. Rajhans (current)
20. Z. Ren (General Electric R & D Center)
21. B. I. de Silva, Jr. (Genius Corp, Brazil)
22. O. Stursberg (TU Munich, Germany)
23. J. Weimer (current)
24. H. Zhang (LSI Corporation)
25. Q. Zhao (Tsinhua University, Beijing, China)

Graduate Advisors

J.B. Cruz, Jr., The Ohio State University
P.V. Kokotovic, University of California at Santa Barbara
EDUCATION:
9/55 - 6/59 Bates College, A.B. (Major: Economics), Magna Cum Laude
9/59 - 6/63 M.I.T., Ph.D. in Economics (1965)

APPOINTMENTS:
Cecilia Yen Koo Professor of Decision Sciences and Public Policy, Wharton School
Co-Director, Wharton Risk Management and Decision Processes Center, Wharton School

RELEVANT PUBLICATIONS:


OTHER SELECTED PUBLICATIONS:

Howard Kunreuther and Erwann Michel-Kerjan, At War with the Weather, Cambridge: MIT Press, 2009


SYNERGISTIC ACTIVITIES

- Fellow of the American Association for the Advancement of Science (AAAS)
- Research Associate of the National Bureau of Economic Research
- Steering Committee Member, Adapting to Climate Change, Resources for the Future
- Distinguished Fellow of the Society for Risk Analysis

COLLABORATORS AND CO-AUTHORS DURING THE PAST 48 MONTHS:

Jon Baron  Wharton School, University of Pennsylvania
Eric T. Bradlow  Wharton School, University of Pennsylvania
Neil Doherty  Wharton School, University of Pennsylvania
Xiaohua Du  University of Pennsylvania
Min Gong  Columbia University
Martin Grace  Georgia State University
Robert Hartwig  Insurance Information Institute
Stefan Hochrainer  International Institute for Applied Systems Analysis (IIASA)
Robert Klein  Georgia State University
Carolyn Kousky  Resources for the Future
Joanne Linnerooth-Bayer  International Institute for Applied Systems Analysis (IIASA)
Stacey McMorrow  Wharton School, University of Pennsylvania
Reinhard Mechler  International Institute for Applied Systems Analysis IIASA)
Robert Muir-Wood  Risk Management Solutions
Alexander Pfaff  Duke University
Nicola Ranger  London School of Economics
Paul Raschky  Monash University (Australia)
Irv Rosenthal  Wharton School, University of Pennsylvania
Harvey Rubin  University of Pennsylvania Medical School
Gabriel Silvasi  Wharton School, University of Pennsylvania
Dylan Small  Wharton School, University of Pennsylvania
J. Shin Teh  University of Pennsylvania
Michael Useem  Wharton School, University of Pennsylvania
Pantea Vaziri  Risk Management Solutions
Matthew White  Wharton School, University of Pennsylvania
Haitao Yin  Erb Institute, University of Michigan
Michael Young  Risk Management Solutions


Howard Kunreuther’s graduate students receiving their doctorates under his supervision from 2003-2010:

Nitin Bakshi  Patricia Grossi
Michael Braun  Yong Kang
Brett Danaher  Chieh Ou-Yang
Matthew Feely  Xin Piao
Min Gong  Adam Powell
Haitao Yin
Biographical Sketches—Michael J. Kuntz/Senior Vice President of Sales & Regional General Manager/Turner Construction

Education and Training:
Penn State University, 1978
• 30-Hour OSHA Certified

Research and Professional Experience:
Senior Vice President of Sales & Regional General Manager, Philadelphia Business Unit - Mike is responsible for the operational and financial success of Turner in Pennsylvania, Maryland, West Virginia, Delaware and Southern New Jersey. He has management responsibility for personnel, field operations, pre-construction services, purchasing, estimating and accounting.

Prior to joining Turner, Mike worked for Pullman Power Products as a Superintendent/Engineer on several nuclear power plant projects.

Mike joined Turner in October 1987. His first assignment with Turner was Superintendent on the 125 Summer Street Project in Boston. Mike worked on various other projects in Boston including Children’s Hospital Enders Research renovation, Two International Place, Filene’s, Two Portland Square and Brookhaven at Lexington. In 1992, Mike was promoted to Project Superintendent on the Genzyme Biopharmaceutical Manufacturing Facility in Allston, MA.

In 1995, Mike took over leadership of the Pharmaceutical Market Group and relocated in August 1996 to the Philadelphia Office. In December 1998 Mike was promoted to Vice President, Pharmaceutical; and in 2000 was promoted to Vice President, Regional Sales Manager.

Mike has vital, extensive hands-on experience in the design, procurement, and start-up of major construction projects. His primary focus is to ensure that the Turner organization exceeds client expectations on a daily basis and delivers on its commitments.

Publications: (including patents, copyrights, and software systems)
None

Synergistic Activities: n/a

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers: n/a

Collaborators and Co-Editors: n/a

Graduate Advisors: n/a

Thesis Advisor for: n/a

Postgraduate-Scholar Sponsor: n/a
Khee Poh Lam, PhD., RIBA
kplam@cmu.edu
School of Architecture
Carnegie Mellon University, Pittsburgh 15213-3890
412-268-8503 (tel.) 412-268-6129 (fax.)

A. Professional Preparation
Bachelor of Arts (Architecture and Environmental Design) (Hons) (1979), University of Nottingham, UK
Bachelor of Architecture (Hons) (1982), University of Nottingham, UK
UK Registered Architect (since 1984)
Chartered Member of the Royal Institute of British Architects (since 1984)

B. Appointments
2003-Present   Professor, School of Architecture, Carnegie Mellon University
1984-2003      Associate Professor, joint appointment in the Department of Architecture and Department of Building, School of Design and Environment, National University of Singapore
1998-2000     Acting Dean, Faculty of Architecture, Building and Real Estate
               Director of the Graduate School of the Built Environment
2000-2002     Head, Department of Building.
2007-2010     Visiting Professor, Xian Jiaotong University, China
2009-2011     Visiting Professor, Chinese University of Hong Kong.

C. i. Related Publication

C. ii. Other Significant Publication


D. Synergistic Activities

1. Teaches architectural design (with a focus on systems integration), building performance modeling, building controls and diagnostics as well as acoustics and lighting.

2. Research in total building performance (TBP) studies and the development of computational design support systems.


4. Consultant to the Energy Foundation, USA specifically to assist in the China Sustainable Energy Program.

5. Building performance consultant for several major award winning projects in the private and public sectors in Singapore, and remains active with current projects in the US, China and Taiwan.

6. In collaboration with the architect Ken Yeang – submitted the winning entry for an international design competition for the National Library Building in Singapore. The completed building was awarded “Platinum” rating for green building by the Building and Construction Authority, Singapore under the Green Mark Scheme as well as the ASEAN 2007 Energy Award (1st place).

E. i. Collaborators

1. Gregory Dobbs – Principal Scientist, United Technologies Research Center, Hartford, CT.

2. Michael Höynck, Senior Engineer, Research and Technology Center, Robert Bosch Corporation, Pittsburgh, PA.

3. Burton Andrews, Engineer, Research and Technology Center, Robert Bosch Corporation, Pittsburgh, PA

E.ii. Graduate and Postdoctoral Advisors

PhD. Advisor: Professor Volker Hartkopf, School of Architecture, Carnegie Mellon University, Pittsburgh, PA

E.iii. Thesis Advisor and Postgraduate-Scholar Sponsor

Doctoral Students: Chaoqin Zhai (graduated 2007), Yun-Shang Chiou (graduated 2009); Yi-Chun Huang, Bing Dong, Rui Zhang, Rongpeng Zhang, Omer Karaguzel.

Post-doctoral Scholars: Prasasto Satwiko (Fulbright).
Amy Elaine Landis  
Assistant Professor, Civil and Environmental Engineering  
University of Pittsburgh

**Education and Training:**
- Denison University  Chemistry  B.S. 2001
- University of Illinois at Chicago  Civil & Materials Engineering  M.S., 2003
- University of Illinois at Chicago  Civil & Materials Engineering  Ph.D., 2007

**Research and Professional Experience:**
- Assistant Professor, University of Pittsburgh, Department of Civil and Environmental Engineering, since August 2007
- Environmental Manufacturing Management Fellow, Institute for Environmental Science and Policy, University of Illinois at Chicago, 2002-2007
- Research Fellow, USEPA National Risk Management Research Laboratory: Systems Analysis Branch 2005-2006; Sustainable Environments Branch May - August 2002
- Fulbright Fellow, Swiss Federal Institute of Technology, Life Cycle Systems Group, 2004-2005

**Related Publications:**

**Synergistic Activities:**
Dr. Landis is involved in many forms of outreach within the community. She hosts an NSF RET Site that trains area high school teachers to incorporate engineering into their classroom. Dr. Landis collaborates with several local nonprofits on sustainability issues and biofuels production.

**Recent Collaborators, Advisors, and Advisees:**
- Eric Beckman (UP), Melissa Bilec (UP), John Brigham (UP), Louise Comfort (UP), Dave Dzombak (CMU), Michael Gonzalez (USEPA), W. Michael Griffin (CMU), Kent Harries (UP), Chris Hendrickson (CMU), Michael Horman (Penn State University), Manuele Margni (University of Montreal), Joe Marriott (UP), H. Scott Matthews (Carnegie Mellon Univ), Matthew Mehalik (Sustainable Pittsburgh), Shelite Miller (Clemson University), Kim Needy (UArk), Robert Nicklewicz (Tegment Corp.), Oleg Prokopyev (UP), Ron Reich (Alcoa Corp), Karl Rockne (University of Illinois at Chicago), Kristin Rogers (Purdue University), Thomas P. Seager (Rochester Institute of Technology), Radisav Vidic (UP). Advisors: Thomas L. Theis (Institute for Environmental Science and Policy at the University of Illinois at Chicago), Heriberto Cabezas (USEPA Sustainable Environments Branch)
Seong. W. Lee  
Professor and Graduate Program Coordinator  
Department of Industrial, Manufacturing and Information Engineering  
Morgan State University  
School of Engineering  
Baltimore, MD 21251

Professional Preparation
The Catholic University of America, Washington DC, Mechanical Engineering, Ph.D. 1989
The Catholic University of America, Washington DC, Mechanical Engineering, M.S. 1986
Pusan National University, Pusan, South Korea, Mechanical Engineering, B.S. 1979

Appointments
1997-present  Graduate Program Coordinator, Industrial, Manufacturing and Information Engineering Department, Morgan State University, Baltimore, MD
1997-present  Director, Center for Advanced Energy Systems & Environmental Control Technologies, Morgan State University, Baltimore, MD
1991-present  Department of Industrial, Manufacturing and Information Engineering, Morgan State University, Baltimore, MD
Professor (2003-present), Associate Professor (1995-2003), Assistant Professor (1991-1995)
1989-1991  Research Engineer, Mechanical System Division of Naval Civil Engineering Laboratory, U.S. Navy

Selected Publications

Synergistic Activities
1. Dr. Lee is the Director of the Center for Advanced Energy Systems and Environmental Control Technologies, and Director of Advanced Instrumentation Laboratory at Morgan State University, which has completed several research projects supported by state and federal agencies, private sectors. These research activities supported more 40 graduate and undergraduate students in past 5 years.

Research Experience
Dr. Lee’s specialized fields and research areas include Energy Systems Design & Analysis, Heat Transfer & Combustion, Multiphase Hydrodynamics, Modeling and Simulation of Thermo-fluid Science, Laser and Optical Diagnostic Instrumentation
Stephen R. Lee, AIA, LEED® AP  
Professor & Head, School of Architecture  
Track Chair, Master of Science in Sustainable Design Program

Educational Background
:: Bachelor of Architecture (1975) Carnegie Mellon

Professional Background
:: Professor, Department of Architecture, Carnegie Mellon University (CMU), Pittsburgh, PA  
:: Visiting Associate Professor, University of Tokyo; Endowed Chair, Urban Environment Systems, RCAST (1993)  
:: Co–Founder/ Principal Emeritus, TAI + LEE, Architects PC, Pittsburgh, PA  
:: Senior Consultant, Romualdi, Davidson and Associates, Forensic Engineering, Homestead, PA

Design, Research and Teaching Activities
Professor Lee’s activities focus on issues of systems integration, material innovation, renewable energy and the integrated design process for high performance commercial and residential architecture. He is a LEED accredited professional and provides sustainable design consulting services for institutional and commercial clients in Europe, Asia, Canada and the United States. Innovative sustainable projects on which Professor Lee has been involved include the Armstrong World Industries Susquehanna House (Lancaster, PA), the Jean Canfield Government of Canada Building (Charlottetown, PEI), the PA Department of Environmental Protection South Central Office Building (Harrisburg, PA), Alcoa Fjardael Smelter (Reydarfjordur, Iceland), Pittsburgh Green Innovators, International Union of Operating Engineer’s Training Facility and Phipps Conservatory (Pittsburgh, PA) and the Robert L. Preger Intelligent Workplace, Stever House, Henderson House, the CIC Building and the Gates Center (Carnegie Mellon Campus). His consulting work with the PA Department of Environmental Protection resulted in a new standard for healthy, flexible, adaptable and energy and environmentally effective buildings in the Commonwealth. Professor Lee has developed and conducted professional enrichment curricula for the PA Departments of General Services and Environmental Protection and the federal General Services Administration.

Professor Lee was appointed in July 2009 to a five-year term as Head of the School of Architecture and is the track chair of the CMU Master of Science in Sustainable Design degree. He has been the faculty adviser for the CMU School of Architecture’s Solar Decathlon teams (2002, 2005 & 2007) and his teaching activities have resulted in the integration of undergraduate courses related to design, environment, materials, structures and construction.

Committees
Professor Lee has recently been selected to the Pittsburgh Solar America Cities Committee by Mayor Luke Ravenstahl and is the past co-chair of the Carnegie Mellon Green Practices Committee. He was recently a Merit Review Committee Member for the American Recovery and Reinvestment Act Lab Call #009-002. He was a member of the Committee on New Technology and Innovation in Building, of the Building Research Board, National Research Council (1990–91), the Advisory Committee of the Pittsburgh Green Building Alliance (1995–99) and he was the co-founder / director of the Pennsylvania Advanced Technology Housing Consortium (1989–91).

Selected Publications/ Presentations
:: “Solar Assets & Liabilities”; NE Solar Cities Conference; Pittsburgh, PA; 15 October 2009.  
:: “Health, Productivity and the Triple Bottom Line”; NEDA’s 2008 Professional Networking Series: Sustainable Building Policy as a Strategic Economic Advantage; Pittsburgh, PA; 13 March 2008  
:: Lee, Stephen; "Demonstrating Design for Flexibility in the Susquehanna House"; Continuous Customization in Housing - Open Building Tokyo 2000; Tokyo, Japan; October 2000.  
PROFESSIONAL EXPERIENCE

IBM T.J. WATSON RESEARCH CENTER, Yorktown Heights, NY 2002-Present
Research Staff Member
Developed, managed various supply chain management, building energy, service sciences and business transformation projects using quantitative analysis, optimization and simulation methods.

BASF CORPORATION, Mount Olive, NJ
Manager, Mathematical Modeling Group & Senior Staff Specialist 1997 – 2002
Developed and managed numerous strategic, tactical and operational decision support systems using mathematical programming, discrete-event simulation tools and information technology.

EDUCATION


SELECTED RELEVANT PUBLICATIONS


SELECTED RELEVANT PATENTS

• Lee, Y.M., Ghosh, S., Ettl, M., “Modeling Distribution of Emergency Distribution of Emergency Relief Supplies for Disaster Response Operations” “System and Method for Multi-Stage Cross Shipping of Disaster Relief Supplies”, YOR820081207 (filed to USPTO on October 2009)
Dr. Jonathan Lenchner  
IBM T.J. Watson Research Center  
19 Skyline Drive,  
Hawthorne, NY 10532  
914-784-7257  
lenchner@us.ibm.com  
http://www.research.ibm.com/people/l/lenchner

Education and Training  
Ph.D., Mathematics, Polytechnic University (now Polytechnic Institute of NYU), Brooklyn, NY, 2008.  
Certificate of Advance Study, Mathematics, Cambridge University, Winston Churchill Scholar, 1982. (Equivalent to an M.S. degree in the United States)  

Recent Professional Experience  
March 2008-Present: Senior Technical Staff Member, Agent-based Intelligent Power Management, IBM T.J. Watson Research Center, NY  
- Research lead for integration of Measurement and Management Technology (MMT) into Tivoli’s Maximo Asset Management for Energy Management product  
- Named Master Inventor, 2010  
December 2005-February 2008: Manager, Knowledge Management and Discovery for Services, IBM T. J. Watson Research Center, NY  
- Conceived and led work on widely deployed knowledge management portal for server system administrators leading to large cost savings and reduced mean time to resolve problems.  
April 2000-November 2005: Senior Engineer, IBM T.J. Watson Research Center, NY  
- Developed rule and policy-based advisory system for server system administrators and popular case-based reasoning system for help desk employees  
July 1997-March 2000: Senior Engineer, IBM Personal Systems Group, Research Triangle Park, NC  
- Led the development of IBM’s e-commerce web sites

Select Publications  


Synergistic Activities  
Christine Liaukus, R.A., Certified Passive House Consultant  
NJIT Center for Building Knowledge, Senior Research Architect

**Education and Training:**
Bachelor of Architecture, Cum Laude, New Jersey Institute of Technology, 1992  
Master of Architecture, University of Oregon, 2001

**Research and Professional Experience:**
NJIT Center for Building Knowledge, 2005-present  
Senior Research Architect. Supports the Center’s housing and community development efforts with a focus on energy efficiency and environmental responsibility. Provides program support, outreach and training for the New Jersey Clean Energy Program

Chris Benedict Architects, 2002 –2005  
Project Architect. Responsible for schematic design, energy analysis, design development, construction documents, and construction administration for various residential projects.

Steven Winter Associates, 1997 - 2002  
Associate. Advised production builders on energy efficiency through the DOE Building America Program. Contributed to various US and state programs focused on high performance building.

The Levy Partnership, 1996 - 1997  
Energy Analyst, Consultant. Performed energy modeling for manufactured home research groups, gas and electric utilities and the Electric Power Research Institute (EPRI).

**Publications (patents, copyrights, and software systems):**
- Affordable Green Academy (lead developer and subject matter expert), Center for Building Knowledge, 2009 (website, affordablegreenacademy.org)
- The Role of Architects in Advancing Technology Innovation in Housing (contributing author), US Department of Housing and Urban Development, 2006
- High Performance Building Guidelines, (consultant), City of New York Department of Design and Construction, 1999

**Synergistic Activities:**
Ms. Liaukus’ experience that is particularly relevant to E-RIC activities includes:
- Tracking and documentation of best practices in energy efficient residential construction techniques and products for the creation of the Affordable Green Academy
- Facilitation of green building design charrettes for various affordable housing developers through the Enterprise Green Communities program
- Technical assistance to a variety of state and national organizations in their efforts to create high performance buildings including: The City of Newark, NJ; The NJ Housing Mortgage Finance Agency; The AIA
- Lead author and project manager for the Meadowlands Developer’s Guide, a handbook for developers pursuing the New Jersey Meadowlands Commission (NJMC) LEED incentives.

**Collaborators and Co-editors/Graduate and Post-doctoral Advisors and Advisees:** NA
Vivian Loftness

Professional Preparation
Massachusetts Institute of Technology Bachelor of Science B.S. 1974
Massachusetts Institute of Technology Master of Architecture M.Arch. 1975

Appointments
2004 - present  University Professor, School of Architecture, Carnegie Mellon, Pittsburgh PA
1994 - 2004  Head, School of Architecture, Carnegie Mellon, Pittsburgh PA
2004-2010  Board of Directors, United States Green Building Council, Washington DC

Publications

Book Chapters:


SYNERGISTIC ACTIVITIES

Supported by a university-building industry partnership, the Advanced Building Systems Integration Consortium, Vivian Loftness is a key contributor to the development of the Intelligent Workplace - a living laboratory of commercial building innovations for performance, completed in 1997, and to the next generation living lab “Building as Power Plant”.

Her work has influenced both national policy and building projects, including the Adaptable Workplace Lab at the U.S. General Services Administration and the Laboratory for Cognition at Electricite de France.

She has served on six National Academy of Science panels as well as being a member of the Academy’s Board on Infrastructure and the Constructed Environment, and given three Congressional testimonies on sustainable design.

As a result of her landmark contributions to undergraduate and graduate curriculum development in environmental design, Vivian Loftness received the 2002 National Educator Honor Award from the American Institute of Architecture Students and a 2003 “Sacred Tree” Award from the US Green Building Council.

Vivian Loftness is on the National Boards of the US Green Building Council, the USGBC Technical and Scientific Advisory Council, the American Institute of Architects Committee on the Environment (2005 national chair), the AIA Communities by Design, Turner Construction Sustainable Advisory Board, and the Global Assurance Group of the World Business Council for Sustainable Development. She is a Fellow of the American Institute of Architects and a registered architect.

Loftness Graduate Advisors
Edward Allen, FAIA, author, formally of MIT and Yale University
Kevin Lynch, MIT Professor, now deceased.

Loftness Thesis Committee Chair and Sponsor
Kung Jen Tu, CMU PhD 1998, Associate Professor, Tainan University
Cecilia Yoon, CMU PhD 2004, Korean Research Center
Ying Hua, CMU PhD 2007, Cornell University Fall 2007
Megan Snyder, Nina Baird, PhD candidate, Joonho Choi - PhD candidates
ALI M. MALKAWI

SCHOOL ADDRESS: University of Pennsylvania
Department of Architecture
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Philadelphia, PA, 19104-6311
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Malkawi@pobox.upenn.edu
Pobox.upenn.edu/~malkawi

EDUCATION:

TEACHING EXPERIENCE:
2007-Present Professor of Architecture, University of Pennsylvania
2006-Present Founder and Director, T.C. Chan Center for Building Simulation and Energy Studies, University of Pennsylvania
2001-2007 Associate Professor, University of Pennsylvania
2002 Visiting Lecturer, Harvard University
2001 Visiting Professor, Harvard University
1996-2001 Assistant Professor, University of Michigan at Ann Arbor.
1994-1996 Visiting Assistant Professor of Architecture.
1992-1994 Instructor, Georgia Institute of Technology.

PUBLICATIONS:
Five Publications most closely related to the proposed project
Five other significant publications

SYNERGISTIC ACTIVITIES
Development of innovative solutions for the integration of building performance analysis tools in the building design process
Development of collaborative reasoning mechanisms and multi-knowledge agents to aid in the design of energy efficient buildings.

COLLABORATORS
Research work collaborators and co-editors of Journals and books
Godfried Augenbroe, Georgia Institute of Technology
Jean Lebrun, University of Liège, Wallonia, Belgium
Ardeshir Mahdavi, Vienna University of Technology, Vienna, Austria
Yi Jiang, Tsinghua University, Beijing, China
Xudong Yang, Tsinghua University, Beijing, China
Ph.D. Thesis Advisors
Max Akridge, Ashok K. Goel, John Templer – Georgia Institute of Technology

THESIS ADVISOR and POSTGRADUATE-SCHOLAR SPONSOR
Hussain Alzoubi, Jordan university of Science and Technology; Ruchi Choudhary, Cambridge University; Geoffrey Lewis, University of Michigan; Hussain Dashtih, Kuwait University
Yun Kyu Yi, University of Pennsylvania; Nuria Pelechano, Universitat Politècnica de Catalunya
Shinming Shyu, University of Michigan; Ah Young Lee, Myongji University, South Korea.
Rahul Mangharam

EDUCATION

ACADEMIC EMPLOYMENT
Director, mLAB Real-Time and Embedded Systems Lab, University of Pennsylvania. May 2008 onwards.
Stephen J. Angello Chair, Electrical and Systems Engineering, University of Penna. April 2008 onwards.
Assistant Professor, Electrical and Systems Engineering, University of Penna. March 2008 onwards.
Assistant Professor-Designate Dept. of Electrical and Systems Engineering, University of Pennsylvania. 10/07-02/08.

RESEARCH INTERESTS
Real-time systems, embedded systems, operating systems, wireless networks, medical devices and automotive networks.

PUBLICATIONS

SYNERGISTIC ACTIVITIES
Participant, NSF Nat’l Workshop on High Confidence Medical Device Software & Safety, Boston, 6/07

FORMER GROUP MEMBERS
Daniel Weller (MIT), Malolan Shantanakrishnan (Mathworks), Ryohei Suzuki (Tokyo University), Jalaja Kuruparathalli (Intel) , Chih-Yuan Liao (Qualcomm), Yoshisato Takeda (Mitsubishi Electric) and Kunal Shah (Cisco).

COLLABORATORS
Roch Guerin, Insup Lee, George Pappas, Raj Rajkumar(CMU), Radu Marcaescu(CMU), Richard Voyels(U. Denver), Fan Bai(GM R&D), Sofie Pollin(Berkeley), Francky Catthoor(IMEC, Belgium).
Education
1989 Bachelor of Technology, Comp. Sci. and Eng, Indian Institute of Technology
1994 Ph.D., Computer Science, University at Albany-SUNY
1994-1996, Postdocotral Institute, Los Alamos National Laboratory

Research and Professional Experience:
Madhav Marathe is a Professor, of Computer Science, and Deputy Director of Network Dynamics and Simulation Science Laboratory (NDSSL), Virginia Bio-Informatics Institute at Virginia Polytechnic Institute and State University. He leads the basic and applied research program in modeling and simulations of large complex networks and the development of associated computational technologies to support this program. He obtained his B.Tech degree in 1989 in Computer Science and Engineering from the Indian Institute of Technology (IIT) Madras, and his Ph.D. in 1994 in Computer Science, from University at Albany under the supervision of Professors Harry B. Hunt III and Richard E. Stearns. Before coming to Virginia Tech, he was a Team Leader in the Basic and Applied Simulation Science group (CCS-5) in the Computer and Computational Sciences division at the Los Alamos National Laboratory (LANL) where he led the theoretical program to support simulation based design, and analyze extremely large socio-technical and critical infrastructure systems. Dr. Marathe’s research interests include interaction based modeling, simulation and analysis of large scale biological, information & socio-technical systems, computational epidemiology & public health, mobile computing and communication, design and analysis of algorithms, data mining, high performance computing, complexity theory, and combinatorial optimization.

Employment For Past Five Years
2005–present: Professor, Virginia Bioinformatics Institute and Dept. of Computer Science; Deputy Director, Network Dynamics and Simulation Sciences Laboratory.
- Principal Investigator: NSF-Nets, NSF-HSD, NSF Peta-Apps,
- Co-PI: NSF-Nets, NIH Midas, CDC-Center of Excellence, DTRA-R&D,
- Senior Investigator: DTRA-CNIMS

Ten Selected Publications (Total 175, Google Scholar Citations: 3000+):

**Software Systems:**
- Developed Algorithms and software for high resolution, scalable modeling urban transport planning (TRANSIMS). TRANSIMS is now an open source software system and is being used extensively.
- Systems for Design and Analysis of Next Generational Wireless Networks: leading the development of end-to-end high resolution modeling tools for representing, analyzing and designing current and next generation information communication networks.
- Design and architecture of an integrated high performance computing oriented modeling environment to support computational epidemiology. Early work - EpiSims and its successors Epifast and EpiSiDermics. EpiSims is an open source software for use by other academic institutions.
- Siminfrastructure: High performance service oriented simulation middleware to support modeling, reasoning pertaining to very large co-evolving socio-technical (10-100 Million agent) systems.
- Led/participated in 10+ significant studies using our modeling decision support systems pertaining to homeland security, sustainable inter-dependent infrastructures & public health. Examples: (i) *Planning and response in the event of natural or human initiated crisis* (part of DHS NISAC, published in Nature), (ii) *Supporting federal pandemic influenza plans* (part of NIH, MIDAS program, IOM letter report 2006), and (iii) DoD *pandemic preparedness*.

**Graduate Dissertations Directed During the Past Five Years**
5. Additionally, currently supervising 7 Ph.D.

**Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:**
Alo, Richard (UofHD); Asal, V. (SUNY-Albany); Atkins, K. (VT); Atran, S. (ARTIS); Bailey-Kellog, C. (Dartmouth); Barrett, C.L. (VT); Beckman, R. (VT); Bisset, K. (VT); Blum, A. (CMU); Bostian, C. (VT); Chafekar, D. (Nokia); Channakeshava, K. (VT); Chen, J. (VT); Collins, T. (Purdue); Contractor, N.S. (NWU); Davis, R. (ARTIS); Davulcu, H. (ASU); Duenas-Osorio, L. (Rice U.); Durbeck, L. (VT); Ebert, D. (Purdue); Epstein, J.M. (Brookings Ins); Eubank, S. (VT); Feng, A. (VT); Feng, W. (VT); Feng, X. (VT); Fishhoff, B. (ARTIS); Fox, E. (VT); Fox, G. (Indiana U.); Frieze, A. (CMU); Ge, F. (VT); Ginges, J. (ARTIS); Graham, F. (UC); Guclu, H. (LANL); Hammond, R. (Univ. of MI); Han, B. (U MD); Hansson, A. (LANL); Harris, S. (VT); Hobeika, A.G. (VT); Huang, F. (VT); Hunt, H.B. III (SUNY-Albany); Istrate, G. (LANL); Khan, M. (VT); Konjevod, G. (ASU); Kuhlman, C. (VT); Leidig, J. (VT); Levin, D. (UMD); Lewis, B. (VT); Lloyd, E. (U DE); Marathe A. (VT); Moret, B. (UNM); Mortveit, H. (VT); Pandurangan, G. (Brown U); Parker, J. (Brookings Ins); Parthasarathy, S. (U MD); Pei, G. (VT); Pemmaraju, S. (U of Iowa); Percus, A. (U of CA. and LANL); Phadke, A.G. (VT); Pirwani, I. (U of Iowa); Ramakrishnan, N. (VT); Ramanathan, R. (BBN); Ravi, R. (CMU); Ravi, S.S. (SUNY-Albany); Rethemeyer, K. (SUNY-Albany); Rosenkrantz, D.J. (SUNY-Albany); Sen, A. (ASU); Srinivasan, A. (U MD); Stearns, R. (SUNY-Albany); Stein, R. (Rice U.); Sageman, M. (ARTIS); Stretz, P. (VT); Subramanian, D. (Rice U.); Sundaram, R. (Northeastern); Thakur, M. (U Missouri Rolla); Thorpe, J. (VT); Vullikanti, Anil (Kumar) (VT); Williams, G. (VT) Young, H.P. (JHU); Zarate, J. (ARTIS).
Nir Mashkif has a B.Sc. in Information Systems and an MBA from the Technion - Israel Institute of Technology. Nir has over ten years of research and practical experience in the areas of Server side deployment, Web Services, J2EE, and DBs, mostly in the Telco Domain. His Research Area includes SOA, Industry Models, Model Management and Models Traceability.
Michael Masin, Ph.D.
michaelm@il.ibm.com, IBM Haifa Research Lab, Mount Carmel, Haifa 31905, Israel

**Education:**

**Research and Professional Experience:**
Dr. Masin is currently a Research Staff Member in the Business Optimization Group at IBM Research – Haifa Lab (HRL) and has strong teaching and research ties to the Davidson Faculty of Industrial Engineering and Management at the Technion, Israel, and Department of Industrial Engineering at the Tel Aviv University, Israel. Between 1998 and 2004, Michael was a postdoctoral fellow and a visiting faculty at the Pennsylvania State University, Tel-Aviv University, and the Technion. During his Ph.D. studies, he was employed by the Israeli Defense Forces for four years, working in the fields of Operations Research and Systems Analysis. Before IBM, Michael was an analyst in the Center of Military Analyses at RAFAEL — Advanced Defense Systems Ltd.

**Current research interests:**
- Development of tools and applications for stochastic and combinatorial multi-objective optimization
- Optimization-based engineering and system of systems design
- Design, control, and integration of production, service, and logistics systems

**Selected publications:**


Monica A. Mazurek, Ph.D.
Rutgers University – Dept of Civil & Environmental Engineering
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Tel: 732-445-0579 x128 Email: mmazurek@rci.rutgers.edu

Education:
UCLA        Los Angeles, CA  B.S.    1977           Chemistry
UCLA        Los Angeles, CA                   Ph.D.  1985                                         Geochemistry

Research and Professional Experience:
2008 – present  Associate Professor, Dept. Civil & Environmental Engineering, Rutgers University
2002-2008        Assistant Professor, Dept. Civil & Environmental Engineering, Rutgers University
2000-2002        Director of Academic Initiatives, Office of the Dean, School of Engineering, Rutgers
                 (50% appointment)
1995-2002        Associate Research Professor, Institute of Marine and Coastal Sciences, Rutgers University
                 (50% appointment)

McDow, S.R., Mazurek, M.A., Li, M., Alter, L., Graham, J. Felton, H.D., McKenna, T., Pietarinen, C.,
compounds in PM2.5 from the New York City Area. I. Sampling network, sampler evaluation,
Molecular Markers in Urban Particulate Matter from Philadelphia, PA, Atmos. Environ., 40,
2260-2273.
mixtures and relationship to atmospheric chemistry and sources, Environ. Health Perspect., 110,
Source apportionment of airborne particulate matter using organic compounds as tracers. Atmos.
Environ. 30, 3837-3855.
Quantification of organic aerosols at a molecular level: Identification, abundance and seasonal

Synergistic Activities (last 5 years):
2010 to present, Member Dean’s Advisory Committee, Rutgers School of Engineering
2010-2013 Senator, Rutgers University Senate, School of Engineering
2008 to present, Director, Center for Advanced Infrastructure and Transportation (CAIT) Environment
and Energy Program, http://cait.rutgers.edu/EEP.
2003 to present, Director Engineering Planet, School of Engineering, Rutgers University. A web-
based pre-engineering curriculum web site for middle school teachers. Lessons in technology
conceived and produced by teacher associates and made available on
www.engineeringplanet.rutgers.edu.

Students, Post-Docs and Collaborators (last 5 years): Ken Demerjian (SUNY-Albany), Brian Gullett
(USEPA), Mike Hays (USEPA), Min Li (California University of Pennsylvania), Kunal Patel (NJDEP),
Steve McDow (USEPA), Bernd R. T. Simoneit (Oregon State University), James Schwab (SUNY-
Albany), Shida Tang (NYDEC). Graduate Advisor: Dr. Walter E. Reed (UCLA); Post Graduate
Advisor: Dr. Glen R. Cass, deceased (Caltech).
BIOGRAPHICAL SKETCH

ALI M. MEMARI, Ph.D., P.E., Associate Professor
Department of Architectural Engineering, The Pennsylvania State University, 104 Engineering A Building, University Park, PA 16802-1416, Phone: (814) 865-3367, Fax: (814) 863-4879, E-mail: amm7@psu.edu

(i) Professional Preparation

- University of Houston, Houston, TX, B.S., Civil Engineering, May, 1979.
- Penn State University, University Park, PA, Ph.D., Civil Engineering, August, 1989.

(ii) Appointments

- Department of Architectural Engineering, Penn State University, University Park, PA, Associate Professor, 7/04 – Present.
- Simpson Gumpertz & Heger, Inc., Waltham, MA and San Francisco, CA, Visiting Senior Engineer in Building Technology, 6/05-12/05.
- Department of Architectural Engineering, Penn State University, University Park, PA, Assistant Professor, 6/98 – 6/04.
- Department of Civil and Environmental Engineering, Penn State University, University Park, PA, Visiting Assistant Professor, 8/95 – 5/98.
- Department of Civil Engineering, Sharif University of Technology, Tehran, Iran, Assistant Professor, 1/90 – 5/95.
- Center for Locomotion Studies, Department of Bioengineering, The Pennsylvania State University, University Park, PA, Senior Research Associate, 8/89 – 12/89.
- Department of Civil and Environmental Engineering, Penn State University, University Park, PA, Instructor, 9/85 – 7/89.
- Department of Civil and Environmental Engineering, Penn State University, University Park, PA, Research Assistant, 9/84 – 7/85.
- PMB Systems Engineering, San Francisco, CA, Senior Engineer, 10/81 – 12/82.

(iii) Publications


(iv) **Synergistic Activities**

• Member, ASCE/AEI
• Chair, Curtain Wall Committee, AEI
• Member, Earthquake Engineering Research Institute (EERI)
• Member, The Masonry Society/MSJC

(v) **Collaborators & Other Affiliations**

(a) **Collaborators and Co-Editors.** Aliaari, M., Behr, R. A. (Penn State), Eminaga, A., Hamid, A. A. (Drexel), Harris, H. G. (Drexel), Kremer, P. A. (Penn State), Liang, J. (Thornton-Tomasetti), Maneetes, H., Scanlon, A. (Penn State), Shirazi, A., Kasal, B. (Penn State), Manbeck, H. B. (Penn State), Adams, A. R., Chen, X.

(b) **Graduate Advisors and Postdoctoral Sponsors.** West, H. H. (Penn State University, University Park), Ph.D. Advisor; Mahin, S. A. (University of California, Berkeley), M.Eng. Advisor.

John I. Messner, Ph.D.
Associate Professor of Architectural Engineering
Director, Computer Integrated Construction Research Program
The Pennsylvania State University

Education and Training:
Penn State University  Architectural Engineering (Business Admin Minor)  PhD - 1994.

Research and Professional Experience:
2001 – Present  Assistant / Associate Professor,  Architectural Engineering,  Penn State Univ.
1996 – 1996  Project Manager for Development,  Rebuild, LLC, Sterling, VA.
1991 – 1994  Research Assistant; Dept. of Architectural Engineering,  Penn State University.

Publications:  (including patents, copyrights, and software systems)
8)  The Virtual Construction Simulator (Educational Software Application)

Synergistic Activities:
Director,  Computer Integrated Construction (CIC) Research Program
In 2003, Dr. Messner became the director of the CIC Research Program.  This program seeks to develop criteria and methods to improve information technology applications in the integration of building management, planning, design, construction, and operation.  This includes the development of core process and product models; the development of specific solutions to field problems; and the use of visualization and simulation to improve the built environment.
Erwann MICHEL-KERJAN  
Risk Management and Decision Processes Center  
The Wharton School of the University of Pennsylvania  
3730 Walnut Street, Huntsman Hall, Room 556, Philadelphia, PA  19104

Education  
Greqam (France) Economics MA 1999  
Greqam/Ecole Polytechnique (France) Economics/Finance Ph.D. 2002  
Wharton, University of Pennsylvania Risk Management Postdoc 2002-2004

Appointments  
2006-present Operation and Information Management Department; The Wharton School, University of Pennsylvania - Managing Director, Center for Risk Management and Decision Processes  
2004-2006 Senior Fellow, Center for Risk Management, The Wharton School  
Summer 2004 Visiting Scholar, Columbia University

Representative Publications

Books  

Articles  
• Come Rain or Shine: Evidence on Flood Insurance Purchases in Florida. Journal of Risk and Insurance. (with C. Kousky). (Forthcoming)  
• Long Term Property Insurance, Journal of Insurance Regulation. (with D. Jaffee and H. Kunreuther). (Forthcoming)  
• An Empirical Analysis of the Terrorism Risk Insurance Act (TRIA), (with H. Kunreuther) in The Economic Costs And Consequences of Terrorism, Harry W. Richardson, Peter Gordon, and James E. Moore II (eds.), Elgar Publishing. (2007; book chapter)
Synergistic Activities

2008-present Elected Chairman, OECD Secretary-General High Level Advisory Board on Financial Management of Large-Scale Catastrophes – Organization for Economic Cooperation and Development (30 developed countries including the United States)

2008-present Member, World Economic Forum’s Global Agenda Council on Leadership and Innovations to Manage Natural Disasters

2007-present Young Global Leader, a five-year nomination bestowed by the World Economic Forum (Davos) to recognize and acknowledge the most extraordinary leaders of the world under the age of 40.

Collaborators and Co-Authors

Philip Auerswald (George Mason University)
Lewis Branscomb (Harvard University)
Michael Budney (The Pentagon, U.S. Dept. of Defense)
Debra Decker (Harvard University)
Nathalie de Marcellis-Warin (HEC Montreal, Canada)
Sabine Lemoine deForges (Ecole Polytechnique, France)
Neil Doherty (Wharton School, University of Pennsylvania)
John Dziminowicz (The Pentagon, U.S. Dept. of Defense)
Claude Henry (Columbia University and Ecole Polytechnique, France)
Ryan Ellis (University of California at San Diego)
Martin Grace, (Georgia State University)
Stefan Hochrainer (International Institute for Applied Systems Analysis IIASA)
Dwight Jaffee (University of California at Berkeley)
Robert Klein (Georgia State University)
Paul Kleindorfer (INSEAD, France)
Carolyn Kousky (Resources for the Future)
Patrick Lagadec (Ecole Polytechnique, France)
Joanne Linnerooth-Bayer (International Institute for Applied Systems Analysis IIASA)
Robert Meyer (The Wharton School, University of Pennsylvania)
Frederic Morlaye (Aon)
Mark Pauly (The Wharton School, University of Pennsylvania)
Burkhard Pedell (University of Stuttgart, Germany)
Nicola Ranger (London School of Economics)
Paul Raschky (Monash University)
Irv Rosenthal (The Wharton School, University of Pennsylvania)
Paul Slovic (University of Oregon)
BARRY MILLER
PRESIDENT & COO
DELAWARE VALLEY INDUSTRIAL RESOURCE CENTER (DVIRC)

Education and Training:
• Bachelor of Science Degree, Accounting/Operations Management, Syracuse University, May 1976

Research and Professional Experience:
• President & COO Delaware Valley Industrial Resource Center – 1989-Present
• VP Manufacturing Systems, Baldwin Hardware corporation, 1976-1989

Synergistic Activities:

  Current Director, Pennsylvania IRC Network
  Serves as Board Member, Murex Investments
  Member Greater Philadelphia Chamber of Commerce

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:
Collaborators and Co-Editors:
N/A
RICHARD G. MISTRICK, Ph.D., P.E., FIES, ASSOCIATE PROFESSOR

A. EDUCATION & TRAINING
Pennsylvania State University, Univ.Park, PA. Bachelor of Architectural Engineering 1984
University of Colorado, Boulder, CO M.S. Civil Engineering 1985
Pennsylvania State University, Univ. Park, PA. Ph.D., in Illuminating Engineering 1991

B. PROFESSIONAL EXPERIENCE
1997 - present Associate Professor of Architectural Engineering, Penn State University
1999 - 2000 Sabbatical Leave, Lawrence Berkeley National Laboratory, Berkeley, CA
1991 - 1997 Assistant Professor of Architectural Engineering, Penn State University,

C. RELATED PUBLICATIONS

D. SOFTWARE DEVELOPMENT
Daysim (2009-2010). PI for major expansion to existing public domain daylighting tool included the addition of electric lighting, detailed modeling of photosensor control systems, shading control, and advanced graphics for annual simulations of daylight delivery systems in complex spaces. Sponsor holds exclusive rights until 2011, then software becomes open source.

E. RELATED ACTIVIES
Co-Editor for the 2010 Edition of the IES Lighting Handbook.
IESNA Committee Chairs held: Papers; Calculation Procedures, Board of Fellows.
Other Committees: Daylighting; Daylight Metrics, Nomenclature

E. COLLABORATORS/CO-EDITORS (limited to non-Penn State personnel within U.S.)
David L. DiLaura, Acuity Brands Lighting
Eleanor Lee, Lawrence Berkeley National Laboratory
Gary Steffy, Gary Steffy Lighting Design, Ann Arbor, MI
MILIND R. NAPHADE
T. J. Watson Research Center, IBM Corporation
19 Skyline Drive, Hawthorne, NY 10532
Email: naphade@us.ibm.com

Areas of Expertise
Smarter Cities, Analytics and Optimization, Information Technology for Smarter Urban Infrastructure, Technology and Innovation Forecasting, Machine Learning, Information Analytics, Global and Collaborative Innovation Process, Multimodal Information Exploitation for Intelligence Agencies and Public Sector

Education
- Ph.D. Electrical Engineering, University of Illinois at Urbana-Champaign, 2001.
- M.S. Electrical & Computer Engineering, University of Illinois at Urbana-Champaign, 1998.
- B.E. Instrumentation and Control (University Topper), University of Pune, India, 1995.

Professional Experience
July 2008- to present: Manager, Services for a Smarter Planet Department
IBM T. J. Watson Research Center, Hawthorne, New York
Managing Research agenda for a smarter planet services that leverage advanced research and development in Analytics, Optimization, Operations Research and System Management for building smarter urban infrastructure and smarter cities. Project Leader for the Smarter Sustainable Dubuque project and for the Smarter Cities Sustainability Model development that integrates information from various sources.

Dec 2006-June 2008: Manager, Technology & Innovation Prog., Global Innovation Outlook, Res Staff Member, IBM T. J. Watson Research Ctr, Hawthorne, NY

April 2001-Dec 2001: Research Staff Member, IBM T. J. Watson Research Center, Hawthorne, New York.
Intelligent Information Analysis Group: Research and development in semantic understanding of multimodal content using statistical machine learning and signal processing techniques

Professional Honors and Awards
- Senior Member, Institute of Electrical and Electronic Engineers
- Wall Street Journal’s Technology Innovation Award in the Multimedia Category for 2004 for the MARVEL technology developed by our team

Over 100 publications, book chapters and patents pending and granted in the areas of machine learning, image processing and analysis, pattern recognition and intelligent infrastructure.
Education and Training
B.E. (Hons.), Mechanical Engineering, Birla Institute of Technology & Science, India
M.S., Mechanical Engineering, University of Houston, Houston, TX
Ph.D., Mechanical Engineering, University of Houston, Houston, TX (ABD)

Research and Professional Experience
Project Leader, Integrated Building Systems, Energy Systems Program Office, UTRC, E. Hartford (01/10-present)

Leading high performance, energy efficient buildings R&D. Program covers research and demonstration efforts in modeling, simulation and analytical tools for building system and controls design, and algorithms for building control and decision support. Leading the UTC-Tsinghua Research Institute for Integrated Building Energy and Safety Control Systems (Beijing, China).

Project Leader, UTC Fire & Security Program Office, UTRC, E. Hartford (01/06-12/09)

Project Leader, Pratt & Whitney Program Office, UTRC, E. Hartford (03/03-12/05)

Associate Fellow, Systems Dept., UTRC, E. Hartford (03/02–03/03)

Research Engineer, Systems Dept., UTRC, E. Hartford (04/00–03/02)

Associate Research Engineer, Mechatronics Dept., UTRC, E. Hartford (04/98–04/00)

Research Assistant, Aerodynamics & Turbulence Lab, U. of Houston, Houston (08/91–04/98)

Publications


Synergistic Activities
Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers: None

Collaborators and Co-editors

Dr. Michael G. Apte (Lawrence Berkeley National Lab, CA)
Professor Prabir Barooah (Univ. Florida, FL)
Professor Jeff Borgaard (Virginia Tech, VA)
Professor Francesco Borrelli (Univ. California at Berkeley, CA)
Professor R. Bitmead (Univ. California at San Diego, CA)
Professor John A. Burns (Virginia Tech, VA)
Professor Luca Carloni (Columbia Univ., NY)
Professor A. Cerpa (Univ. California at Merced, CA)
Mr. Paul Ehrlich (Building Intelligence Group LLC)
Professor W. Fan (Tsinghua Univ., Beijing, China)
Professor X. Guan (Tsinghua Univ., Beijing, China)
Professor Martin Guay (Queens Univ., Quebec, Canada)
Dr. Phil Haves (Lawrence Berkeley National Lab, CA)
Professor B. Hencey (Cornell Univ., NY)
Professor Yi Jiang (Tsinghua Univ., Beijing, China)
Mr. Teja Kurungati (Oakridge National Lab, TN)
Mr. Wayne Manges (Oakridge National Lab, TN)
Professor Prashant Mehta (Univ. Illinois and Urbana-Champaign, IL)
Professor Sean P. Meyn (Univ. Illinois and Urbana-Champaign, IL)
Professor Igor Mezic (Univ. California at Santa Barbara, CA)
Professor Manfred Morari (ETH, Zurich, Switzerland)
Dr. Kevin Otto (Robust Systems & Strategy LLC)
Mary Ann Piette (Lawrence Berkeley National Lab, CA)
Dr. Michael D. Sohn (Lawrence Berkeley National Lab, CA)
Dr. Michael Wetter (Lawrence Berkeley National Lab, CA)
Professor Hui Zhang (Tsinghua Univ., Beijing, China)

Graduate and Post-doctoral Advisors and Advisees:

Professor Fazle Hussain (M.S/PhD advisor)
Cullen Distinguished Professor
School of Mechanical Engineering
University of Houston
Houston, TX
Kofi A. Nyarko, D.Eng.

**Education and Training:**
Morgan State University, Baltimore MD
- B.S. in Electrical Engineering - Cumulative GPA: 3.6/4.0 Dec 1998
- M.S. in Electrical Engineering - Cumulative GPA: 3.8/4.0 August 2000
- D.Eng. in Electrical Engineering - Cumulative GPA: 3.9/4.0 Dec 2003

**Research & Professional Experience:**
- **Chesapeake Information Based Aeronautics Consortium, Morgan State University** - Title: Research Engineer (1/04 – Present)
  Direct Engineering Visualization Research Laboratory in research concerning general aviation safety.
- **ARGTEC Inc.** Title: Consulting Software Engineer (2/04 – Present)
  Developed web-based interface for the Automatic Indexing, Search & Retrieval engine system for automatic target identification from synthetic aperture radar scans.
- **Morgan State University, Engineering Visualization and Scientific Characterization Laboratory (EVSC)** - Title: Research Technical Lead(1/98 -12/03)
  Developed a low-cost scalable haptic renderer for Atomic Force Microscope data; Developed simulation and visualization routines for mobile tactical ad hoc networks; Develop a PDA crossbar for remote server-side operations from PDA thin client; Created a file conversion utility for the Silvaco file format used by several high-end physical device simulators; Developed custom software and hardware solutions for Projection Reality Corporation (PRC), which simulated and tested raster scan routines for a prototype large liquid crystal display; Created distributed rendering algorithms which allowed complex simulations to be rendered on multiple networked SGI Octane systems.

**Publications:**

**Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:**

**Collaborators & Co-editors:**
- Craig Scott – Morgan State University
- Jumoke Ladeji-Osias – Morgan State University
- Otsebele Nare – Hampton University

**Graduate and Post-doctoral Advisors and Advisees:**
- Schinnel Small, Bridgette Latimer, Amaro Thiam
Stella Maris Oggianu  
Principle Research Engineer  
United Technologies Research Center  

Education and Training  
Bachelor of Science in Nuclear Engineering, Institute Balseiro, Argentina, 1995.

Research and Professional Experiences  
Project Leader, United Technologies Research Center, Carrier and UTC Power Program Office, Feb. 2008-Present  
Developed direction and executed Carrier and UTC Power technology projects ranging from advanced HVAC systems modeling and simulation to support building basic capability for energy microgrids  
Projects: HVAC System Architecture, HVAC Set-Points Optimization, Model Predictive Controls, Occupancy Based Ventilation, Energy Visualization, Energy Microgrids  
Principal Investigator, United Technologies Research Center, Systems Department and Otis Program, Feb. 2004-Present  
Developed and executed technical programs for hybrid transportation and CHP  
Projects: CHP Modelling and Simulation, CHP Economic and Market Analysis, Otis-Hybrid System

Publications  

Synergistic Activities: (List no more than five professional and scholarly activities related to the building research and technology area)
RALPH A. OLIVA

Executive Director, Institute for the Study of Business Markets
Professor of Marketing, Smeal College of Business
ISBM - Penn State
402 BAB, University Park, Pennsylvania 16802
(814) 863-2782, (814) 863-0413 (fax)
E-mail: rao8@psu.edu  www.isbm.org

Ralph is the Executive Director of the Institute for the Study of Business Markets, and Professor of Marketing in the Smeal College of Business, Penn State University. The ISBM is the leading academic center devoted to advancing knowledge and practice in Business-to-Business marketing worldwide. The ISBM is supported by 65 major firms, and a network of over 100 researchers, all focused on B-to-B.

Ralph is a regular columnist for Marketing Management magazine, and teaches in Executive Education, as well as the Smeal College MBA program. Before joining Penn State, Ralph spent 23 years at Texas Instruments, where he served as Vice President of Market Communications and Design, and leader of the TI.com web Team.
Zheng D. O’Neill  
Staff Research Engineer  
United Technologies Research Center

Education and Training
Ph.D., Mechanical Engineering, Oklahoma State University, Stillwater, OK, 2004  
M.S., Heating, Ventilation and Air Conditioning Engineering, Tongji University, Shanghai, China, 2000  
B.S., Building Services Engineering, Shenyang Architectural and Civil Engineering Institute, China, 1996

Research and Professional Experience
United Technologies Research Center East Hartford, CT  
Staff Research Engineer November, 2006–present  
Senior Research Engineer October, 2006–October, 2009  
Conducted R&D in the area of building energy and control systems simulation, modeling, estimation, and optimization.  
Real time decision support system in buildings for fault detection and diagnostics.  

Cimetrics, Inc. Boston, MA  
Provided engineering assistance in the support of remote monitoring and ongoing commissioning of building mechanical and energy systems.  
Led energy simulation and modeling, and helped establish scalable energy modeling standards.  

Oklahoma State University Stillwater, OK  
Research Assistant August, 2000–December, 2004  

Gebrüder TROX GmbH Shanghai, China  
Mechanical Engineer January, 1999–July, 2000  

Tongji Construction Project Supervision and Management Company Shanghai, China  
Mechanical Engineer September, 1996–August, 1997

Publications  
2 pending patents and 5 pending invention disclosures  
Over 15 publications in archival journals and conference proceedings

Synergistic Activities  
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)  
TC Member for TC7.5 Smart Building Systems and TC1.5 Computer Application  
American Society of Mechanical Engineers (ASME)  
International Building Performance Simulation Association (IBPSA)  
Professional Registered Engineer (PE), 2006 – present
Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers: Provide the following information in this section:

Collaborators and Co-editors
Philip Haves, PhD
Leader, Simulation Research Group and Commercial Building Systems Group
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 90R3111 Berkeley, CA 94720-8134

Xiufeng Pang, PhD
Building Technologies Department, EETD
Lawrence Berkeley National Laboratory
One Cyclotron Road, MS 90R3111 Berkeley, CA 94720-8134

Graduate and Post-doctoral Advisors and Advisees:
Jeffrey D. Spitler PhD (advisor)
Regents Professor and C.M. Leonard Professor
School of Mechanical Engineering
Oklahoma State University
218 Engineering North
Stillwater, OK 74078

Simon J. Rees PhD (co-advisor)
Senior Research Fellow
Institute of Energy and Sustainable Development
De Montfort University
Queens Building, The Gateway, Leicester, LE1 9BH
United Kingdom
Biographical Sketch

Brian Orland / Professor of Landscape Architecture / The Pennsylvania State University

Education and Training:
University of Manchester Architecture BA (Hons), 1974
University of Manchester Architecture BArch, 1976
University of Arizona Landscape Architecture MLA, 1982

Research and Professional Experience:
2008-present Director, School of Architecture and Landscape Architecture, Penn State University
2000-2008 Professor and Head, Department of Landscape Architecture, Penn State University
1999-2000 Faculty Fellow, National Center for Supercomputing Applications
1989, 1996 Research Fellow, Centre for GIS and Modeling, University of Melbourne
1982-2000 Professor of Landscape Architecture, University of Illinois at Urbana-Champaign

Publications:

Collaborators and Co-editors
K. Donaghy, Cornell University
J.W. Eheart, University of Illinois at Urbana-Champaign
E. Herricks, University of Illinois at Urbana-Champaign

Graduate and Post-doctoral Advisors and Advisees:
Advisor: Terry C. Daniel, Prof of Psychology+Renewable Natural Resources, University of Arizona.
2008, Selek Sayan, Post-Doc, Akdeniz University, Turkey
2008, Jeff Fitzpatrick, MLA. Private Consulting, Vancouver
2005, Cenk Ursavas, MS, Industrial Engineering, Unknown
2004, K. Budthimedhee, PhD, Urban and Regional Planning, Chulalunlorn University, Thailand
Eric Orts
The Wharton School, University of Pennsylvania (1991 to present)
Guardsmark Professor (2003 to present)

Education and Training:
University of Michigan Law School. J.D. cum laude 1988. Articles editor, University of

Research and Professional Experience:
The Wharton School, University of Pennsylvania (1991 to present)
Guardsmark Professor (2003 to present)
Professor of Management (secondary appointment) (2001 to present)
Professor of Legal Studies and Business Ethics (2000 to present)
Associate Professor of Legal Studies (with tenure) (1996 to 2000)
Nelson Peltz Term Assistant Professor of Legal Studies (1991 to 1996)
Director, Initiative for Global Environmental Leadership (2007 to present)
Director, Environmental Management Program (1998 to 2007)
Academic Co-Director, FINRA Institute at Wharton (2000 to present)
New York University School of Law – Visiting Professor (2005-2006)
University of Sydney Law School – Visiting Professor (summer 2005)
Harvard University (2002-2003)

Publications:
RETHINKING THE FIRM: THEORIES OF THE BUSINESS ENTERPRISE [forthcoming in
Oxford University Press].
ENVIRONMENTAL CONTRACTS: COMPARATIVE APPROACHES TO REGULATORY
INNOVATION IN THE UNITED STATES AND EUROPE (Eric W. Orts & Kurt Deketelaere
Series Editor (with Kurt Deketelaere), Comparative Environmental Law & Policy Series,

Book Chapters:
“Ethics, Risk, Environmental Management, and Corporate Responsibility” in
ENVIRONMENTAL
PROTECTION AND THE SOCIAL RESPONSIBILITY OF FIRMS: PERSPECTIVES FROM
LAW, ECONOMICS, AND BUSINESS (Robert Stavins, Bruce Hay & Richard Vietor eds.,
Resources for the Future Press, 2005), pp. 184-96. 3 “From Corporate Social Responsibility to
Global Citizenship” in THE INSEAD-WHARTON ALLIANCE ON GLOBALIZING (Hubert
“War and the Corporation” in FINANCIAL TIMES HANDBOOK OF MANAGEMENT (3d
ed.) (Stuart

4-182
“Conflict of Interest on Corporate Boards,” in CONFLICT OF INTEREST AND THE PROFESSIONS

Articles
“Putting a Stake in Stakeholder Theory” (with Alan Strudler), JOURNAL OF BUSINESS ETHICS vol. 88. (2009).

Other Publications
“Green Evolution: Managing the Risks, Reaping the Benefits,” special report by IGEL and Knowledge@Wharton (edited with Jim Motavelli and other K@W writers) (2010).
“The Challenge of a New Environmental Contract,” prepared for discussion at the U.N. Secretary-General’s Global Colloquium for University Presidents (New York University, 2007).
GLOBAL ENVIRONMENTAL HEALTH IN THE 21ST CENTURY (Institute of Medicine of the National Academies, 2007) (workshop summary, contributor especially to ch. 5).
George J. Pappas

EDUCATION
Ph.D., EECS, University of California at Berkeley, Berkeley, CA, December 1998.

ACADEMIC EMPLOYMENT
Deputy Dean, School of Engineering and Applied Sciences, University of Pennsylvania, 1/08 onwards.
Director, General Robotics Automation Sensing Perception (GRASP) Lab, University of Pennsylvania, 8/05 – 1/08
Assistant Professor, Graduate Group Chair, Electrical and Systems Engineering and Computer and Information Sciences, University of Pennsylvania, Philadelphia, PA. March 00 - July 04

HONORS AND AWARDS
IEEE Fellow, Class of 2009.
Finalist, Best Paper Award, IEEE/RSJ IROS 2007, San Diego, CA
Finalist, Best Student Paper Award, IEEE Robotics and Automation 2007
N.A.E.-A. von Humboldt German-American Frontiers of Engineering Program, 2007
Presidential Early Career Award for Scientists and Engineers (PECASE), 2004
National Science Foundation CAREER Award, 2002
Finalist, Best Student Paper Award, American Control Conference 2001, 2004
Eli Jury Award for Excellence in Systems Research, University of California at Berkeley, 1999

PUBLICATIONS
6. Discrete abstractions of hybrid systems Rajeev Alur, Tom Henzinger, Gerardo Lafferriere, and George J. Pappas

SELECTED SYNERGISTIC ACTIVITIES
Steering Committee Co-organizer, Inaugural Cyber-Physical Systems (CPS) Week, St. Louis, MI, April 08
Program Committee, NSF Workshop on Cyber-Physical Systems, Austin, TX, October 2006.
BIOGRAPHICAL SKETCH

Steven D. Pekarek
Electrical and Computer Engineering
Purdue University
West Lafayette, IN 47907

Phone: (765) 494-3434
Email: spekarek@purdue.edu

Education and Training
- Undergraduate
  Purdue University, West Lafayette, IN  Electrical Engineering  B.S.  1987-91
- Graduate
  Purdue University, West Lafayette, IN  Electrical Engineering  M.S.  1992-94
  Purdue University, West Lafayette, IN  Electrical Engineering  Ph.D.  1994-96

Research and Professional Experience
9/1/07 – present  Professor of ECE, Purdue University
9/1/04-8/31/07  Associate Professor of ECE, Purdue University
9/02-8/31/04  Associate Professor of ECE, University of Missouri-Rolla
9/97-9/02  Assistant Professor of ECE, University of Missouri-Rolla
1/97-8/02  Postdoctoral Research Engineer, Purdue University
1992-1996  Research Assistant, Teaching Assistant, Purdue University

Publications (41 Journal, 60 Conference)


**Synergistic Activities**

- Co-director of Energy Systems Analysis Consortium (UM-Rolla, Illinois, Purdue, MIT, Naval Academy)
- Chairman of the 2005 Future Energy Challenge International Student Competition
- Secretary of 2003 Future Energy Challenge International Student Competition
- Technical co-chair of 2005 International Electric Machines and Drives Conference.
- Associate Editor for IEEE Transactions on Power Electronics, IEEE Transactions on Energy Conversion
- Program Chair 2007 Applied Power Electronics Conference
- General Chair 2008 Applied Power Electronics Conference

**Conflicts of Interest**

Collaborators: Paul Ainslie, Delphi; Patrick Chapman, UIUC; John Ciezki, USNA; Babak Fahimi, UTA; Tom Habetler, Georgia Tech; Ron Harley, Georgia Tech; Jim Kirtley, MIT; Phil Krein, UIUC; Mischa Steurer, Florida State; Scott Sudhoff, Purdue; Oleg Wasynczuk, Purdue;

MS/Ph.D. Students of Last 4 years: Brad Deken, Southeast Missouri State, Andreas Koenig, Hamilton Sundstrand; Kevin McCarthy, P.C. Krause and Associates; Kevin Rosenbaum, Bioanalytical Systems; Amanda Scheinfeldt, Raytheon; Josh Williams, Caterpillar; Dezheng Wu, ABB;
THOMAS D. RADCLIFF, PH.D., P.E.

Education and Training
Ph.D. Nuclear Engineering, University of Tennessee, Knoxville, 1995
M.S. Nuclear Engineering, University of Tennessee, Knoxville, 1992
B.S. Nuclear Engineering, University of Missouri, Rolla 1980

Research and Professional Experience

United Technologies Research Center, East Hartford, CT

Fellow, Thermal and Fluid Sciences Department 2007 – Current

- Provide broad technical oversight on thermal-fluid projects within several program offices, including: dynamic two-phase cycle modeling and controls, supersonic ejector design, advanced cycle design, alternate refrigerants, solid-state cooling, high fidelity modeling of steady and unsteady heat transfer enhancement, minichannel evaporator maldistribution, hydronic fire suppression, modular design, and integrated building systems
- Technical leader for UTRC multiphase modeling validation efforts including design and commissioning of a 100 kW pumped refrigerant test facility.
- Technical contributor to logistic fuel solid oxide fuel cell plant development for flight and stationary applications

Project Leader, Carrier Program Office 2006 -2007

Administered $3.4M in Carrier, UTC corporate, and Department of Energy sponsored research dealing with natural and advanced refrigerants, advanced vapor compression systems, and non-compression-based cooling technology. Project elements in CO2 heat pump cycle field demonstration, transcritical system modeling, expansion work recovery, flammable refrigerant inerting, and thermoelectric and magnetocaloric cooling

Principal Research Engineer / Senior Research Engineer 2000 – 2005

- Task leader in development of transient two-phase, two-fluid modeling and associated experimental validation for virtual qualification of new HVAC products
- Responsible for system thermal-fluid design, system modeling, and reliability / qualification of a new UTC organic Rankine cycle product for waste heat recovery
- Tiger team leader for resolution of Carrier Foxfire screw compressor acoustic issues
- Thermal-fluid lead for advanced thermoelectric cooling projects
- Consultant for resolution of persistent thermal design issues on CO2 heat pump product
- Consultant for technical aspects of major HVAC system and component test facilities

Assistant Professor, Mechanical Engineering, University of Akron 1997 – 2000
Visiting Asst. Professor, Mechanical Engineering, The Ohio State University 1994 – 1997
Research Assistant, Nuclear Engineering, University of Tennessee 1990 – 1994
Engineer, Research Reactors Division, Oak Ridge National Laboratory 1988 - 1990
Titled Engineer, Transient Analysis, Yankee Atomic Electric Company 1984 – 1988
Engineer, Thermal-Fluids Engineering, Babcock & Wilcox 1980 – 1983
Select Recent Publications and Patents
Author of 10 journal articles and 19 conference publications.


Authored or co-authored over 100 invention disclosures with 12 applications currently pending in advanced cooling cycle, organic Rankine cycle, solar combined heat and power, heat exchange, solid oxide fuel cell, and thermoelectric technologies. 5 patents issued in ORC technology.

Synergistic Activities:
- Registered Professional Engineer in Connecticut and Ohio
- ANS Professional Engineering Examination Committee
- ASME FED Multiphase Flow Committee

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:
- Collaborators and Co-editors: None.
- Graduate and Post-doctoral Advisors and Advisees: None.
ARVIND RANGASWAMY
Senior Associate Dean, Anchel Professor of Marketing
The Smeal College of Business
Penn State University

(www.arvind.info)

PROFESSIONAL PREPARATION

<table>
<thead>
<tr>
<th>Institution</th>
<th>Degree</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northwestern University, Evanston</td>
<td>Marketing</td>
<td>PhD - 1985</td>
</tr>
<tr>
<td>Indian Institute of Management, Calcutta</td>
<td>Post-Graduate Diploma in</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Management (MBA)</td>
<td>MBA - 1979</td>
</tr>
<tr>
<td>Indian Institute of Technology, Madras</td>
<td>Mechanical Engineering</td>
<td>B Tech - 1976</td>
</tr>
</tbody>
</table>

APPOINTMENTS

2009 - Present  **Senior Associate Dean** The Smeal College of Business, Penn State Univ.
1999 - Present  **Anchel Professor of Marketing** The Smeal College of Business, Penn State Univ.
1998 - 1999    **Professor of Marketing**, The Smeal College of Business, Penn State Univ.
1993 - 1998    **Associate Professor of Marketing**, The Smeal College of Business, Penn State Univ.
1984 - 1992    **Assistant Professor of Marketing**, The Wharton School, Univ. of Pennsylvania.
1983 - 1984    **Lecturer**, Kellogg Graduate School of Management, Northwestern Univ.

RELATED PUBLICATIONS AND PRESENTATIONS

Lilien, Gary L., Arvind Rangaswamy, and Arnaud De Bruyn (2007) *Principles of Marketing Engineering*, published Trafford Publications. (For more information, visit [www.mktgeng.com](http://www.mktgeng.com)).


SYNERGISTIC ACTIVITIES

Research Director, eBusiness Research Center, The Smeal College of Business, Penn State Univ.
Co-Founder, DecisionPro, Inc. State College, PA (www.decisionpro.biz)

RECENT COLLABORATORS

- Gary L. Lilien, Penn State University
- Arnaud De Bruyn – ESSEC Business School, France
- Wayne S. DeSarbo – Penn State University

GRADUATE ADVISORS

Andris Zoltners (PhD), Nemmers Professor of Marketing, Northwestern University
Prabhakant Sinha (PhD), Founder, ZS Associates, Evanston, Illinois

GRADUATE STUDENTS

Joonwook Park, 2007 (Southern Methodist University)
Tarun Kushwaha, 2007 (PhD from Texas A&M; Now at University of North Carolina)
Hari Prasad Tadakamalla, 2008 (Oracle Corporation)
Ushanandini Raghavan, 2008 (Bon-Ton Stores)
Education and Training:
- Loyola College, Baltimore, MD, MBA, 1983
- Morgan State University, Baltimore, MD, Chemistry, B.S., 1974.

Research and Professional Experience:
- Writer/Editor, Technical Analyst, Morgan State University School of Engineering 8/2004 to present. Produce technical documents, manage special projects, support in implementation of strategic plan.
- Principle Owner and Sr. Consultant, R & B Unlimited, Inc., 2300 Calvert Street, Baltimore, Maryland 21218; 1/1989 to 4/2004 – Provided business planning, development and technology transfer consulting services to for profits, non-profits and government agencies

Synergistic Activities:
- Member Baltimore Workforce Investment Board (2001 to present)
- Founding Member and Member Board of Directors of the Jobs Opportunity Task Force (2000 to present)
- As consultant with R&B Unlimited, Inc, Founder and manager of worker-owned cooperative
- As consultant with R&B Unlimited, Inc. Project manager of residential weatherization project

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers: None
Dr. Ali Rashid
PPG Industries, Inc. | Glass Business & Development Center | 400 Guys Run Road | Cheswick, PA 15024
(412) 820-8511 | arashid@ppg.com

Education and Training:
2001-2003  Postdoctoral Researcher, Physics Department, ETH, Switzerland
2001       Ph.D. in Physical Chemistry, University of Nebraska-Lincoln, USA
1995       B.S. in Chemistry, City University of New York, USA

Research and Professional Experience:
Senior Research Scientist, PPG Industries, Pittsburgh, PA   12/2008-Present
- Performed sensor development for intelligent solutions for aerospace products
- Thin film stacks development for solar control in cabin windows
- Project management of two products to be commercialized in 2011
- Directed and coordinated marketing, manufacturing and external research activities

R&D Project Scientist, Discovery Group, PPG Industries   12/2006-12/2008
- Developed new technologies for next generation glass products.
- Among these technologies were, IR reflective glass coating for the solar market
- Hybrid organic/inorganic solar cells
- Electrochromic materials and devices
- Electrically conductive coating for static dissipation in the aerospace industry
- Polymer composites with nanotubes for light weight and ballistic applications
- Nano-particle infused coating to improve their properties

Research Fellow, Quantum Electronics Device Group, 12/2003-02/2005
School of Physics University of New South Wales, Australia.
- Led the establishment of UNSW’s Organic Electronic and Optoelectronic Device Fabrication Facility
- Designed, tested and operated a facility for the growth of high quality organic semiconductor crystals, thin films and nanotubes using vacuum deposition technology
- Designed Organic-inorganic hybrid materials and electrodeposited polyaniline thin films for the fabrication of electronic devices, sensors and solar cells.

Publications: None

Synergistic Activities: None

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers

Collaborators and Co-editors: None

Graduate and Post-doctoral Advisors and Advisees: None
DAVID R. RILEY; ASSOCIATE PROFESSOR
Dept of Arch. Engineering
Director: Center for Sustainability
Penn State University

PROFESSIONAL PREPARATION

<table>
<thead>
<tr>
<th>Institution</th>
<th>Program</th>
<th>Degree</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penn State University</td>
<td>Architectural Engineering</td>
<td>Post Doctoral</td>
<td>1995.</td>
</tr>
<tr>
<td>Penn State University</td>
<td>Architectural Engineering</td>
<td>PhD</td>
<td>1994.</td>
</tr>
<tr>
<td>Penn State University</td>
<td>Architectural Engineering</td>
<td>BAE</td>
<td>1991.</td>
</tr>
</tbody>
</table>

APPOINTMENTS

2001 - Present  Associate Professor; Dept. of Architectural Engineering, Penn State Univ.
2000  Associate Professor; Dept. of Construction Management, Univ. of Washington.
1997- 2000  Adjunct Professor; Dept. of Architecture, Univ. of Washington.
1996 -2000  Assistant Professor; Dept. of Construction Management, Univ. of Washington.
1991- 94  Research Assistant; Dept. of Architectural Engineering, Penn State Univ.

RELATED PUBLICATIONS AND PRESENTATIONS


SYNERGISTIC ACTIVITIES

Director; Penn State Center for Sustainability (CfS)
Director; American Indian Housing Initiative (AIHI)
Director; Partnership for Achieving Construction Excellence (PACE)
Director; DOE Northern Mid Atlantic Solar Education and Training Center
Director; DOE GridStar: Smart Grid Education and Training Center

RECENT COLLABORATORS

- Michael Horman Penn State University - Chaz Haba, ICEL Systems, CA
- Jelena Srebric, Penn State University - Don Bradley, Solar Strategies, Inc
- Samuel Dennis, University of Wisconsin - Victor Sanvido, Southland Industries
- Amy Glasmeier, MIT - Jeffrey Brownson, Penn State
- Joel Anstrom, Penn State University - Stephen Treado, Penn State University
- Patrick McDaniel, Penn State University - Charles Wilson, Alliance to Save Energy

Graduate Advisors

Victor Sanvido (PhD); Executive Vice President, Southland Industries
Paul Seaburg (Post Doctoral), Southern Illinois University
Paul Romano, RA, CEM, LEED AP  
NJIT Center for Building Knowledge, Senior Research Architect

Education and Training:  
Bachelor of Architecture, Magna cum Laude, Pratt Institute, 1992  
Certificate in Project Management, New York University, in progress

Research and Professional Experience:  
NJIT Center for Building Knowledge, 2004 - Present  
Senior Research Architect. Supports the Centers commercial and institutional buildings research and technical assistance efforts, including program support for the New Jersey Clean Energy Program and Public Service Electric and Gas.

Platt Byard Dovell White, (formerly Buttrick White & Burtis), 2000 – 2004  
Project Architect. Team leader for the addition to and renovation of the City University of New York’s largest library at Brooklyn College. Developed a campus-wide master plan and provided design, documentation, and construction administration services for several capital construction projects at the historically significant Marymount Manhattan College urban campus.

Associate. Developed prototypical housing under the US Department of Energy’s Building America program for several large production home builders throughout the nation incorporating innovative, cost effective technologies. Conducted applied research and field assessment testing of building products and assemblies for several large manufacturers including DuPont, Louisiana Pacific, and Greenstone Industries. Authored a volume for the U.S. Department of Housing and Urban Development Rehab Guide identifying best practices and innovative technologies suitable for renovation of windows and doors in residential buildings.

Publications (patents, copyrights, and software systems)

- Commercial Buildings Multimedia Series, Principal Curriculum Developer, DuPont Building Knowledge University, 2005
- 21st Century Schools Design Manual, Editor and contributing author, New Jersey Schools Construction Corporation, 2004
- Blue Sky Construction Details, Editor, Blue Sky Foundation, 1998

Synergistic Activities:

- Developed and delivered training on whole building commissioning practices for the NJ Schools Development Authority, responsible for a $15 billion school construction program across the state.
- Managing implementation of a retro-commissioning pilot program for Public Service Electric and Gas, New Jersey’s largest utility.
- Developed and produced two online courses on energy efficient design for NSTAR, the largest investor-owned utility in Massachusetts.
- Developed a 40-hour course curriculum - titled, “An Introduction to Energy Auditing and Building Performance” – for NJ Community College’s “green workforce” initiative.

Collaborators and Co-editors / Graduate and Post-doctoral Advisors and Advisees: NA
Maryam Saeedifard  
School of Electrical and Computer Engineering, Purdue University  
EE146, 465 Northwestern Ave., West Lafayette, IN 47907  
Phone: (765) 494-4272, maryam@ecn.purdue.edu

EDUCATION AND TRAINING

- University of Toronto  
  Electrical Eng.  
  Postdoctoral  
  2009
- ABB Switzerland Ltd.  
  Electrical Eng.  
  Internship  
  2008
- University of Toronto  
  Electrical Eng.  
  Ph.D.  
  2008
- Isfahan University of Technology, Isfahan, Iran  
  Electrical Eng.  
  M.Sc.  
  2002
- Isfahan University of Technology, Isfahan, Iran  
  Electrical Eng.  
  B.Sc.  
  1998

RESEARCH AND PROFESSIONAL EXPERIENCE

- Assistant Professor, Purdue University, West Lafayette, IN  
  Jan. 10-Present
- Postdoctoral fellow, University of Toronto, Toronto, ON, Canada  
  Sep. 08-Dec. 09
- Visiting Research Associate, ABB Switzerland Ltd., Baden, Switzerland  
  Sep. 07-Aug. 08
- Research Assistant, University of Toronto, ON, Canada  
  Sep. 04-Aug. 07

RELEVANT PUBLICATIONS


SYNERGISTIC ACTIVITIES

• Editor of IEEE Trans. on Sustainable Energy
• Member of Institute of Electrical and Electronic Engineers (IEEE)

COLLABORATORS AND OTHER AFFILIATIONS

Collaborators:
Josep Pou (Technical University of Catalonia, Barcelona), Saeed Mohammadi (Purdue University), Hassan Nikkhajoei (Al-Ain University, United Arab Emirates), Alireza Bakhshai (Queen’s University, Canada)

Graduate and Postdoctoral Advisor:
Reza Iravani: University of Toronto (post-doctoral and Ph.D. advisor)
Alireza Bakhshai: Queen’s University (M.Sc. Advisor)
Laura A. Schaefer  
Associate Professor, Department of Mechanical Engineering and Materials Science  
Associate Director, Center for Energy, and Deputy Director, Mascaro Center for Sustainable Innovation, University of Pittsburgh

**Education and Training:**

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<tr>
<th>Degree</th>
<th>Year</th>
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<th>Location</th>
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<tr>
<td>Ph.D.</td>
<td>2000</td>
<td>Mechanical Engineering</td>
<td>Georgia Institute of Technology, Atlanta, Georgia.</td>
</tr>
<tr>
<td>M.S.</td>
<td>1997</td>
<td>Mechanical Engineering</td>
<td>Georgia Institute of Technology, Atlanta, Georgia.</td>
</tr>
<tr>
<td>B.S.</td>
<td>1995</td>
<td>Mechanical Engineering</td>
<td>Rice University, Houston, Texas.</td>
</tr>
<tr>
<td>B.A.</td>
<td>1995</td>
<td>English</td>
<td>Rice University, Houston, Texas.</td>
</tr>
</tbody>
</table>

**Research and Professional Experience:**

- 2008 - Present  
  *Associate Director, Center for Energy, University of Pittsburgh.*
- 2006 - Present  
  *Associate Professor, Mechanical Engineering, University of Pittsburgh.*  
  *Deputy Director, Mascaro Sustainability Initiative, University of Pittsburgh.*
- 2000 - 2006  
  *Assistant Professor, Mechanical Engineering, University of Pittsburgh.*
- 1998 - 2000  
  *Graduate Research Assistant, Mechanical Engineering, Georgia Inst. of Tech.*
- 1995 - 1998  
  *NSF Graduate Research Fellow, Mechanical Engineering, Georgia Tech.*

**Related Publications:**


**Synergistic Activities:**

2. Service: Executive Committee, AESD, ASME; TC 8.3 and TC 1.1, ASHRAE;  
3. Session and Track Chair: Advanced Energy Systems Division and Heat Transfer Division, ASME; TC 1.1 and TC 8.3, ASHRAE.

**Recent Collaborators, Advisors, and Advisees:**

- **U. Pitt:** Eric Beckman, Mary Besterfield-Sacre, Melissa Bilec, Minking Chyu, William Clark, Peyman Givi, Kent Harries, Oleg Prokopyev, Andrew Schaefer, Jeffrey Vipperman, Lisa Weiland;  
- **CMU:** Volker Hartkopf, Vivian Loftness, Jeanne Van Briessen, David Greve;  
- **PSU:** David Riley, Susan White;  
- **U. Auckland:** Hamish Waterer, Rosalind Archer.  
- M.S. and Ph. D. Advisor: Samuel Shelton, Associate Professor, Georgia Institute of Technology.  
- Doctoral Students: Jie Bao, Justin DeBlois, Michael Guido, Michael Ikeda, Tony Kerzmann, Yixin Lu, Veronica Miller, Peng Yuan, Florian Zink.  
- M.S. Student: Raymond Brush, Ben Leven. Post-Doctoral Scholars: Peiwen Li, Yuksel Korkmaz, Mustafa Bayrak, Florian Zink.
James C. Sexton – Curriculum Vitae

Program Director, Computational Science Center
IBM T. J. Watson Research Center, Yorktown Heights, NY
P. O. Box 218, Yorktown Heights, NY 10598
email: sextonjc@us.ibm.com
phone: +1 914 945 1679

Areas of Special Interest:

Professional Preparation:
Trinity College Dublin Theoretical Physics B.A. MOD (1980)
Columbia University NY Theoretical Physics Ph.D. (1986)

Appointments:
Jun 2004 - Present Research Staff Member, IBM T. J. Watson Research Center
Jan 1991 - Jun 2004 Lecturer then Professor, Trinity College Dublin
Apr 1988 - Jan 1991 Research Fellow, IBM T. J. Watson Research Center
Sep 1986 - Apr 1988 Research Fellow, Institute for Advanced Study, Princeton
Sep 1984 - Sep 1986 Research Fellow, Fermi National Accelerator Laboratory

Adjunct Appointments:
Sep 2002 - Dec 2004 Board Member, Board of Trinity College Dublin
Jun 1998 - Jun 2004 Dir and Founder, Trinity Center for High Performance Computing
Sep 1998 - Sep 2001 Senior Research Consultant, Hitachi Dublin Laboratory
Jan 1995 - Apr 1995 Hitachi HIVIPS Fellow, Hitachi Central Research Laboratory

Honors and Awards:
Elected Fellow, Trinity College Dublin, 1997
Irish Research Scientist’s Association, Gold Medal, 1998
Gordon Bell Peak Performance Award, Supercomputing Conference 2005
Gordon Bell Peak Performance Award, Supercomputing Conference 2006
Gordon Bell Special Achievement Award, Supercomputing Conference 2006

Selected Publications:
Rachael L. Shwom, Ph.D.
Dept. of Human Ecology, Rutgers University,
55 Dudley Road, New Brunswick, NJ 08901
Tel: 732-932-9153 ext. 416; E-mail: shwomrac@rci.rutgers.edu

Education & Training:
Syracuse University Syracuse, NY B.A. 1999 English and Textual Studies
Duke University Durham, NC M.S. 2001 Environmental Management
Michigan State University E. Lansing, MI Ph.D. 2008 Sociology

Research & Professional Experience:
01/2009 to present Assistant Professor of Climate and Society, Department of Human Ecology
Rutgers University, New Brunswick, NJ
10/01-08/04 Community Program Manager
Consortium for Energy Efficiency, Boston, MA,

Relevant Publications:

Synergistic Activities:
National Science Foundation funded research from the Innovation and Organizational Change Program; Past Organizer/ Reviewer/Participant for Behavior Energy and Climate Change Conference; Graduate Student Representative, Environment., Technology & Society Section, American Sociological Association; Developing curricular materials for “Energy and Society” undergraduate class.

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:
Bidwell, David - Michigan State University, Sociology Graduate Student; Dan, Amy -Michigan State University, Environmental Science and Policy Program, Post-doctoral fellow; Dietz, Thomas -Michigan State University, Sociology and Environmental Science and Policy Program, Full Professor; Ehrenfeld, Joan -Rutgers University, Department of Ecology, Full Professor; Gray, Steven - Rutgers University, Department of Ecology, Graduate Student; Lorenzen, Janet - Rutgers University, Department of Sociology, Graduate Student; McCright, Aaron - Michigan State University, Sociology and Environmental Science and Policy Program, Assistant Professor; O’Neill, Karen - Rutgers University, Department of Human Ecology, Asst. Prof.; Rudel, Thomas - Rutgers University, Department of Human Ecology, Full Professor; Maguire, Lynn - Duke University, Professor of the Practice of Environmental Decision Analysis, Director of Professional Studies; Kalof, Linda - Michigan State University, Sociology Department & Animal Studies Program Director; Frank, Ken - Michigan State University, School of Education and Fish and Wildlife Department.
William M. Sisson, Director, Sustainability, United Technologies Research Center

Education and Training:
MIT/Sloan School of Mgt.; Cambridge, MA; MBA with Thesis, Advisor: Eleanor D. Westney, 1999
RPI at Hartford ; Troy, NY; MS Mechanical Engineering, 1991;
Virginia Tech, Blacksburg, VA; BS Engineering Science and Mechanics, 1985

Research and Professional Experience:
Director, Sustainability; UTRC, UTC Liaison Delegate to World Business Council for Sustainable Development (WBCSD): Reporting to UTC SVP, Science and Technology and presently serves UTC in strategic capacity for technology sustainability and leadership including the WBCSD, buildings energy efficiency technology strategy, advocacy and communications, and implementation of UTC’s building energy efficiency program with UT Realty and UTC’s Environmental, Health and Safety organization;
Director, Sustainability; UTRC: WBCSD Buildings Project Responsible for creation, alignment, sponsorship, and organization of $15M/4yr WBCSD Project on sustainable, energy efficiency in buildings, co-chaired by UTC and Lafarge, partnered with 14 multi-national firms ranging from energy to building services, and in conjunction with UTC Chairman’s Office;
Director, Carrier Program Office, UTRC: Leader of multi-disciplined research teams for the adoption of new technologies and product insertion within the Carrier business operations.
Responsible for creation, strategic definition, portfolio leadership, leadership alignment, growth and effective execution of $15-20M RD&D portfolio;
Senior Global Product Manager, Carrier Corporation; Carrier Electronics Commercial Business Unit: Responsible for $34M in global internal sales for commercial HVAC integrated equipment and building management system controls and software delivering 12-15% ROS annually.
MIT Sloan Fellow Candidate, Sponsor UTC: One of five UTC sponsored full-time candidates in 1998 for MIT’s Sloan Fellows MBA program with thesis entitled: “Fueling Innovation and Growth Strategies using Corporate Venturing”
Department Leader, UTRC, Mechatronic Systems: Mechatronic systems branched technology areas of systems, controls, and components around a core theme of advancing UTC’s RD&D interests in systems level solutions. Established, operated and managed department budget with 60 staff and 5 Group Leader direct reports.
Group Leader, UTRC, Control Components and Systems: Led group of 5-10 principle investigators in the areas of smart materials, advanced actuation, and sensor systems for controls.
Senior Research Engineer, UTRC, Electronic Systems: Led and managed key research projects for UTRC in the areas of advanced experimental facilities and high bandwidth actuator systems for Stall Line Management (SLM) of gas turbine engines; HVAC comfort systems experimental facility development and experimental evaluations, and developed inspection techniques and systems for nondestructive testing; led field teams involved with testing and scale systems installations for solid rocket motor inspections;
Publications: (including patents, copyrights, and software systems)
Co-developer of WBCSD EEB Policy Decision Analysis Model, 2009

Synergistic Activities:
Co-chair, WBCSD Energy Efficiency in Buildings Project
Working Group Lead, WBCSD EEB In Action
Member Building Energy Efficiency Codes Network (BEECN)

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers: Provide the following information in this section:

**Collaborators and Co-editors** None
**Graduate and Post-doctoral Advisors and Advisees:** None
Biographical Sketch
Martin J. Sliwinski
Professor of Human Development & Family Studies / The Pennsylvania State University

Education and Training:
1986 B.A. Interdisciplinary Studies Georgetown University, Washington D.C.

Research and Professional Experience:
2009-present Pennsylvania State University, Human Development and Family Studies
2009-present Director: Gerontology Center, Pennsylvania State University
2000-2006 Syracuse University, Department of Psychology.
1992-2000 Albert Einstein College of Medicine, Department of Neurology
1995-2000 Director, Biometrics Unit: Albert Einstein College of Medicine, Rose F. Kennedy Center for Mental Retardation and Human Development. (Asst Dir. 1993-4)

Publications:


Collaborators and Co-editors
Richard Lipton, Albert Einstein College of Medicine
Joshua Smyth, Syracuse University
Brent Small, University of South Florida

Graduate and Post-doctoral Advisors and Advisees:
Advisor: Herman Buschke, Professor of Neurology, Albert Einstein College of Medicine.
2008, Christopher Terry, PhD, Assistant Professor, Elmira College, NY
2007, Christina Wasyllyshyn, PhD, Contractor, US Navy
2006, Robert Stawski, PhD, Faculty Research Fellow, University Michigan (Institute for Social Research)
Biographical Sketches– Gregory T. Smith/Preconstruction Manager/Turner Construction

Education and Training:
BSCE, Construction Management, Lawrence Technological University, 1986
MSCE, Building Envelope Systems, Drexel University, 2000
• 30-Hour OSHA Certified
• LEED Accredited Professional

Research and Professional Experience:
Villanova University, Vasey Hall Phase I Renovation/Addition, Philadelphia, PA – This project includes renovations to an existing 1930s building that is now used for theatre productions and classes. The scope includes modifications and systems for compliance with correct building codes and compliance with the Americans with Disabilities Act. This renovation includes installing a new elevator, ramps, handrails, and handicap accessible bathrooms. This project also includes upgrading the entire building with a new sprinkler and fire alarm system.

SCA Americas Headquarters, Philadelphia, PA - This project includes 70,000 SF of interior fit-out in the newly constructed Cira Centre. This project includes an elliptical monumental communicating stair, a sliding glass office front system, a data center, a product testing center, and a glass waterwall feature in the reception area. This project is also Turner’s 100th Green Building project nationally, and the first LEED-CI-certified project for the Philadelphia territory.

Academic Building for Towson University, Harford Community College, Bel Air, MD – Turner is providing preconstruction and construction services for a 55,000 SF, 3 to 4-story Towson University Academic Center building on the west campus of Harford Community College. This Towson University satellite campus is intended to provide opportunity to residents of NE Maryland, and others located in geographical proximity, to complete their 4-year undergraduate and/or graduate degree exclusively at this location. The building will contain wet labs, computer labs, retail, offices, and classrooms, and is designed to achieve LEED® Silver Certification.

Skirkanich Hall, University of Pennsylvania, Philadelphia, PA – Preconstruction services for a 58,000 SF research/teaching facility. This facility provides labs and office space for the bioengineering department, improves circulation through the School, creates a grand entrance from 33rd St., and is architecturally respectful of its historic neighbors.

School of Veterinary Medicine, University of Pennsylvania, Philadelphia, PA – Turner provided construction management services for the five-story, 122,400 SF vet school. This state-of-the-art facility includes small seminar rooms, library space, research laboratories, a vivarium, lecture halls, and a conference center. The challenging site lies on a brownfield site amidst roads, a subway tunnel and the operating veterinary hospital. Before building could occur, roads and intersections had to be relocated and the site had to be dewatered and waterproofed. The interior includes all new finishes, architectural millwork, terrazzo floors, acoustical ceilings and laboratory equipment. The mechanical and electrical systems include new AHUs, ductwork, mechanical piping, glycol system, laboratory gas distribution equipment, water processing equipment, new electrical distribution equipment, emergency power system and fixtures.
**Rorer Center for Science & Technology, Chestnut Hill Academy, Philadelphia, PA** - The new facility consists of a two story stone and stucco building (23,800 GSF), on the campus of Chestnut Hill Academy. Work also includes installation of a new Middle School parking lot on the north end of the campus. The new parking lot incorporates a storm water management system with porous paving, an underground retention system and is designed to accept storm water from the Inn Building’s roof drains. Building and sitework will be designed and constructed following “green design” intent. Project earned a LEED® Gold Rating.

**Synergistic Activities:** n/a

**Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:** n/a

**Collaborators and Co-Editors:** n/a

**Graduate Advisors:** n/a

**Thesis Advisor for:** n/a

**Postgraduate-Scholar Sponsor:** n/a
PROFESSIONAL PREPARATION
- Ph.D., Industrial and Systems Engineering, and Certificate in Computer Integrated Manufacturing Systems, The Georgia Institute of Technology, Atlanta, GA.
- M.S. in Industrial & Operations Engineering, Univ. of Michigan, Ann Arbor, MI
- B.S. with distinction, Industrial & Manufacturing Systems Engineering, Pennsylvania State University, University Park, PA

APPOINTMENTS / HIGHLIGHTS:
Jan. 2010 to present: Sr. Manager, Smarter Buildings Research, Industry Solutions and Emerging Business, IBM T. J. Watson Research Center, Yorktown Heights NY. Responsible for developing and driving Research strategy worldwide to create innovative smarter building solutions. Instrumental in defining a partnership with universities for research collaboration to help address a major city’s energy challenges. Member of NIST Smart Grid Interoperability Roadmap, OASIS Energy Interoperation Technical Charter on OpenADR, OASIS Blue Steering Committee. Co-Chair of Watson Women’s Network.
Jan 2005 – Dec 2009: Sr. Manager, Global Small and Medium Business, IBM T. J. Watson Research Center, Yorktown Heights, NY. Responsible for technical strategy, research and prototype deployment of advanced technologies to meet the needs of small and medium businesses globally. Successfully drove project that exploited Web 2.0 and collaboration technologies with text mining and sophisticated search algorithms to improve business partner productivity. Co-led Industry Impacts of Climate Change study.

SELECT PUBLICATIONS

SYNERGISTIC COLLABORATIONS
General Chair, 20002 Winter Simulation Conference
Senior Member, IEEE and IIE and Member, INFORMS
Jelena Srebric, Ph.D.

Associate Professor of Architectural Engineering
Pennsylvania State University
222 Engineering Unit A
University Park, PA 16802

Phone: 814-863-2041
Fax: 814-863-4789
Email: jsrebric@psu.edu
http://www.engr.psu.edu/jsrebric/

Education and Training

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<th>Institution</th>
<th>Major</th>
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<tr>
<td>University of Belgrade, Serbia</td>
<td>Mechanical Engineering</td>
<td>B.Eng./1994</td>
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<tr>
<td>University of Belgrade, Serbia</td>
<td>Mechanical Engineering</td>
<td>M.Sc./1997</td>
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<tr>
<td>Massachusetts Institute of Technology, MA</td>
<td>Building Technology</td>
<td>Ph.D./2000</td>
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Research and Professional Experience

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<tr>
<td>06/06-date</td>
<td>The Pennsylvania State University, PA</td>
<td>Associate Professor</td>
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<tr>
<td>09/09-12/09</td>
<td>Harvard School of Graduate Design, MA</td>
<td>Visiting Professor</td>
</tr>
<tr>
<td>08/00-05/06</td>
<td>The Pennsylvania State University, PA</td>
<td>Assistant Professor</td>
</tr>
<tr>
<td>09/97-08/00</td>
<td>Massachusetts Institute of Technology, MA</td>
<td>Research Assistant</td>
</tr>
<tr>
<td>01/95-08/97</td>
<td>University of Belgrade, Serbia</td>
<td>Research Associate</td>
</tr>
<tr>
<td>Summer 92</td>
<td>Physikalisch-Technische Bundesanstalt, Germany</td>
<td>Research Engineer</td>
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Ten Publications Most Related to the Project


Synergistic Activities
Received CAREER award from NSF (National Science Foundation) and SERCA award from NIOSH (National Institute of Occupational Safety and Health).
Direct, designed and built a state-of-the-art environmental laboratory for graduate research and education (http://www.engr.psu.edu/jsrebric/facility.html)
Presented twenty one invited guest lecturers in the U.S. (including Stanford, MIT, and Harvard) and abroad (including Canada, United Kingdom, Serbia, China and Thailand).
Authored one book, one book chapter, two engineering handbook chapters, twenty seven journal papers, twenty one conference papers, and seven final reports to sponsors.
Develop two new graduate courses AE559 “Computational Fluid Dynamics in Building Design,” AE543“Research Methods in Architectural Engineering.”
Developed CFD0 program, a simple computational program for building environment design for engineers and architects (more than 200 students from MIT have used the program).
Chair ASHARE (American Society of Heating, Refrigerating and Air Conditioning Engineers) research committee on indoor environment, which creates requests for proposal, organizes review panels, and monitors research progress and deliverables.

Collaborators and Co-Editors in the Past 48 Months
J. Braun (Purdue University, IN), E. Burnett (Penn State University, PA), Q. Chen (Purdue University, IN), L.R. Glicksman (Massachusetts Institute of Technology, MA), , D. Riley (Penn State University, PA), J.D. Spengler (Harvard), C. Tantasavasdi (Thammasat University, Thailand), and X. Yang (Tsinghua University, China), and Z. Zhai (University of Colorado, CO)

Graduate Students Advised and Postgraduate-Scholars Sponsored during the Last 5 Years
T. Ayata (Bozok University, Turkey), B. Burley (Affiliated Engineers Inc., MD), D. Davidovic (Simpson Gumpertz & Heger Inc., MA), M. Heidarinejad (Penn State Univ., PA), D. Jareemit (Penn State Univ., PA), A. Mansour (National Research Centre, Egypt), K. K. Moon (Penn State Univ., PA), T. Nawrocki (BSA Life Structures, IN), A. Novoselac (University of Texas Austin, TX), J. Pinon (SGH, MA), V. Vukovic (Österreichisches Forschungs- und Prüfzentrum Arsenal Ges.m.b.H., Austria), P.C. Tabares-Velasco (National Renewable Energy Laboratory), M. Zhao (Penn State Univ., PA), and S. Zhu (Harvard School of Public Health, MA).
James C. Sturm

Director, Princeton Institute for the Science and Technology of Materials (PRISM)
William and Edna Macaleer Professor of Engineering and Applied Science
Professor, Department of Electrical Engineering
Princeton University

Professional Preparation
Princeton University  Electrical Engineering (engineering physics)  B.S.E. 1979
Stanford University  Electrical Engineering  M.S.E.E., 1981
Stanford University  Electrical Engineering  Ph.D., 1985

Appointments
2003 – Present  Director, Princeton Institute for the Science and Technology of Materials (PRISM)
1996 – 2003  Director, Center for Photonics and Optoelectronic Materials, Princeton University
1994 - 1995  Von Humboldt Fellow, Faculty of Elektrotechnik, University of Stuttgart
1985 - 1986  Research Associate, Stanford University, for J.F. Gibbons
1981  Design Engineer, Siemens Corporation, Munich, Germany
1979 – 1980  Microprocessor Design Engineer, Intel Corporation

Selected Publications
Nicolas Sunderland Ph.D.

Education
2000  Ph.D., Chemistry,  Pennsylvania State University, State College, PA
1995  BS, Chemistry, Honors Carleton University, Ottawa, Ontario

Professional Experience
2007 - Senior Associate Scientist, Bayer Material Science, Polycarbonate Business Development—Product Application Development Group, Pittsburgh, PA
Responsibilities: Identification of new product application opportunities in the Electrical Enclosures and Information Technology market segments and support of customer commercialization efforts
• Led Bayer’s NAFTA EE/IT application development efforts, supporting customer commercialization via project management and customer advisory
• Initiated projects to support new customer applications—successfully specified resins at OEMs for LED lighting, cellular phones, and post-consumer recycling applications
2002 - 06 Research Associate, Wellman Inc., Fibers Division R&D, Fort Mill, SC
Responsibilities: Identification of new product opportunities and designing research projects in order to increase profitability and competitiveness
• Led all aspects of Wellman Inc.’s global antimicrobial strategy, including participation with key leaders to define business growth strategy, identification of competitive threats, patent strategies, and customer interactions
• Developed and launched a polyester antimicrobial fiber for home and industrial markets – increased product line sales from 200M to 2MM lbs/yr
2002 - 06 Product Safety Coordinator, Wellman Inc., Fibers Division, Fort Mill, SC
Responsibilities: Ensure Wellman fiber compliance in all safety and regulatory fields
• Engaged cross-functional team to ensure Wellman Inc. fibers met safety and regulatory requirements (such as FDA) and approved commercialization
2000 - 02 Platform Chemist, GE Plastics, Crystalline Technology, Mt. Vernon, IN

Patents and Publications
6. Provisional patent detailing the use of a sulfonated polyester as a cationic dye enhancer and pigment dispersant in polyamide/polyester blends
Biographical Sketch: Charles Tong
Research Staff Member, Center for Applied Scientific Computing
Lawrence Livermore National Laboratory

Education and Training:
Ph.D., Computer Science, University of California, Los Angeles, August 1990
B.S., Electrical Engineering/Computer Science, University of California, Berkeley, June 1982
M.S., Electrical and Computer Engineering, University of California, Davis, August 1986

Research and Professional Experience:

• Sept 1999 to present: Staff Member, Lawrence Livermore National Laboratory, Livermore, CA. Perform research into numerical methods for partial differential equations, parallel numerical computing, and uncertainty quantification.

• Feb 1996 to Sept 1999: Senior Member of Technical Staff, Sandia National Laboratories, Livermore, CA. Perform research into numerical methods for partial differential equations, parallel numerical computing, and uncertainty quantification.

• Jan 1994 to Feb 1996: Assistant Professor, Mathematics Department, Hong Kong University of Science and Technology, Hong Kong. Taught courses in numerical analysis and scientific computing, supervised graduate students, served as undergraduate student adviser.

• Dec 1990 to Dec 1993: Senior Member of Technical Staff, Sandia National Laboratories, Livermore, CA. Perform research into numerical methods for partial differential equations and parallel numerical computing.

• Aug 1990 to Dec 1990: Postdoctoral Researcher, University of California, Los Angeles

Selected Publications:


Software Systems: PSUADE: a problem solving environment for uncertainty analysis and design exploration which includes many mathematical and statistical tools for uncertainty analysis, sensitivity analysis, response surface analysis, risk analysis and numerical optimization.

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:

Collaborators and Co-Editors:
David Higdon (LANL), Professor Herbert Lee (UC Santa Cruz), Robert Falgout (LLNL), Ulrike Yang (LLNL), Allison Baker (LLNL), Barry Lee (PNNL), Zhiqiang Cai (Purdue), Gardar Johannesson (LLNL), Gianluca Iccarino (Stanford)

Thesis Advisor: Prof. Tony Chan, Chancellor, Hong Kong University of Science and Technology
CV

Stephen Treado
Associate Professor
Department of Architectural Engineering
Pennsylvania State University
University Park, PA 16802

Education
B.S., Environmental Engineering, Stanford University, 1974
M.S., Mechanical Engineering, University of Maryland, 1983
Ph.D., Mechanical Engineering, University of Maryland, 1987

Previous Experience
Deputy Associate Director for Technology and Environmental Policy
White House Council on Environmental Quality
Executive Office of the President
Washington, DC 20503

Mechanical Engineer, Acting Group Leader, Project Leader
Mechanical Systems and Controls Group/ Lighting Group/Thermal Analysis Group
Building Environment Division, Building and Fire Research Laboratory
National Institute of Standards and Technology, Gaithersburg, MD 20899

Adjunct Professor
Professional Masters of Engineering Program
University of Maryland, College Park, MD 20742

Publications

Treado, S., Vinh, A., Bushby, S., Authentication and Authorization of Building Information Users in BACnet, NIST Technical Note 1615, National Institute of Standards and Technology, Gaithersburg, MD 20899, 10/08


Synergistic Activities
ASHRAE- SSPC 135 BACnet- Member
CIB- TG66- Energy and the Built Environment,
W108- Climate Change and the Built Environment
IESNA- Controls Protocols Committee
Security Industry Association- Access Control Standards Committee

Collaborators and Co-editors: David Holmberg, NIST, Mark Kedzierski, NIST

Graduate and Post-doctoral Advisors and Advisees: None
BIOGRAPHICAL SKETCH

Athanasios (Thanos) Tzempelikos
Assistant Professor of Civil Engineering
Purdue University
550 Stadium Mall Dr.
West Lafayette IN 47907

Phone: (765)-496-7586
Fax: (765)-494-0395
Email: ttzempel@purdue.edu

Education and Training:

<table>
<thead>
<tr>
<th>Institution</th>
<th>Major</th>
<th>Degree &amp; Year</th>
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<tbody>
<tr>
<td>National University of Athens</td>
<td>Physics</td>
<td>B.Sc., 1999</td>
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<tr>
<td>Concordia University</td>
<td>Building Engineering</td>
<td>M.A.Sc., 2001</td>
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<tr>
<td>Concordia University</td>
<td>Building Engineering</td>
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Research and Professional Experience:

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<th>Period</th>
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<tbody>
<tr>
<td>10/09-date</td>
<td>Purdue University, USA</td>
<td>Assistant Professor of Mechanical Engineering (by courtesy)</td>
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<tr>
<td>08/08-date</td>
<td>Purdue University, USA</td>
<td>Assistant Professor of Civil (Architectural) Engineering</td>
</tr>
<tr>
<td>09/05-06/08</td>
<td>NSERC/Concordia University, Canada</td>
<td>Post-doctoral Fellow/Research Associate</td>
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<tr>
<td>01/00-06/05</td>
<td>Concordia University, Canada</td>
<td>Graduate Research Assistant</td>
</tr>
<tr>
<td>01/04-06/04</td>
<td>Concordia University, Canada</td>
<td>Building Science lab instructor</td>
</tr>
<tr>
<td>09/08-date</td>
<td>Advanced Building Energy Consultants, Canada</td>
<td>Building energy consultant</td>
</tr>
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Publications mostly related to proposed research:


Synergistic Activities:
1. Development of the new Architectural engineering program at Purdue University (curriculum, new courses, new lab facilities and research planning), focused on energy-efficient building design.
2. Participation in the Canadian Solar Buildings Research Network: strategic NSERC grant, 5-year collaborative effort between 10 universities, government agencies and industry for solar energy utilization in buildings.
3. Development of an integrated methodology for integrated thermal-lighting design in commercial buildings, using advanced controls and innovative renewable technologies; demonstration projects and short courses.
5. Member of Steering Committee, Architectural Engineering Institute of ASCE 2011 National Conference, Member of ASHRAE Technical committees, reviewer for 5 journals and has published 30 articles in peer-reviewed journals and conference proceedings.

Collaborators and Co-editors:
A. Athienitis (Concordia University), S. Bolton, J. Braun, Q. Chen, P. Davies, E. Groll, P. Karava, (Purdue University), R. Zmeureanu (Concordia University)

Graduate advisor: A. Athienitis (Concordia University)
Post-doctoral sponsor: NSERC/Solar Buildings Research Network
Graduate students: Mark Bessoudo, Halsall Associated Limited, Toronto, Canada
Naveen Verma
Assistant Professor of Electrical Engineering
Tel: (609) 258-1424
Princeton University, Princeton, NJ 08544
Email: nverma@princeton.edu

Education and Training
• University of British Columbia Computer Engineering B.A.Sc., 2003
• Massachusetts Institute of Technology Electrical Engineering M.Sc., 2005
• Massachusetts Institute of Technology Electrical Engineering Ph.D., 2009

Research and Professional Experience
July/2009-Present  Assistant Professor of Electrical Engineering, Princeton University.
Sept./2003-May/2009  Graduate Student Research Assistant, Massachusetts Institute of Tech.
Jan./2002-Aug./2003  Circuit Design Intern, NetLogic Microsystems, Mountain View, CA.

Publications

Synergistic Activities
5. Program Committee Chair (2006) and Steering Committee Member (2007) for MIT Microsystems Laboratory Annual Review Conference (MARC).

Conflicts
Collaborators and co-editors: Prof. B. Calhoun (UVA), Ms. J. Kwong (MIT), Dr. Y. Ramadass (TI), Dr. A. Shoeb (MIT/MGH), Dr. A. Wang (TI), Dr. K. Zhang (Intel).
M.Sc. and Ph.D. Advisor: Prof. Anantha Chandrakasan (MIT).
Graduate Students: Mr. Shoaib Mohammed, Mr. Yingzhe Hu, Mr. Kyong Ho Lee (Princeton).
Jeffrey S. Vipperman  
Associate Professor, Director of Mechanical Engineering Graduate Studies  
University of Pittsburgh

**Education and Training:**
Virginia Tech  
Mechanical Engineering  
B.S., 1990  
Virginia Tech  
Mechanical Engineering  
M.S., 1992  
Duke University  
Mechanical Engineering  
Ph.D., 1997

**Research and Professional Experience:**
1/1/08-Present  
Director of Mechanical Engineering Graduate Studies  
4/05-Present  
Associate Professor of Mech. Eng., University of Pittsburgh, Pittsburgh, PA  
4/05-Present  
Associate Professor of BioEngineering, University of Pittsburgh, Pittsburgh, PA  
6/00-6/02  
Mechanical Engineer, NIOSH, Pittsburgh Research Laboratory  
1/99-Present  
Assistant Professor, University of Pittsburgh, Pittsburgh, PA  
9/97-12/98  
Assistant Professor, University of Maine, Orono, ME  
2/97-8/97  
Assistant Research Professor, Duke University, Durham, NC

**Related Publications:**

**Synergistic Activities:**
- Director of Mechanical Engineering Graduate Studies
- Fellow, American Society of Mechanical Engineers
- Executive Committee member for the Noise Control and Acoustics Division, ASME
- Past Chair of Active Noise Control Technical Committee for ASME NCAD

**Recent Collaborators, Advisors, and Advisees:**
Dr. William Clark, U. of Pittsburgh; Dr. Amro El-Jaroudi, U. of Pittsburgh; Dr. Piervincenzo Rizzo, U. of Pittsburgh; Matt Rhudy, MS, PhD Student at WVU, David DeJohn, MS, Bechtel Plant Machinery, Nate Black, MS, L3-Brashear, Jesse Bisnette, MS, US Army; Josh Magnussen, MS, Infatable Packaging, Inc.; Adam Hahn, MS, McKesson Automation; Angela Flamm, MS, Allegheny General Hospital; Adam K. Smith, MS, NIOSH, Bucci, Brian A., MS, Current PhD student; Laurel Kuxhaus, PhD, Clarkson Univ; Schimoler, Patrick, MS, Currently at PhD Student, Nathan Black, MS, L3 Communications Brashear Division.
Education and Training:

Ph.D.: Boston College, 1974 (Economics); B.A.: Harvard, 1965 (Economics)

Research and Professional Experience:

Current Position: Richard B. Worley Professor of Financial Management, Professor of Real Estate and Finance, The Wharton School; Professor of City and Regional Planning, PennDesign; Co-Director of Penn Institute for Urban Research, University of Pennsylvania

Previous Positions:
- 2004 Celia Moh Visiting Professor, Singapore Management University
- 2003-04 Grosvenor Chair Professor Selection Committee, Cambridge University
- 1998-01 Assistant Secretary for Policy Development and Research, HUD
- 1997-00 Chairperson, Wharton Real Estate Department
- 1979-94 The Wharton School, University of Pennsylvania, Associate Professor
- 1974-78 The Wharton School, University of Pennsylvania, Assistant Professor
- 1972-74 The Wharton School, University of Pennsylvania, Lecturer
- 1970 Department of Economics, University of Pennsylvania, Lecturer
- 1969-72 Department of Economics, Lecturer in Economics, Bryn Mawr College
- 1967 Department of Economics, Instructor in Economics, Boston College

Publications: (including patents, copyrights, and software systems)


Synergistic Activities: Penn Institute for Urban Research, Spatial Impact Laboratory for Urban Systems, Wharton GeoSpatial Initiative, Masters in Urban Spatial Analytics Program

Collaborators and Co-editors: Richard Bernknopf, USGS; Eugénie L. Birch, PennDesign; Carolyn Brown, PennDesign; Kevin Gillen, Econsult; Grace Wong, Wharton

Graduate and Post-doctoral Advisors and Advisees: Carolyn Brown, Kevin Gillen, Ralph Rosado, Kenneth Steif, Sergiy Stetsenko
Sigurd Wagner, Ph.D.

Title: Professor
Address: Princeton University, Department of Electrical Engineering, Princeton, NJ 08544
Phone: 609-258-4641
Fax: 609-258-6279
Email: wagner@princeton.edu

Education and Training

<table>
<thead>
<tr>
<th>Institution</th>
<th>Major/Area</th>
<th>Degree</th>
<th>Year</th>
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<tr>
<td>Post doctoral training</td>
<td>Ohio State University, Columbus, Ohio</td>
<td></td>
<td>1969-70</td>
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<tr>
<td>Graduate Education</td>
<td>University of Austria, Vienna</td>
<td>Physical Chemistry</td>
<td>1968</td>
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</table>

Research and Professional Experience

Since 1980: Princeton University, Professor of Electrical Engineering
1970-1978: Bell Telephone Laboratories, Murray Hill and Holmdel, NJ, Member of Technical Staff

Publications
   http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1362777&isnumber=29861
   http://scitation.aip.org/getpdf/servlet/GetPDFServlet?filetype=pdf&id=APPLAB000008800002020410300001&idtype=cvips&prog=normal
   http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1419164&isnumber=30682
    http://apl.aip.org/applab/v96/i4/p042111_s1

Synergistic Activities
1. S. Wagner is one of the originators of large-area flexible electronics, electronic skin, e-textiles, and the application of large-area electronics to biomedical engineering. He focuses on (i) flexible active-matrix backplanes; (ii) the interdependence of electrical and mechanical properties in film-on-foil electronics when rolled, conformally shaped, or stretched; (iii) elastic electronic surfaces and structures; (iv) elastically stretchable metal films, (v) functional cells for large area electronics including displays, solar cells, mechatronic materials, sensor skin, and e-textiles. See elastically stretchable metal films, (v) functional cells for large area electronics including displays, solar cells, mechatronic materials, sensor skin, and e-textiles. See
   http://www.ee.princeton.edu/~wagner/
2. Co-organized Sensitive Skin Workshop to open the field of skin-like electronic surfaces. This October 14-15, 1999, workshop was sponsored by NSF and DARPA. See workshop report at http://nina.ecse.rpi.edu/sensitive_skin/. Was a member of the ISAT study group on Computational Fabric. Both of these emerging technologies require the same kind of integration of very different materials - inorganic and organic semiconductors, ceramics, polymers, metals, for electronic and mechanically compliant human/machine interfaces.
3. Advised approximately 80 undergraduate researchers from within and without Princeton University, including PSI and REU students.
4. Established a lab for undergraduate instruction in the fabrication of diodes, solar cells, transistors and integrated circuits. This lab is for all sophomores in Electrical Engineering, all incoming PhD students in solid state, PhD students in nanotechnology, and undergraduate summer researchers including those coming to Princeton under the NSF-sponsored PSI and REU summer research programs.
Timothy C. Wagner  
Principal Engineer, Energy Systems Program Office  
United Technologies Research Center

**Education and Training:**

**Ph.D.  Mechanical Engineering,** February 1987, Virginia Tech, Blacksburg, VA  
**M.S.  Mechanical Engineering,** March 1983, Virginia Tech, Blacksburg, VA  
**B.S.  Mechanical Engineering,** June 1981, Virginia Tech, Blacksburg, VA

**Research and Professional Experience:**

**Feb. 87 - Present**  
Principal Engineer, United Technologies Research Center, East Hartford, CT

**May88 – Present**  
Adjunct Assistant Professor of Mechanical Engineering, Rensselaer Polytechnic Institute at Hartford, CT

**May83 - Feb.87**  
NASA Fellow, NASA Langley Research Center, Hampton, VA

**Sep 81 - May 83**  
Research Assistant, Virginia Tech, Blacksburg, VA

**Publications:** (including patents)


Performance Characteristics of a Microturbine-Double Effect Absorption Chiller CHP System Wagner, T.C., Marler, M.E. and Jung, S.H.; (IMECE2004-61598)


Nine issued patents

Synergistic Activities:
American Society of Heating, Refrigerating, and Air-Conditioning Engineers:
(i) TC8.3 Absorption and Heat Operated Machines (Chairman)
(ii) TC10.1 Cogeneration Systems (Secretary)
American Society of Mechanical Engineers – Heat Pump Technical Committee
American Institute of Aeronautics and Astronautics – Associate Fellow

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:
Ms. Therese Stoval, (Oak Ridge National Laboratory)
Mr. Richard Sweetser, (Exergy Partners Corp.)
Mr. Milton Meckler, P.E. (Design Build Systems)
Mr. Lucas Hyman, P.E. (Goss Engineering)
Dr. Thomas Rosfjord, (Everyhour Energy)
Craig R. Walker - Director UTC Energy Systems Program Office

Education and Training:
M.S. and B. S. in Materials Science and Engineering, University of Florida, 1986 and 1984
UTC Executive Program, Darden Business School University of Virginia, 2005
UTC Emerging Leaders Program, Darden Business School University of Virginia, 2002

Research and Professional Experience:
Director UTC Energy Systems Program, United Technologies Research Center (UTRC), January 2010 to present. Lead strategy development and maturation of energy systems technologies including high performance buildings, wind, solar, biomass and geothermal power systems, biomass to biofuels, hydrogen production and storage and energy microgrids.
Director UTC Power Program, UTRC, January 2005 to January 2010. Strategy development and maturation of advanced onsite power technologies and fuel cells.
Director UTC Power Cooling Heating and Power Program, UTRC, February 2003 to January 2005. Maturation of advanced onsite power technologies. Launched two product families (PureComfort and PureCycle) and five product variations in partnership with DoE.
ACE Leader/Manager GP7000 Program Design for Cost, Pratt & Whitney, April 2002 to December 2002, Lead development of system and standard work for cost management of the GP7000 engine including target costing system, design for cost, supplier engagement/negotiation.
Manager Materials and Processes Development, Pratt & Whitney, August 2001 to December 2002, Lead development and application of materials and processes technology and standard work including: Structural, hot section alloys, hot section coatings TBC’s and metallic, advanced hot section materials, supply base management, non hot section coatings and seals and organic matrix composites including LO.
Materials Discipline Manager CSMC/CSCC Materials Discipline Chief, Pratt & Whitney, July 1997 to August 2001, Support CSMC strategic and tactical goals through application of materials and processes technology.
Supervisor Failure Analysis Group/Failure Analyst, Pratt & Whitney, May 1986 to July 1997. Provide a leadership role in major failure investigations involving Pratt & Whitney military engines and space systems.

Publications:
"Failure Analysis Handbook" 750 page manual of fractography and failure analysis techniques.
Master’s thesis: "The use of Rotating Ring-Ring-Ring Electrodes, Differential Reflectometry and Surface Analytic Techniques for In-situ Investigation of the Aqueous Corrosion of Copper in the Presence of N-Heterocyclic Inhibitors".
Inventor or Co-inventor on more than 10 Patent Applications

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:
Collaborators and Co-editors None
Graduate and Post-doctoral Advisors and Advisees: None
Michael S. Waring, Ph.D., Assistant Professor, CAEE Department, Drexel University

Education and Training

University of Texas at Austin  Civil Engineering  PhD 2009
University of Texas at Austin  Environmental Engineering  MSE 2006
University of Texas at Austin  Architectural Engineering  BSE 2005
University of Texas at Austin  English/Economics  BA 2000

Research and Professional Experience

Assistant Professor, Drexel University  09/09 – Present
Guest Researcher, National Institute for Occupational Safety and Health  09/08 – 12/08

Publications

• Waring, M.S., Siegel, J.A. 2008 Indoor air quality implications of using ion generators in residences. *Indoor Air Conf. 2008*, Copenhagen, Denmark.

Synergistic Activities

• Development Team Leader, Building Mass and Energy Balances Website at University of Texas at Austin: http://www.ce.utexas.edu/bmeb/
• Invited Participant, Workshop on Interfacial Chemistry in Indoor Environments, July 2007, Berkeley, CA. Sponsored by NSF, California Air Resources Board, and the MST Environmental Research Center for Emerging Contaminants
• Professional Reviews: Papers submitted to *Journal of Occupational & Environmental Hygiene, Journal of Aerosol Science, and Environmental Engineering Science*

Collaborators and Co-editors

• *University of Texas at Austin*: Corsi, R.L.; Siegel, J.A.; Yu, X
• *Missouri University of Science and Technology*: Morrison, G.C.

Graduate and Post-doctoral Advisors and Advisees

• None
Damian Watkins, D.E.

CAREER SUMMARY
Dr. Watkins has 9 experience in the areas of research and technical design. He has also performed requirements analysis and systems administration for wireless and traditional data networks. He has demonstrated the ability to successfully win funding, meet project goals, and publish technical articles in cutting-edge technologies. For his dissertation work, Dr. Watkins worked extensively in security, vulnerability analysis, benchmarking, and intrusion detection development. Dr. Watkins has extensive background in network analysis, design, and security.

EDUCATION:
- Morgan State University - D.E. Electrical Engineering, 2004
- Morgan State University - M.E. Electrical Engineering, 2001
- Morgan State University - B.S. Electrical Engineering, 1999

PROFESSIONAL EXPERIENCE
Morgan State University - Research Engineer

Knowledge Management and Integration Center of Excellence (KIMCOE) - Principle Investigator
June 2004 – Present

Collaborative Technology Alliance (Communication & Networks) - Principle Investigator
July 2003 – Present

National Center for the Study of Preparedness and Catastrophic Event Response (PACER) a DHS center of excellence.
Associate Investigator – Project D5 Disaster Preparedness Metrics July 2007 – July 2009

Contractor – DoD
Analyst/Developer - Survey Support
June 2008 – Present

SELECTED PUBLICATIONS
- Clayton Thomas, Damian Watkins and Craig Scott,” Three Dimensional Peer-2-Peer (3DP2P) Networks”, The 17th International Conference on Geoinformatics 2009
Lisa Mauck Weiland  
Assistant Professor, Department of Mechanical Engineering and Materials Science  
University of Pittsburgh  

**Education and Training:**

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<th>Field</th>
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<tr>
<td>Univ. of Maryland</td>
<td>Mechanical Engineering</td>
<td>BSME</td>
<td>1992</td>
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<tr>
<td>Purdue University</td>
<td>Mechanical Engineering</td>
<td>MSME</td>
<td>1997</td>
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<tr>
<td>Georgia Inst. of Tech</td>
<td>Mechanical Engineering</td>
<td>PhD</td>
<td>2002</td>
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**Research and Professional Experience:**

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<tr>
<td>Assistant Professor</td>
<td>University of Pittsburgh</td>
<td>2005-Present</td>
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<tr>
<td>Research Scientist</td>
<td>Virginia Polytechnic Institute</td>
<td>2003 - 2004</td>
</tr>
<tr>
<td>Research Assistant</td>
<td>Georgia Institute of Technology</td>
<td>1997 - 2002</td>
</tr>
<tr>
<td>Research Assistant</td>
<td>Purdue University</td>
<td>1994 - 1995</td>
</tr>
<tr>
<td>Design Standards Engineer</td>
<td>AT&amp;T</td>
<td>1993 -1994</td>
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**Related Publications:**


**Synergistic Activities:**

**CAREER:** High Performance, Mechanically Robust Ionomeric Sensors Program. May 2008-April 2013. Preliminary exploration of hydrokinetic energy harvest included in education plan.


**Aeroelastic Wind Harvest From Bluff Interfaces, Weiland (PI) & Harries,** 12 month grant seed-funded by MCSI explores wind harvest in the urban environment.

**Recent Collaborators, Advisors, and Advisees:**

**Collaborators:** Univ of Pitt: William Clark, Tara Meyer, David Waldeck, Eric Beckman, Kent Harries, Irene Frieze, Sung Cho, Daniel Cole; Duquesne Univ: Wilson Meng; Lebanese Amer. Univ: Barbar Akle; CMU: John Kitchin; NC State: Ralph C. Smith; VCU: Vishnu Sundaresan; Univ. of Cincinnati: John Cuppoletti; NextGen Aeronautics: Shiv Joshi, Jay Kudva; Bayer MaterialScience: Brent Crenshaw; DOE NETL: Evan Granite, Dave Luebke; Cornerstone Research Group: Ernie Havens, Chris Hemmelgarn.

Graduate and Postdoctoral Advisors: Christopher Lynch (UCLA); Donald J. Leo (Virginia Tech).

**Thesis Advisor and Postgraduate Scholar-Sponsor:** Current: PhD - Eric Freeman, Mark Delaney, Ursula Zangrilli; MS - Timothy Bagatti; Graduated: PhD - Richard Beblo, Fei Gao; MS - Christopher Homison, Brad Boyerinas, Korey Gross.
Joseph P. Welsh, Esq.

Mr. Welsh is the Chief Executive Officer of the Collegiate Consortium for Workforce and Economic Development. The Consortium includes 5 regional community colleges from Pennsylvania and New Jersey and Drexel University. The Consortium provides education and training for companies, government and supports regional economic and workforce development initiatives. The Consortium is a 501 (c) (3) organization that works with industry to develop strategic workforce and training plans to build organizational capacity to foster increasing knowledge, skills and productivity to promote regional economic development. In this capacity, Mr. Welsh works with multiple public and state agencies, Workforce Investment Boards, grant programs and Federal funding vehicles to promote human capital development in the Greater Philadelphia Region.

Previously Mr. Welsh served as the Executive Director of the Life Science Career Alliance, a workforce intermediary for the life science industry in Southeastern Pennsylvania. In this capacity he worked with Pennsylvania Biotechnology Association and its member companies to define the human capital infrastructure for the Biotechnology industry. He also developed a regional training model with more than one million dollars ($1M) of funding from Commonwealth of PA to deliver innovative customized training to small and mid sized biotechnology companies.

Mr. Welsh also served as a Senior Research Fellow in International Law and Health Policy at Temple University School of Law where he worked to develop a research tool to evaluate law, policy and practice relating to the spread of disease in more than 20 countries. The program provided training for international researchers on a rapid policy assessment

Mr. Welsh has also served as the Chief Operating Officer of Carelift International and established a model technology transfer program that served to rebuild healthcare services in the Former Soviet Union, Central and Eastern Europe and Central Asia. He was responsible for working with USAID, US Dept of State and private foundations to deliver more than $50M of medical technology, supplies and pharmaceuticals to a 20 counties in the region.

In the beginning of his career, Mr. Welsh served as a health administrator, healthcare consultant and attorney focusing on occupation injury and illness in the Greater Philadelphia Region.

Mr. Welsh holds a Juris Doctor from Temple University School of Law, an M.B.A. from Philadelphia University and is a active member of the Pennsylvania Bar.
Biographical Sketches – Jin Wen, Assistant Professor, Department of Civil, Architectural, and Environmental Engineering, Drexel University

Education and Training:
Beijing University of Aeronautics and Astronautics Mechanical Engineering B.S. 1995
Beijing University of Aeronautics and Astronautics Mechanical Engineering M.S. 1997
University of Iowa Mechanical Engineering Ph.D. 2003

Research and Professional Experience:
Assistant Professor; Department of Civil, Architectural, and Environmental Engineering, Drexel University, Philadelphia, Pennsylvania; 2003 to present
Research Assistant; Iowa Energy Center Energy Resource Station, Ankeny, Iowa; 2000 to 2003
Research Assistant; Department of Mechanical and Industrial Engineering; The University of Iowa, Iowa City, IA; 1998 to 2003
Engineer and Training Officer; Johnson Controls (Beijing) Ltd., Beijing, China; 1997 to 1998

Selected Publications:

Synergistic Activities:
• American Society of Heating, Refrigerating and Air-Conditioning Engineers, member, Fault Detection and Diagnosis Technical Subcommittee Chair
• Principle Investigator, Framework of Assessing Building Energy Efficiency Strategies for Philadelphia Housing Authority, Philadelphia Housing Authority

Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:
(a) COLLABORATORS: Drexel University: Eugenia Ellis, Patrick Gurian, Caroline Schauer; Arizona State University: Agami Reddy; The University of Iowa: A. Kusiak;
(b) GRADUATE AND POSTDOCTORAL ADVISORS: Theodore F. Smith
(c) THESIS COMMITTEE: Neal Babcock, Wei Jiang, Jian Sun, Tim Bartrand, Vefa Narli, Shun Li

4-226
Daniel E. Willis, AIA
Professor of Architecture and Science, Technology and Society
The Pennsylvania State University, University Park, PA 16802 USA
Phone/fax: (814) 863-2451/865-9536 & Email: dew2@psu.edu

Professional Preparation
Penn State University, University Park, PA M.S. in Architecture 1989
Carnegie Mellon University, Pittsburgh, PA Bachelor of Architecture 1979

Appointments
06/03-present Professor of Architecture, Penn State University
06/02-06/09 Department Head, Department of Architecture, Penn State University
07/08-present Affiliate Faculty, Science, Technology and Society program, Penn State
06/97-05/01 Vice President, L.D. Astorino & Associates, Architects, Pittsburgh & State College, PA
05/96-09/96 Consulting Architect, James Oleg Kruhly & Associates, Philadelphia, PA
06/95-06/03 Associate Professor of Architecture, Penn State University
06/89-08/95 Assistant Professor of Architecture, Penn State
08/87-05/89 Instructor of Architecture, Penn State
02/85-08/87 Architect/Project Manager, L.D. Astorino & Associates, Pittsburgh, PA
01/82-01/85 Architect/Project Manager, City of Pittsburgh, Bureau of Engineering and Construction
01/81-01/82 Intern Architect, DRS Associates, Pittsburgh, PA

Five Publications Related to Project

Five Other Publications

Awards & Honors
• 2010 Dr. James R. Robinson Equal Opportunity Award, Penn State University
• 2009 Middle PA Chapter AIA nominee for PA Medal of Distinction
• 2007 Penn State recognition for strategic planning and program assessment
• 2006 Architecture in Perspective 20: 20th International Exhibition of Architectural Illustration, AIA National Headquarters, Washington, DC
• 2001 Facilities of Merit Award, *Athletic Business Magazine*, for Design of Lasch Football Building (with LDA Architects)
• 1999 Middle PA Chapter AIA Silver Medal Design Award for Recreation Hall Renovation, Penn State University, with LDA Architects.
• 1999 Middle PA Chapter AIA Research Award for *The Emerald City and Other Essays on the Architectural Imagination*
• 1990 Landscapes of the 21st Century Design Competition winner, *Landscape Architecture* magazine,
• 1990 Selected Project: Project Atlas Design International Competition, the Storefront for Art and Architecture, New York
• 1989 Hugh Ferriss Award for Excellence in the Graphic Representation of Architecture (first place in international drawing competition)
• 1988 Graduate Research Award, Honorable Mention, Penn State Graduate Research exhibit

**Synergistic Activities**

- **Interdisciplinary Activity:** One of the founding faculty members of Penn State’s Center for Research in Design and Innovation. Affiliate appointment in Science, Technology and Society; developing a new STS course on the History and Theory of Craftsmanship. Advisory Board member for Mercyhurst College Interior Design program, Erie, PA.

- **Activities to Diversify Professional Education:** While Department Head, increased the percentage of minority students in the Architecture major from 7.3% in 2001 to 24.2% in 2009. Also doubled the number of female tenured or tenure-track professors in the Department. Assisted and encouraged the creation of a Penn State chapter of the National Organization of Minority Architecture Students (NOMAS), and helped to establish a Freedom by Design community service program.

- **Licensed Practicing Architect since 1983:** Continuously practicing architecture in addition to teaching, conventional research, scholarship, and administrative work as Department Head. Current projects include a $5 million private residence and an addition to a homeless shelter in State College, PA.

- **Guest Design Critic and/or Accreditation Team Member:** Iowa State University, University of Pennsylvania, Parsons School of Design (NYC), Temple University, Columbia University, City College of New York, Philadelphia University, Carnegie Mellon University, Notre Dame University, Colorado State University.

- **Educational Activities:** (1) Developed a new Ph.D. program in Architecture for Penn State (2) Started Architecture Summer Camp for high school students (3) Assisted in the design and programming of the new LEED Gold-rated Stuckeman Building for the School of Architecture at Penn State.

**Collaborators & Other Affiliations**

- **Collaborators:** Russell Barton, Cari Bryant-Arnold, David Celento, Charles Cox, Rebecca Henn, Samuel Hunter, Brian Orland, Matthew Parkinson, John Messner, Timothy Simpson (all Penn State); William Braham (University of Pennsylvania); Todd Woodward (Temple U.).

- **Graduate student advisees in last five years:** none.

- **Undergraduate Honors Theses supervised:** Richard Alderiso, Adam Loughry, Jennifer James, Barbara Voight, Todd Woodward.

- **M.S. Advisor:** Donald Kunze
Mark W. Witman Ph.D

EDUCATION

Ph.D in Organometallic Chemistry, June 1976 - University of New Hampshire, Durham, NH
BS in Chemistry, June 1971 - St. Lawrence University, Canton, NY

RESEARCH AND PROFESSIONAL EXPERIENCE

2004-present : Future Business - Bayer Material Science
Director – Construction, Healthcare, Consumer Industry Innovation Department, Americas

- Initiated and led Bayer’s support of Penn State’s 2009 Solar Decathlon Natural Fusion project. Twelve BMS materials, technologies and concepts are specified into the building. Building is now located on the Bayer campus in Pittsburgh and serves as a showcase and incubator for new technology development with Bayer partners.
- Developed value proposition for, and initiated cross-divisional sustainable, zero energy, zero emission building program/focus area within BMS North America. Developed strong working relationships with industry partners and DOE National Labs. Led development of Bayer Material Science's EcoCommercial Building concept in North America.
- Initiated Architectural Glazing Project with Sheffield and BU-PCS, project has resulted in 9 actively funded projects targeting a growth of over $450 MM in new business. Project on-going with active FB involvement. Project is now part of global MAKROSCOPE growth initiative. Several sub-projects initiated from own ideas.
- Established relationships and projects with top management of National Labs and Agencies, including US Department of Energy (DOE), Oak Ridge National Lab, and Berkeley National Laboratory.

2002 - 2003 Business Development, Bayer Polymers, Director, Business Development, Plastics
1996-2002 – Polymers Division, Director- Plastics Technology and Technical Services
1994-1996 – Polymer Division-Bayer, Vice President – Polycarbonate Business
1993-1994 – Polymer Division-Bayer, Director – Compounded Products Business

PATENTS (Partial List)
- Impact Modified Polycarbonates, US 4,328,449, M.W.Witman
- Impact Modified Polycarbonates, US 4,299,928, M.W.Witman
- UV Stabilized Polycarbonate Moulding Compositions, EP0,162,245, W. Paul, M.W.Witman, H. Muller, P.R Mueller
- Translucent Polycarbonate Composition, US 4,410,662 M. Witman
- Thermoplastic Molding Compounds, M. W. Witman, W. Stix, K.H. Kohler, L. Morbitzer
- Moulding Compositions Comprising an Aromatic Polycarbonate and a Sufone Group Containing Polyester, US 4,603,170, M. Witman, W. Stix, K.H. Kohler, L. Morbitzer
- Flame Retardant Polycarbonate Compositions, US 4,753,994, S. Krishnan, M.W.Witman
Biographical Sketches – John Yen / University Professor and Director of Strategic Research Initiatives / College of Information Sciences and Technology, The Pennsylvania State University

Education and Training:

Ph.D., Computer Science, University of California, Berkeley, Dec. 1986
MS (scholarship), Computer Science, University of Santa Clara, June 1982
BS (Honor), Electrical Engineering, National Taiwan University, June 1980

Research and Professional Experience:

• Associate Dean/Director of Strategic Research Initiatives, College of Information Sciences and Technology, The Pennsylvania State University, 2009 – present: Launched the smart data center initiative, in collaboration with Architecture Engineering, ITS, and Office of Physical Plant.
• University Professor of Information Sciences and Technology, College of Information Sciences and Technology, The Pennsylvania State University, Aug 2001 – present: Conducted research regarding agent-based modeling, human-agent trust, social network analysis and modeling.
• Affiliated Professor of Computer Science and Engineering, The Pennsylvania State University, January 2002 - present.
• Professor of Computer Science, Texas A&M University, Sep 1998 – July 2001.
• Associate Professor of Computer Science, Texas A&M University, Sep 1993 – Sep 1998
• Assistant Professor of Computer Science, Texas A&M University, 1989 - Aug 1993
• Research Scientist, University of Southern California, Information Sciences Institute, 1986-1989:

Publications: (including patents, copyrights, and software systems)


**Synergistic Activities:** List no more than five professional and scholarly activities related to the effort proposed.

2005 Co-inventor of a US patent (pending) on Agent-Based Collaborative Recognition-Primed Decision-Making, filed by PSU (serial No. 11/181,146).

2006 Co-Chair, The Third SNA-KDD (Social Network Mining and Analysis) Workshop, The 15th ACM SIGKDD Conference on Knowledge Discovery and Data Mining, June 2009.


Lizette Zietsman
Interdisciplinary Center for Applied Mathematics (ICAM)
Virginia Polytechnic Institute and State University
Blacksburg, VA, 24061-0531
lzietsma@vt.edu

Education
1990  B.S., Applied Mathematics, University of Pretoria, South Africa
1992  M.S., Applied Mathematics, University of Pretoria, South Africa
2000  Ph.D., Applied Mathematics, University of Pretoria, South Africa

Research and Professional Experience:
Lizette Zietsman is an assistant professor at the Interdisciplinary Center for Applied Mathematics (ICAM) at Virginia Tech. She has over 25 research papers and has given more than 30 invited presentations. She is currently advising one MS student and has directed one MS student and served on more than 11 Ph.D. committees. She also directed 5 undergraduate research projects and is involved in an NSF-funded Research Experience for Undergraduates (REU), since 2007.

Dr. Zietsman’s primary interests involve the development and analysis of numerical methods for solving optimal control problems where the dynamics are described by partial differential equations. This includes applications such as the design, optimization and control of energy efficient buildings. Considering the whole building as an integrated system and applying modern estimation and control techniques to this system leads to models that are complex, multi-scale, highly uncertain dynamic systems with wide varieties of disturbances. Discretization leads to extremely large systems that result in numerous computational challenges including computational algorithms for the optimal placement of sensors and actuators that maximize observability and controllability. Discretization of the optimal control problem leads to extremely large systems of finite dimensional Riccati equations. To generate practical algorithms, we take advantage of the underlying infinite dimensional partial differential equation structure. This includes studying the sensitivity of the algebraic Riccati equation, mesh-independence of Newton methods used to solve the Riccati equation, as well as the use of adaptive methods to compute the optimal feedback gain.

Employment
1988-1997  Lecturer, University of Pretoria
1997-2001  Senior Lecturer, University of South Africa
2001-2003  Post-doctoral researcher, ICAM, Virginia Polytechnic Institute and State University,
2003-2005  Assistant Professor, George Mason University
2005-Present  Assistant Professor, Virginia Polytechnic Institute and State University

Ten Selected Publications:

4-232


**Synergistic Activities:**


2. On the Steering Committee of the Southeast-Atlantic Regional Conference on Differential Equations since October and is organizing the conference in 2010.


4. Serve as mentor for recent Ph.D students in the Association of Women in Mathematics Mentor Network.


6. Career Advisor, Department of Mathematics, Virginia Tech, 2008 till present.

7. Faculty Advisor for the Virginia Tech, Society of Industrial and Applied Mathematics (SIAM), Student Chapter, 2008 till present.

**Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers:**

Imran Akhtar (Virginia Tech), Jeff Borggaard (Virginia Tech), Gene Cliff (Virginia Tech), Lisa Davis (Montana State), Katie Evans (Louisiana Tech), T. L. Herdman (Virginia Tech), E. W. Sachs (U. Trier, Germany), Miroslav Stoyanoc (Florida State University), A. Surana (UTRC).
Andrew P. Zwicker  
Princeton Plasma Physics Laboratory, PO Box 451, Princeton, NJ 08543  
azwicker@pppl.gov or azwicker@princeton.edu


RESEARCH AND PROFESSIONAL EXPERIENCE: Head, Science Education Program, Princeton Plasma Physics Laboratory; Responsible for leading K-16 education programs and outreach efforts. Includes internships for undergraduate and high school students, professional development workshops for K-12 teachers, and outreach to the general public.


CONFLICTS OF INTEREST: None
May 3, 2010

The Honorable Steven Chu  
Secretary  
U.S. Department of Energy  
1000 Independence Ave., SW  
Washington, DC 20585

Dear Dr. Chu:

I am writing as an authorized official to confirm that I am an employee of The Pennsylvania State University, which is the lead DOE Co-Applicant for the Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, and to express my personal commitment to serve as Director of the DOE Hub and the GPIC and to certify that serving in this role poses no conflict of interest for me.

Penn State is very pleased to lead the GPIC for Energy Efficient Buildings, and we are fully committed to this effort. The goals of the GPIC are to improve energy efficiency and operability and reduce carbon emissions of existing and new buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond. We have assembled an extremely dynamic and diversified team of globally prominent government, industry, and educational partners that is working together to achieve these goals.

We hope that the Department of Energy and the other participating federal agencies will support the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings. Thank you.

Sincerely,

Henry C. Foley

Henry C. Foley
Appendix 8B
DOE HUB Individual Commitment Statements

1. The Pennsylvania State University (Lead)
2. Bayer Materials Science
3. Ben Franklin Technology Partners of SE PA
5. Collegiate Consortium
6. Drexel University
7. DVIRC
8. IBM Corporation
9. Lawrence Livermore National Laboratory
10. Morgan State University
11. New Jersey Institute of Technology
12. Philadelphia Industrial Development Corporation
13. PPG Industries
14. Princeton University
15. Purdue University
16. Rutgers University
17. Turner Construction
18. United Technologies Research Center
19. University of Pennsylvania and Wharton SBDC
20. University of Pittsburgh
21. Virginia Tech
May 5, 2010

The Honorable Steven Chu
Secretary
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585

Dear Dr. Chu:

We are pleased to provide this commitment statement signed by our participating faculty/personnel as a member of the Energy Innovation Hub component of the proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The personnel listed below are committed to perform the work described in the HUB/GPIC proposal at the level and effort indicated. Our organization fully supports these commitments. We understand that membership in the DOE HUB component of the Greater Philadelphia Innovation Cluster entails a commitment by personnel from our organization to perform work at the HUB headquarters at the Navy Yard in Philadelphia. We intend to help develop the HUB at the Navy Yard as a locus for robust ongoing exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings.

Below please find the names and the signatures of our personnel committed to this project, including their individual levels of time commitment for the period of five years.

<table>
<thead>
<tr>
<th>Name</th>
<th>Time Commitment/Year</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henry C. Foley</td>
<td>33% calendar year</td>
<td>Henry C. Foley</td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Anumba, Chimay</td>
<td>2 calendar weeks</td>
<td></td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Bahnfleth, William P.</td>
<td>2 summer weeks</td>
<td>William P.</td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Blumsack, Seth A.</td>
<td>2 summer weeks</td>
<td></td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Bose, Mallika</td>
<td>2 summer weeks</td>
<td>Mallika</td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Brownson, Jeffrey R. S.</td>
<td>2 summer weeks</td>
<td></td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Name</td>
<td>Time Offered</td>
<td>Signature</td>
<td>Date</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------</td>
<td>------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Echols, Stuart</td>
<td>2 summer weeks</td>
<td></td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Freihaut, James</td>
<td>100% calendar year</td>
<td></td>
<td>05/04/2010</td>
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<tr>
<td>Hallacher, Paul</td>
<td>50% calendar year</td>
<td></td>
<td>05/04/2010</td>
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<tr>
<td>Houser, Kevin W.</td>
<td>2 summer weeks</td>
<td></td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Kleit, Andrew N.</td>
<td>2 summer weeks</td>
<td></td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Memari, Ali M.</td>
<td>2 summer weeks</td>
<td></td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Messner, John I.</td>
<td>3 summer month</td>
<td></td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Mistrick, Richard</td>
<td>3 summer month</td>
<td></td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Oliva, Ralph</td>
<td>2 calendar weeks</td>
<td></td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Orland, Brian</td>
<td>2 calendar weeks</td>
<td></td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Rangaswamy, Arvind</td>
<td>2 calendar weeks</td>
<td></td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Riley, David</td>
<td>2 summer weeks</td>
<td></td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Sliwinski, Martin</td>
<td>2 summer weeks</td>
<td></td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Srebric, Jelena</td>
<td>2 summer weeks</td>
<td></td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Treado, Stephen</td>
<td>3 summer month</td>
<td></td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Willis, Daniel E.</td>
<td>2 summer weeks</td>
<td></td>
<td>05/04/2010</td>
</tr>
<tr>
<td>Yen, John</td>
<td>2 summer weeks</td>
<td></td>
<td>05/04/2010</td>
</tr>
</tbody>
</table>
27 April 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802  

Dear Dr. Foley,

Bayer MaterialScience LLC (BMS) is pleased to provide this commitment statement on behalf of our participating personnel as a member of the proposed Energy Innovation Hub component of the Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

BMS understands that membership in the DOE Hub component of the GRIC entails a commitment by personnel from BMS organization to perform work at the Hub. BMS will assign and provide qualified individuals committed to the success of the Hub and to meeting BMS project obligations.

Below please find the names and the signatures of our personnel committed to perform the work described in the GPIC proposal. We intend to help develop the Hub as a locus for robust ongoing exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings.

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
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</thead>
<tbody>
<tr>
<td>Dr. Nicolas Sunderland</td>
<td></td>
<td>04/27/2010</td>
</tr>
<tr>
<td>Dr. David Jurbergs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dr. John Hayes</td>
<td></td>
<td>04/27/2010</td>
</tr>
<tr>
<td>Steve J. Harasin</td>
<td></td>
<td>04/30/2010</td>
</tr>
<tr>
<td>Dr. Mark W. Witman</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jerry Phelan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>George Pavlovich</td>
<td></td>
<td>04/27/2010</td>
</tr>
</tbody>
</table>

Sincerely,

Mike Gallagher  
Director, Government Services
Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley,

Bayer MaterialScience LLC (BMS) is pleased to provide this commitment statement on behalf of our participating personnel as a member of the proposed Energy Innovation Hub component of the Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

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<th>Name</th>
<th>Signature</th>
<th>Date</th>
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</thead>
<tbody>
<tr>
<td>Dr. Nicolas Sunderla</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dr. David Jurbergs</td>
<td></td>
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<tr>
<td>Dr. John Hayes</td>
<td></td>
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<tr>
<td>Steve J. Harasin</td>
<td></td>
<td></td>
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<tr>
<td>Dr. Mark W. Witman</td>
<td></td>
<td></td>
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<tr>
<td>Jerry Phelan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>George Pavlovich</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sincerely,

Mike Gallagher  
Director, Government Services
April 22, 2010

RE: Individual Commitment Letter(s)

To Whom It May Concern:

I, James Gambino, as Vice President of Technology Commercialization, Physical Sciences, for Ben Franklin Technology Partners of Southeastern PA, commit to the following for Task 5 of the HUB project:

- Individual Level of Time Commitment for five years:

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>40%</td>
<td>40%</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
</tr>
</tbody>
</table>

[Signature]

James Gambino
Vice President, Technology Commercialization
Physical Sciences

4/23/10

Date

I, Anthony Green, as Vice President of Technology Commercialization, Life Sciences, for Ben Franklin Technology Partners of Southeastern PA, commit to the following for Task 5 of the HUB project:

- Individual Level of Time Commitment for five years:

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
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<tbody>
<tr>
<td>20%</td>
<td>20%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
</tbody>
</table>

[Signature]

Anthony Green
Vice President, Technology Commercialization
Life Sciences

2/1 April 2010

Date
May 3, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley:

We are delighted to provide this letter of commitment to participate as a member of the Energy Innovation Hub component proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia. This letter will serve as a joint letter of individual level of time commitment, for a minimum period of five years from the senior personnel at Carnegie Mellon University:

Khee Poh Lam, PI – 2 months/year

Burcu Akinci – 0.40 month/year

Azizan Aziz – 12 months/year

James Garrett – 0.40 month/year

Volker Hartkopf – 1 month/year

Bruce Krogh – 0.40 month/year

Stephen R. Lee – 2.5 months/year

Vivian Loftness – 2 months/year

Lucio Soibelman– 0.40 month/year
Dear Dr. Foley,

The Collegiate Consortium for Workforce and Economic Development is pleased to provide this commitment statement on behalf of our participating colleges, university, faculty/ and staff as a member of the Energy Innovation Hub component proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The personnel listed below are committed to perform the work described in the GPIC proposal at the level and effort indicated. Our organization fully supports these commitments.

We understand that membership in the DOE Hub component of the Greater Philadelphia Innovation Cluster entails a commitment by personnel from our organization to perform work at the Hub headquarters at the Navy Yard in Philadelphia and to provide outreach into our Regional community to insure inclusion in this important economic engine from our traditionally underserved communities. We intend to help develop the Hub at the Navy Yard as a locus for robust ongoing exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings.

In order to support this initiative the Collegiate Consortium will be employing a full time Program Director who will commit 100% if their time to this project for the full duration of the five year period. We will utilized education and training coordinators from 25% to 33% to coordinate the delivery of education and training to community college faculty, incumbent workers, trade members, and for participants from our One-Stop system in the Region.

I hereby commit the resources, network and personnel to fully support this initiative as the representative of our member colleges, faculty and staff of the Collegiate Consortium that includes Community College of Philadelphia, Montgomery County Community College, Delaware County Community College, and Bucks County Community College in Pennsylvania and Camden County College in New Jersey.

Regards,

Joseph P. Welsh, Esq.
CEO
Collegiate Consortium
Civil, Architectural & Environmental Engineering
3141 Chestnut Street
Philadelphia, PA 19104, USA
TEL (215) 895-2341 (215) 895-1828
FAX (215) 895-1363

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

RE: Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings

Dear Dr. Foley,

It is our great pleasure to provide this letter of commitment to participate as members of the Drexel University team for the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

We promise that we will work actively and closely with other members involved in this proposed energy hub. Each of us will spend minimum one month per year on this project for at least five years. We will also advise graduate students and one Post-Doc student that are funded by this project. We will contribute to various research topics proposed in Tasks 1, 2, 3, and 4 and will contribute to the overall management and operation of the proposed energy hub.

We look forward to this excellent opportunity to work with colleagues from Pennsylvania State University and all participating organizations.

Sincerely,

Jin Wen  Michael Waring  Patrick Gurian

4/26/10

Department of Civil, Architectural, and Environmental Engineering
Drexel University
3141 Chestnut Street, Philadelphia, PA, 19104
Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings  
DOE Hub Individual Commitment Statement

April 29, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley,

We are pleased to provide this commitment statement on behalf of our participating personnel as a member of the Energy Innovation Hub component proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

We are committed to performing the work described in the GPIC proposal. DVIRC fully supports these commitments. We understand that membership in the DOE Hub component of the Greater Philadelphia Innovation Cluster entails a commitment by personnel from DVIRC to perform work at the Hub headquarters at the Navy Yard in Philadelphia. We intend to help develop the Hub at the Navy Yard as a locus for robust ongoing exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings.

Below please find the names and the signatures of our personnel committed to this project, including their individual levels of time commitment for the period of five years.

<table>
<thead>
<tr>
<th>Name</th>
<th>Percent (%) time commitment for 5 years</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joseph Houldin</td>
<td>506 hours</td>
<td></td>
<td>4-29-10</td>
</tr>
<tr>
<td>Name</td>
<td>Hours</td>
<td>Signature</td>
<td>Date</td>
</tr>
<tr>
<td>----------------</td>
<td>--------</td>
<td>--------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Barry Miller</td>
<td>371</td>
<td>Barry Miller</td>
<td>4-29-10</td>
</tr>
<tr>
<td>Anthony Girifalco</td>
<td>926</td>
<td>Anthony Girifalco</td>
<td>4-29-10</td>
</tr>
</tbody>
</table>
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802  

Dear Dr. Foley,  

IBM Research is pleased to provide a commitment statement of key IBM research staff member that will participate in the Energy Innovation Hub component of the proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.  

The key personnel listed below are committed to lead IBM Research’s contribution to the overall GPIC proposal. IBM understands the need in the DOE Hub component of the Greater Philadelphia Innovation Cluster for people to perform work at the Hub headquarters at the Navy Yard in Philadelphia, but we are not ready to identify those people.  

The key IBM Research personnel committed to this project includes the following individuals:  

<table>
<thead>
<tr>
<th>Name</th>
<th>Percent (%) time commitment for 5 years</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Katharine Frase</td>
<td>&lt;5% time at no cost</td>
<td>Katharine Frase</td>
<td>4/29/10</td>
</tr>
<tr>
<td>Jane L Snowden</td>
<td>25%</td>
<td>Jane L Snowden</td>
<td>4/29/10</td>
</tr>
<tr>
<td>Jim Sexton</td>
<td>25%</td>
<td>James C. Sexton</td>
<td>4/29/10</td>
</tr>
<tr>
<td>Bruce D’Amora</td>
<td>75%</td>
<td>Bruce D’Amora</td>
<td>4/29/10</td>
</tr>
</tbody>
</table>


dr. Katharine Frase  
VP, Industry Solutions and Emerging Business  
IBM Research  
1101 Kitchawan Rd/Route 134  
Yorktown Heights, NY 10598
Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley,

This letter represents a commitment statement on behalf of our participating technical staff as a member of the Energy Innovation Hub component proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia. The personnel listed below are committed to perform the work described in the GPIC proposal at the level of effort indicated, pending contract award and sufficient funding.

We understand that membership in the DOE Hub component of the Greater Philadelphia Innovation Cluster entails a commitment by our organization to perform work at the Hub headquarters at the Navy Yard in Philadelphia. Our goal is to contribute to the team’s goals for developing the Hub at the Navy Yard as a center for collaboration and exchange between industry, university faculty and students, economic and workforce development professionals, and others interested in achieving the goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings.

Below are the names and signatures of our personnel committed to this project, including their individual levels of time commitment for the period of five years.

<table>
<thead>
<tr>
<th>Name</th>
<th>Percent (%) time commitment over five years</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Grosh</td>
<td>10%</td>
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<td>4/18/2010</td>
</tr>
<tr>
<td>Bill Henshaw</td>
<td>22%</td>
<td></td>
<td>4/18/2010</td>
</tr>
<tr>
<td>Charles Tong</td>
<td>18%</td>
<td></td>
<td>4/18/2010</td>
</tr>
</tbody>
</table>
Subject: Letter of Commitment  

Date: April 21, 2010

The purpose of this letter is to express the full support and commitment for the “Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings” proposal over the five year period of its existence. It is significant that this proposal will address solutions for the efficient energy improvement of buildings through retrofitting of old and the energy innovations of new to improve the overall energy footprint. The results of this research have the potential to significantly change the way societies will manage and control energy when retrofitting or building new buildings in the future. This commitment is being made by the following Morgan State University researchers:

Dr. LeeRoy Bronner  
Commitment 3.0 Months/Year

Dr. Corey Dickens  
Commitment 2.5 Months/Year

Dr. Kofi Nyarko  
Commitment 2.5 Months/Year

Dr. Damian Watkins  
Commitment 2.5 Months/Year

Dr. James Hunter  
Commitment 2.5 Months/Year

Dr. Soong Lee  
Commitment 2.5 Months/Year

Ms. Avis Ransom  
Commitment 2.0 Months/Year

Dr. Mary Akers  
Commitment 2.0 Months/Year

The Clarence M. Mitchell, Jr. School of Engineering
1700 E. Cold Spring Lane • Baltimore, Maryland 21251
Tel: 443-885-3251 • Fax: 443-885-8218
The Center For Building Knowledge

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley,

We are pleased to provide this commitment statement on behalf of our participating faculty/personnel as a member of the Energy Innovation Hub component proposed for the Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The personnel listed below are affiliated with NJIT’s Center for Building Knowledge, a 20-year old research and technical assistance center focused on improving the energy efficiency and sustainability of the built environment. Each listed individual has substantial experience in the energy efficient retrofit of buildings – residential and commercial – and in creating technical resources for the building industry. They are all committed to working with other members of the Energy Innovation Hub team at the Navy Yard to undertake the research, development, demonstration, and deployment activities described in detail in the Hub proposal.

We look forward to helping establish the Hub at the Navy Yard as an internationally recognized knowledge center, research nexus and business incubator that will, over time, attract the talent and the investment to transform the energy efficient buildings paradigm in the US and internationally.

Below please find the names and the signatures of our personnel committed to this project, including their individual levels of time commitment for the period of five years.

<table>
<thead>
<tr>
<th>Name</th>
<th>Percent (%) time commitment for 5 years</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deane Evans</td>
<td>27%</td>
<td></td>
<td>04/26/10</td>
</tr>
<tr>
<td>Paul Romano</td>
<td>27%</td>
<td></td>
<td>04/26/10</td>
</tr>
<tr>
<td>Christine Liaukus</td>
<td>34%</td>
<td></td>
<td>04/26/10</td>
</tr>
<tr>
<td>Erv Bales</td>
<td>6%</td>
<td></td>
<td>04/26/10</td>
</tr>
</tbody>
</table>
May 5, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16801

Dear Dr. Foley:

We are pleased to provide this commitment statement as a member of the Energy Innovation Hub component of the proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

I am fully committed to perform the work described in the HUB/GPIC proposal at the level and effort indicated. We intend to help develop the HUB at the Navy Yard as a locus for robust ongoing exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings.

We are delighted to be part of the exciting initiative.

Sincerely

John S. Grady, Jr.
Executive Vice President
April 27, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley:

We are pleased to provide this commitment statement as proposed members of the Energy Innovation Hub component of the Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

If selected for award, PPG Industries, Inc. (PPG) commits to perform the work described in the GPIC proposal at the level and effort indicated, subject to final negotiations and PPG’s acceptance of the Hub contract terms and conditions, including final statement of work and budget. PPG fully supports these commitments.

We understand that membership in the DOE Hub component of the GPIC entails a commitment to perform a portion of our work at the Hub headquarters at the Navy Yard in Philadelphia. We intend to help develop the Hub at the Navy Yard as a locus for robust ongoing exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings.

The proposed names and individual levels of time commitment for the period of five years are indicated below, subject to future staffing changes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Percent (%) time commitment for 5 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yu Jiao</td>
<td>10%</td>
</tr>
<tr>
<td>Ali Rashid</td>
<td>50%</td>
</tr>
</tbody>
</table>

Sincerely,

Charles F. Kahle, II

/maw

cc: Mehran Arbab
April 23, 2010

To Whom It May Concern:

I, David August, am committed to the E-RIC Hub project for a period of 0.25 summer month for Year 1 and 0.5 summer month per year for Year 2-5. I expect to contribute further during the academic year. My academic year salary is paid by Princeton University. Princeton makes no specific commitment of academic year time or salary to this particular research project.

Sincerely,

David August, Ph.D
Associate Professor of Computer Science
April 23, 2010

To Whom It May Concern:

I, Niraj Jha, am committed to the E-RIC Hub project for a period of 0.25 summer month for Year 1 and 0.5 summer month per year for Year 2-5. I expect to contribute further during the academic year. My academic year salary is paid by Princeton University. Princeton makes no specific commitment of academic year time or salary to this particular research project.

Sincerely,

Niraj Jha, Ph.D
Professor of Electrical Engineering
April 23, 2010

To Whom It May Concern:

I, James C. Sturm, am committed to the E-RIC Hub project for a period of 0.25 summer month for Year 1 and 0.5 summer month per year for Year 2-5. I expect to contribute further during the academic year. My academic year salary is paid by Princeton University. Princeton makes no specific commitment of academic year time or salary to this particular research project.

Sincerely,

James C. Sturm, Ph. D
Director Princeton Institute for the Science and Technology of Materials
Professor of Electrical Engineering
April 23, 2010

To Whom It May Concern:

I, Naveen Verma, am committed to the E-RIC Hub project for a period of 0.25 summer month for Year 1 and 0.5 summer month per year for Year 2-5. I expect to contribute further during the academic year. My academic year salary is paid by Princeton University. Princeton makes no specific commitment of academic year time or salary to this particular research project.

Sincerely,

Naveen Verma, Ph.D
Assistant Professor of Electrical Engineering
April 23, 2010

To Whom It May Concern:

I, Sigurd Wagner, am committed to the E-RIC Hub project for a period of 0.25 summer month for Year 1 and 0.5 summer month per year for Year 2-5. I expect to contribute further during the academic year. My academic year salary is paid by Princeton University. Princeton makes no specific commitment of academic year time or salary to this particular research project.

Sincerely,

[Signature]

Sigurd Wagner, Ph.D.
Professor of Electrical Engineering
May 4, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley,

I, Andrew Zwicker, am pleased to support the “Greater Philadelphia Innovation Cluster” proposal, in response to Fiscal Year (FY) 2010 Energy Efficient Building Systems Regional Innovation Cluster Initiative Funding Opportunity Announcement. I commit to the E-RIC Hub project for a period of one month per year for five years.

Please keep us informed of the status of this proposal.

Sincerely,

Andrew Zwicker
Principal Investigator, Princeton Plasma Physics Laboratory
Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley,

We are pleased to provide this commitment statement on behalf of our participating faculty/personnel as a member of the Energy Innovation Hub component proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

We understand that membership in the DOE Hub component of the Greater Philadelphia Innovation Cluster entails a commitment by personnel from our organization to perform work at the Hub headquarters at the Navy Yard in Philadelphia. We intend to help develop the Hub at the Navy Yard as a locus for robust ongoing exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings.

Below please find the names and the signatures of our personnel committed to this project, including their individual levels of time commitment, which includes cost share effort supported by Purdue University, for the period of five years.

<table>
<thead>
<tr>
<th>Name</th>
<th>Percent (%) time commitment for 5 years</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>James E. Braun</td>
<td>39.4%</td>
<td>[Signature]</td>
<td>4/27/10</td>
</tr>
<tr>
<td>Qingyan Chen</td>
<td>39.4%</td>
<td>[Signature]</td>
<td>4/27/10</td>
</tr>
<tr>
<td>W. Travis Horton</td>
<td>10.0%</td>
<td>[Signature]</td>
<td>4/27/10</td>
</tr>
<tr>
<td>Jianghai Hu</td>
<td>21.8%</td>
<td>[Signature]</td>
<td>4/28/10</td>
</tr>
<tr>
<td>Steven Pekarek</td>
<td>14.7%</td>
<td>[Signature]</td>
<td>4/28/10</td>
</tr>
<tr>
<td>Maryam Saeedifard</td>
<td>14.7%</td>
<td>[Signature]</td>
<td>4/28/10</td>
</tr>
<tr>
<td>Athanasios Tzempelikos</td>
<td>18.0%</td>
<td>[Signature]</td>
<td>4/27/10</td>
</tr>
<tr>
<td>Panagiota Karava</td>
<td>18.0%</td>
<td>[Signature]</td>
<td>4/28/10</td>
</tr>
</tbody>
</table>
Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Re: Hub Individual Commitment Statements

Dear Dr. Foley,

We are pleased to provide this commitment statement on behalf of our participating faculty/personnel as a member of the Energy Innovation Hub component proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The personnel listed below are committed to perform the work described in the GPIC proposal at the level and effort indicated. Our organization fully supports these commitments. We intend to help develop the Hub as a locus for robust ongoing exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings.

Below please find the names and the signatures of our personnel committed to this project, including their individual levels of time commitment for the period of five years.

<table>
<thead>
<tr>
<th>Name</th>
<th>Percent (%) time commitment for 5 years</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLINTON J. ANDREWS</td>
<td>10%</td>
<td>Clinton J. Andrews</td>
<td>4/27/10</td>
</tr>
<tr>
<td>MARGARET F. BRENNANTONETTA</td>
<td>10%</td>
<td>Margaret F. Brennan-Tonetta</td>
<td>4/27/10</td>
</tr>
<tr>
<td>RACHAEL L. SIWOM</td>
<td>10%</td>
<td>Rachael L. Siwom</td>
<td>4/27/10</td>
</tr>
<tr>
<td>AREND-JAN BOTH</td>
<td>5%</td>
<td>Arend-Jan Both</td>
<td>4/27/10</td>
</tr>
<tr>
<td>DUNBAR P. BIRNIE</td>
<td>10%</td>
<td>Dunbar P. Birnie</td>
<td>4/27/10</td>
</tr>
<tr>
<td>MOHSEN JAFARI</td>
<td>10%</td>
<td>Mohsen Jafari</td>
<td>4/27/10</td>
</tr>
<tr>
<td>FRANK FELDER</td>
<td>10%</td>
<td>Frank Felder</td>
<td>4-27-10</td>
</tr>
</tbody>
</table>
April 30, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley,

Turner Construction Company is pleased to provide this statement of commitment on behalf of our participating staff as a member of the Energy Innovation Hub component proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

Turner is committed to assign the personnel listed to perform the work described in the GPIC proposal at the level and effort indicated for Turner.

We understand that membership in the DOE Hub component of the Greater Philadelphia Innovation Cluster entails a commitment by personnel from our organization to support or perform work at the Hub headquarters at the Navy Yard in Philadelphia. We intend to help develop the Hub at the Navy Yard as a locus for exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings.

Below please find the names and the signatures of our personnel committed to this project, including their individual levels of time commitment for the period of five years:

<table>
<thead>
<tr>
<th>Name</th>
<th>Percent (%) time commitment for 5 years</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jeffrey Klinger, VP and General Manager</td>
<td>5%</td>
<td></td>
<td>~May 4, 2010</td>
</tr>
<tr>
<td>Nicole Barbero, Project Engineer</td>
<td>60%</td>
<td></td>
<td>May 4, 2010</td>
</tr>
<tr>
<td>Greg T. Smith, Preconstruction Manager</td>
<td>16%</td>
<td></td>
<td>May 4, 2010</td>
</tr>
<tr>
<td>Douglas Jadico, Equipment Manager</td>
<td>22%</td>
<td></td>
<td>May 4, 2010</td>
</tr>
</tbody>
</table>

Sincerely,

Turner Construction Company

Jeffrey A. Klinger  
VP and General Manager
Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings

April 30, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley,

We are pleased to provide this commitment statement on behalf of our participating faculty/personnel as a member of the Energy Innovation Hub component proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The personnel listed below are committed to perform the work described in the GPIC proposal at the level and effort indicated. Our organization fully supports these commitments. We understand that membership in the DOE Hub component of the Greater Philadelphia Innovation Cluster entails a commitment by personnel from our organization to perform work at the Hub headquarters at the Navy Yard in Philadelphia. We intend to help develop the Hub at the Navy Yard as a locus for robust ongoing exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings.

Below please find the names and the signatures of our personnel committed to this project, including their individual levels of time commitment for the period of five years.

<table>
<thead>
<tr>
<th>Name</th>
<th>Percent (%) time commitment for 5 years</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>George Pappas</td>
<td>4%</td>
<td></td>
<td>30-April-10</td>
</tr>
<tr>
<td>Rahul Mangharam</td>
<td>5%</td>
<td></td>
<td>30-April-10</td>
</tr>
<tr>
<td>Ali Jadbabaie</td>
<td>4%</td>
<td></td>
<td>30-April-10</td>
</tr>
<tr>
<td>Name</td>
<td>Percentage</td>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>------------</td>
<td>------------</td>
<td></td>
</tr>
<tr>
<td>Rajeev Alur</td>
<td>4%</td>
<td>30-April-10</td>
<td></td>
</tr>
<tr>
<td>Ali Malkawi</td>
<td>15%</td>
<td>30-April-10</td>
<td></td>
</tr>
<tr>
<td>Eugenie Birch</td>
<td>18%</td>
<td>30-April-10</td>
<td></td>
</tr>
<tr>
<td>Susan Wachter</td>
<td>24%</td>
<td>30-April-10</td>
<td></td>
</tr>
<tr>
<td>Mark Alan Hughes</td>
<td>40%</td>
<td>30-April-10</td>
<td></td>
</tr>
</tbody>
</table>

Sincerely,

George J. Pappas, Ph.D.
Deputy Dean, School of Engineering and Applied Science
Joseph Moore Professor of Electrical and Systems Engineering
University of Pennsylvania
April 30, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Re: Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings
DOE Hub Member Letter of Commitment

Dear Dr. Foley,

We are pleased to provide this commitment statement on behalf of our participating faculty/personnel as a member of the Energy Innovation Hub component proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The personnel listed below are committed to perform the work described in the GPIC proposal at the level and effort indicated. Our organization fully supports these commitments. We understand that membership in the DOE Hub component of the Greater Philadelphia Innovation Cluster entails a commitment by personnel from our organization to perform work at the Hub headquarters at the Navy Yard in Philadelphia. We intend to help develop the Hub at the Navy Yard as a locus for robust ongoing exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings.

Below please find the names and the signatures of our personnel committed to this project, including their individual levels of time commitment for the period of five years.

<table>
<thead>
<tr>
<th>Name</th>
<th>Percent (%) time commitment for 5 years</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Howard Kunreuther</td>
<td>11%</td>
<td></td>
<td>4/30/2010</td>
</tr>
<tr>
<td>Erwann Michel-Kerjan</td>
<td>25%</td>
<td></td>
<td>4/30/2010</td>
</tr>
</tbody>
</table>
April 20, 2010

Re: Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings

It is with pleasure that I provide this letter of commitment for faculty at the University of Pittsburgh to participate in the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

Faculty within the Swanson School of Engineering at the University of Pittsburgh will be contributing to the success of the Innovation Cluster in many ways. We will be collaborating with other institutions in the Hub to advance research and development in the areas of component- and building-level heat transfer analyses, novel materials for structures, combined system simulations and controls, local energy harvesting to aid distributed generation, and the creation of environmental and performance metrics for more energy efficient buildings. We are also committed to furthering the education and outreach aims of the Innovation Cluster through our partnerships with local schools, community organizations, and workforce groups.

As the coordinator for the efforts at the University of Pittsburgh, I will commit two person-months per year for five years toward the success of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings. The other participating faculty members at the University of Pittsburgh are Melissa Bilec, William Clark, Daniel Cole, Mark Kimber, Amy Landis, Jeffrey Vipperman, and Lisa Weiland. Each of those participants will commit one person-month per year for five years.

Sincerely,

Laura A. Schaefer
Associate Professor and Bicentennial Board of Visitors Faculty Fellow
Associate Director, Center for Energy
Deputy Director, Mascaro Center for Sustainable Innovation

Faculty Participants:

Melissa Bilec  William Clark  Daniel Cole
Mark Kimber  Amy Landis  Jeffrey Vipperman  Lisa Weiland
April 26, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley,

This letter is to serve as a faculty commitment statement on behalf of our participating faculty/personnel as a member of the Energy Innovation Hub component proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The personnel listed below are committed to perform the work described in the GPIC proposal at the effort indicated in column two. Virginia Tech fully supports these commitments. We understand that membership in the DOE Hub component of the Greater Philadelphia Innovation Cluster entails a commitment by personnel from our organization to perform work at the Hub headquarters at the Navy Yard in Philadelphia. We intend to help develop the Hub at the Navy Yard as a locus for robust ongoing exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings.

The following faculty members are committed to this project at the effort cited below.

<table>
<thead>
<tr>
<th>Name</th>
<th>% Effort for 5 yrs.</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>John A. Burns</td>
<td>30%</td>
<td>John A. Burns</td>
<td>4/26/2010</td>
</tr>
<tr>
<td>Terry Herdman</td>
<td>21%</td>
<td>Terry Herdman</td>
<td>4/26/2010</td>
</tr>
<tr>
<td>Lizette Zietsman</td>
<td>21%</td>
<td>Lizette Zietsman</td>
<td>4/26/2010</td>
</tr>
<tr>
<td>Jeff Borggaard</td>
<td>21%</td>
<td>Jeff Borggaard</td>
<td>4/26/2010</td>
</tr>
<tr>
<td>Traian Iliescu</td>
<td>21%</td>
<td>Traian Iliescu</td>
<td>4/26/2010</td>
</tr>
<tr>
<td>Serkan Gugercin</td>
<td>21%</td>
<td>Serkan Gugercin</td>
<td>4/26/2010</td>
</tr>
<tr>
<td>John Burkardt</td>
<td>21%</td>
<td>John Burkardt</td>
<td>4/26/2010</td>
</tr>
<tr>
<td>Gene Cliff</td>
<td>27%</td>
<td>Gene Cliff</td>
<td>4/26/2010</td>
</tr>
<tr>
<td>Madhav Marathe</td>
<td>05%</td>
<td>Madhav Marathe</td>
<td>4/26/2010</td>
</tr>
</tbody>
</table>

Roop L. Mahajan  
Tucker Chair Professor of Engineering  
Director, ICTAS (Institute for Critical Technology and Applied Science)
Appendix 9

Current and Pending Support

PI – Foley, Henry C., Penn State
Akers, Mary Ann Alabanza, Morgan State
Akinci, Burcu H., CMU
Alur, Rajeev, Penn
Amaba, Ben, IBM
Andrews, Clinton, Rutgers
Anumba, Chimay J., Penn State
August, David, Princeton
Aziz, Azizan, CMU
Bahnfleth, William P., Penn State
Bailey, Trevor, UTC
Bales, Erv, NJIT
Barton, William, Turner
Bilec, Melissa, Pitt
Birch, Eugenie, Penn
Birnie, Dunbar, Rutgers
Blumsack, Seth A., Penn State
Borggaard, Jeff, Virginia Tech
Bose, Mallika, Penn State
Both, Arend-Jan, Rutgers
Braun, James, Purdue
Brennan-Tonetta, Margaret, Rutgers
Bronner, Lee Roy, Morgan State
Brownson, Jeffrey, Penn State
Burkardt, John Vetter, Virginia Tech
Burns, John Allen, Virginia Tech
Caton, James M., IBM
Chen, Qingyan, Purdue
Clark, William, Pitt
Cliff, Eugene Matthew, Virginia Tech
Cohen, Adam, Princeton
Cole, Daniel, Pitt
D'Amora, Bruce D., IBM
Dickens, Corey, Morgan State
Echols, Stuart, Penn State
Evans, Deane, NJIT
Felder, Frank, Rutgers
Finn, Alan, UTC
Fisher, Amit, IBM
Frase, Katharine G., IBM
Freihaurt, James, Penn State
Gambino, James, BFTP
Garrett, James H., CMU
Girifalco, Anthony, DVIRC
Grady, John, PIDC
Green, Anthony, BFTP
Grosh, John, LLNL
Gugercin, Serkan, Virginia Tech
Gurian, Patrick, Drexel
Hallacher, Paul, Penn State
Hamann, Hendrik F., IBM
Harasin, Steve, Bayer
Hartkopf, Volker, CMU
Hayes, John, Bayer
Henshaw, William, LLNL
Herdman, Terry L., Virginia Tech
Horton, Travis, Purdue
Houldin, Joseph J., DVIRC
Houser, Kevin W., Penn State
Hu, Jianghai, Purdue
Hughes, Mark Alan, Penn
Hunter, James, Morgan State
Iliescu, Traian, Virginia Tech
Isom, Joshua, UTC
Jadbabaie, Ali, Penn
Jafari, Mohsen, Rutgers
Jha, Niraj, Princeton
Jiao, Yu, PPG
Jurbergs, David, Bayer
Kalagnanam, Jayant, IBM
Karava, Panagiota, Purdue
Kimber, Mark, Pitt
Klein, Levente J., IBM
Kleit, Andrew N., Penn State
Klinger, Jeffrey, Turner
Krogh, Bruce H., CMU
Kunreuther, Howard, Penn
Kuntz, Michael, Turner
Lam, Khee Poh, CMU
Landis, Amy Elaine, Pitt
Lee, Seong, Morgan State
Lee, Stephen R., CMU
Lee, Young M., IBM
Lenchner, Jonathan, IBM
Liaukus, Christine, NJIT
Loftness, Vivian, CMU
Malkawi, Ali, Penn
Mangharam, Rahul, Penn
Marathe, Madhav V., Virginia Tech
Mashkif, Nir, IBM
Masin, Michael, IBM
Mazurek, Monica, Rutgers
Memari, Ali M., Penn State
Messner, John I., Penn State
Michel-Kerjan, Erwann, Penn
Miller, Barry W., DVIRC
Mistrick, Richard, Penn State
Napade, Milind R., IBM
Narayanan, Satish, UTC
Nyarko, Kofil, Morgan State
Oggianu, Stella Maris, UTC
Oliva, Ralph, Penn State
O'Neil, Zheng D., UTC
Orland, Brian, Penn State
Orts, Eric, Penn
Pappas, George J., Penn
Pekarek, Steven, Purdue
Radcliffe, Thomas, UTC
Rangaswamy, Arvind, Penn State
Ransom, Avis, Morgan State
Rashid, Ali, PPG
Riley, David, Penn State
Romano, Paul, NJIT
Saeedifard, Maryam, Purdue
Schaefer, Laura A., Pitt
Sexton, James C., IBM
Shwom, Rachael, Rutgers
Sisson, William, UTC
Sliwinski, Martin, Penn State
Smith, Gregory, Turner
Snowdon, Jane L., IBM
Srebric, Jelena, Penn State
Sturm, James, Princeton
Sunderland, Nicolas, Bayer
Tong, Charles L., LLNL
Treado, Stephen, Penn State
Tzempelikos, Athanasios, Purdue
Verma, Naveen, Princeton
Vipperman, Jeffrey S., Pitt
Wachter, Susan, Penn
Wagner, Sigurd, Princeton
Wagner, Timothy, UTC
Walker, Craig, UTC
Waring, Micheal, Drexel
Watkins, Damian, Morgan State
Weiland, Lisa Mauck, Pitt
Welsh, Joseph, Collegiate Consortium
Wen, Jin, Drexel
Willis, Daniel E., Penn State
Witman, Mark, Bayer
Yen, John, Penn State
Zietsman, Lizette, Virginia Tech
Zwicker, Andrew, Princeton

4-268
Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

| Investigator: Mary Anne Alabanza Aker | Other agencies (including NSF) to which this proposal has been/will be submitted: US Small Business Administration |

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Great Opportunities for Flexible Green Manufacturing Networks

Source of Support: PRIME grant

Total Award Amount: $500,000

Total Award Period Covered: 10/01/10 to 9/30/11

Location of Project: Morgan State University, Baltimore, Maryland

Person-Months Per Year Committed to the Project. Cal: 5 Acad: 10 Sumr: 5

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Total Award Amount: $500,000

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**Current and Pending Support**

*(See GPG Section II.D.8 for guidance on information to include on this form.)*

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
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## Current and Pending Support

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<td>Investigating Opportunities for Improving Building Performance through Simulation of Occupant and Operator Behavior</td>
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<td>05/01/2010 - 04/30/2012</td>
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<tr>
<td>Location of Project:</td>
<td>Rutgers University</td>
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<tr>
<td>Person-Months Per Year Committed to the Project.</td>
<td>Cal: 0  Acad: 0  Sumr: 0</td>
</tr>
</tbody>
</table>

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99)  USE ADDITIONAL SHEETS AS NECESSARY
<table>
<thead>
<tr>
<th>Investigator: C. Anumba</th>
<th>Other Agencies (including NSF) to which this proposal has been/will be submitted: None</th>
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</thead>
<tbody>
<tr>
<td>Support:</td>
<td>X Current</td>
</tr>
<tr>
<td>Project/Proposal Title:</td>
<td>Virtual Construction Simulator 3D: A Simulation Game for Construction Engineering Education</td>
</tr>
<tr>
<td>Source of Support: National Science Foundation</td>
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<tr>
<td>Award Amount (or Annual Rate):</td>
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<td>Location Of Project:</td>
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<tr>
<td>Person-Months Per Year Committed to the Project.</td>
<td>Cal: 0.1</td>
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<tr>
<td>Support:</td>
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<tr>
<td>Project/Proposal Title:</td>
<td>Dependency Modeling and Change Management in Building Information Models</td>
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<tr>
<td>Source of Support: Bentley Systems</td>
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<td>Award Amount (or Annual Rate):</td>
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<td>Support:</td>
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<td>Project/Proposal Title:</td>
<td>Measuring the Impact of Process Variations in the Facility Delivery Process for Complex Projects</td>
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<tr>
<td>Source of Support: NIST</td>
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<td>Award Amount (or Annual Rate):</td>
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<td>Location Of Project:</td>
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<td>Person-Months Per Year Committed to the Project.</td>
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<tr>
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<td>Project/Proposal Title:</td>
<td>MAJOR CREATIVE IT: Enhancing Creativity through Experience-based Design for Healthcare Facilities in Virtual Environments</td>
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<td>Source of Support: National Science Foundation</td>
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<td>Award Amount (or Annual Rate):</td>
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<td>Support:</td>
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<tr>
<td>Project/Proposal Title:</td>
<td>Innovation and Sustainability: Computing and Information Technology Support US-Nigeria International Workshop</td>
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<td>Source of Support: National Science Foundation</td>
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<td>Award Amount (or Annual Rate):</td>
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<td>Person-Months Per Year Committed to the Project.</td>
<td>Cal: 0.0</td>
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</table>
## Current and Pending Support

**Investigator:** David August

<table>
<thead>
<tr>
<th>Support:</th>
<th>Current</th>
<th>Pending</th>
<th>Submission Planned in Near Future</th>
<th>*Transfer of Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project/Proposal Title:</td>
<td>AACE Architecture Aware Compiler Environment</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### Project/Proposal Title: AACE Architecture Aware Compiler Environment

- **Source of Support:** BAE Systems, Inc
- **Total Award Amount:** $283,499
- **Total Award Period Covered:** 05/11/09 - 09/09/11
- **Location of Project:** Princeton University
- **Person-Months Per Year Committed to the Project:** Cal: 0.00, Acad: 0.00, Sumr: 0.00

### Project/Proposal Title: Scalable Automatic Thread Extraction of C/C++ Codes for Multicore Systems

- **Source of Support:** Semiconductor Research Corporation
- **Total Award Amount:** $100,000
- **Total Award Period Covered:** 04/01/08 - 03/31/11
- **Location of Project:** Princeton University
- **Person-Months Per Year Committed to the Project:** Cal: 0.00, Acad: 0.00, Sumr: 0.00

### Project/Proposal Title: CSR: Medium: Collaborative Research: Scaling the Implicitly Parallel Programming Model with Lifelong Thread Extraction and Dynamic Adaptation (co-PI with 2 others)

- **Source of Support:** National Science Foundation
- **Total Award Amount:** $1,200,000
- **Total Award Period Covered:** 09/01/10 - 08/31/12
- **Location of Project:** Princeton University
- **Person-Months Per Year Committed to the Project:** Cal: 0.00, Acad: 0.00, Sumr: 0.50

### Project/Proposal Title: CPS: Medium: Cyber-Physical Methods for Dynamic Energy Analysis and Optimization of Buildings

- **Source of Support:** National Science Foundation
- **Total Award Amount:** $1,500,000
- **Total Award Period Covered:** 09/01/10 - 08/31/13
- **Location of Project:** Princeton University
- **Person-Months Per Year Committed to the Project:** Cal: 0.00, Acad: 0.00, Sumr: 1.00
The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Azizan Aziz</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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</thead>
<tbody>
<tr>
<td>Support:</td>
<td>Current  Pending  Submission Planned in Near Future  *Transfer of Support</td>
</tr>
</tbody>
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**Project/Proposal Title:** Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings

**Source of Support:** DOE
- **Total Award Amount:** $5,501,231
- **Total Award Period Covered:** 9/10-9/15
- **Location of Project:** Carnegie Mellon University
  - **Person-Months Per Year Committed to the Project:** Cal:  Acad: 9  Sumr: 3

| Support:                  | Current  Pending  Submission Planned in Near Future  *Transfer of Support |

**Project/Proposal Title:** e-Pod* environmental live, work and learn spaces

**Source of Support:** Green Building Alliance
- **Total Award Amount:** $40,000
- **Total Award Period Covered:** 7/1/09-6/30/10
- **Location of Project:** Carnegie Mellon University
  - **Person-Months Per Year Committed to the Project:** Cal:  Acad: 6  Sumr: 3

| Support:                  | Current  Pending  Submission Planned in Near Future  *Transfer of Support |

**Project/Proposal Title:** Passive Energy and Building Systems Finance, Design, Engineering, Construction, and Operations

**Source of Support:** NSF
- **Total Award Amount:** $1,975,769
- **Total Award Period Covered:** 7/10-6/14
- **Location of Project:** Carnegie Mellon University
  - **Person-Months Per Year Committed to the Project:** Cal:  Acad: 0.60  Sumr: 0.50

| Support:                  | Current  Pending  Submission Planned in Near Future  *Transfer of Support |

**Project/Proposal Title:**

**Source of Support:**
- **Total Award Amount:** $
- **Total Award Period Covered:**
- **Location of Project:**
  - **Person-Months Per Year Committed to the Project:** Cal:  Acad:  Sumr:  

| Support:                  | Current  Pending  Submission Planned in Near Future  *Transfer of Support |

**Project/Proposal Title:**

**Source of Support:**
- **Total Award Amount:** $
- **Total Award Period Covered:**
- **Location of Project:**
  - **Person-Months Per Year Committed to the Project:** Cal:  Acad:  Sumr:  

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99)  USE ADDITIONAL SHEETS AS NECESSARY

4-275
<table>
<thead>
<tr>
<th>Source (Status)</th>
<th>Project title (PI and Co-PIs)</th>
<th>Award Amount</th>
<th>Duration</th>
<th>Time Committed</th>
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<tbody>
<tr>
<td>United Technologies Research Center (Current)</td>
<td>CBTool Software for Architects and Designers (PI)</td>
<td>$384,681</td>
<td>04/27/2009-09/30/2011</td>
<td>3.1 months</td>
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<tr>
<td>Department of Energy (Current)</td>
<td>PSU Mid-Atlantic Clean Energy Application Center (CEAC) Proposal (Co-PI)</td>
<td>$2,000,000</td>
<td>10/01/2009-09/30/2013</td>
<td>3.3 months</td>
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**Current and Pending Support**

See GPG Section II.D.8 for guidance on information to include on this form.

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Trevor Bailey</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted</th>
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<tr>
<td><strong>Support:</strong></td>
<td><strong>Pending</strong></td>
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<tr>
<td><strong>Project/Proposal Title:</strong> Automated Continuous Commissioning of Commercial Buildings</td>
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<tr>
<td>Source of Support: DOD-ESTCP</td>
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<tr>
<td>Total Award Amount: $1,347,457</td>
<td>Total Award Period Covered: 08/2010 – 10/2011</td>
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<td>Location of Project: IL</td>
<td>Person-Months Per Year Committed to the Project: 16 person-months/yr</td>
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<tr>
<td><strong>Support:</strong></td>
<td><strong>Current</strong></td>
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<tr>
<td><strong>Project/Proposal Title:</strong> Scalable Deployment of Advanced Building Energy Management Systems</td>
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<tr>
<td>Source of Support: DOD/ESTCP</td>
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<td>Total Award Amount: $2,436,569</td>
<td>Total Award Period Covered: 04/2010 – 04/2012</td>
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<td>Location of Project: IL</td>
<td>Person-Months Per Year Committed to the Project: 24 person-months/yr</td>
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<tr>
<td><strong>Support:</strong></td>
<td><strong>Current</strong></td>
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<tr>
<td><strong>Project/Proposal Title:</strong> Energy Performance Monitoring and Optimization System for DOD Campus</td>
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<td>Source of Support: DOD-ESTCP</td>
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<td>Total Award Amount: $2,499,810</td>
<td>Total Award Period Covered: 03/2011 – 03/2013</td>
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<td>Person-Months Per Year Committed to the Project: 24 person-months/yr</td>
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<td><strong>Support:</strong></td>
<td><strong>Current</strong></td>
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<tr>
<td><strong>Project/Proposal Title:</strong> Integrated Whole-Building Energy Diagnostics</td>
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<td>Source of Support: DOE</td>
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<td>Location of Project: CA</td>
<td>Person-Months Per Year Committed to the Project:</td>
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</table>

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.
The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator:</th>
<th>Erv Bales</th>
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**Current and Pending Support**

(See GPG Section II.D.8 for guidance on information to include on this form.)

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<th>□ Pending</th>
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<th>□ *Transfer of Support</th>
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<tr>
<td>Project/Proposal Title:</td>
<td>(Mr. Bales has no research projects at this time.)</td>
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Source of Support:

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Location of Project:

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**Current and Pending Support**

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<th>□ Submission Planned in Near Future</th>
<th>□ *Transfer of Support</th>
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<tbody>
<tr>
<td>Project/Proposal Title:</td>
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Source of Support:

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Location of Project:

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<th>Person-Months Per Year Committed to the Project.</th>
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**Current and Pending Support**

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<th>□ Submission Planned in Near Future</th>
<th>□ *Transfer of Support</th>
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<tbody>
<tr>
<td>Project/Proposal Title:</td>
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Source of Support:

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Location of Project:

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**Current and Pending Support**

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<th>□ Submission Planned in Near Future</th>
<th>□ *Transfer of Support</th>
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<tbody>
<tr>
<td>Project/Proposal Title:</td>
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Source of Support:

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Location of Project:

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<tr>
<th>Person-Months Per Year Committed to the Project.</th>
<th>Cal:</th>
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<th>Sumr:</th>
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</table>

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY
Support: Current  
Title: Investigating the Environmental LCA, Performance, and Life-Cycle Expanded Polystyrene for Construction Material and Supplies: Focus on Insulating Concrete Forms  
Source of Support: Green Building Alliance  
Total Award Amount: $220,000  
Dates: 01/01/08-12/31/11  
Person-Months Per Year: 1.0 Summer Months

Support: Current  
Title: Beyond Design for the Environment – Improving Products, Processes, and Actions  
Source of Support: National Collegiate Inventors and Innovators Alliance  
Total Award Amount: $35,000  
Dates: 01/01/08-12/31/11  
Person-Months Per Year: 0.1 Summer Months

Support: Current  
Title: Biodiesel Fleet Transition  
Source of Support: Pennsylvania Department of Transportation  
Total Award Amount: $272,068  
Dates: 06/25/08 – 4/24/2010  
Person-Months Per Year: 1 Summer Months

Support: Pending  
Title: CCLI-1: Integrating Sustainability into the Civil Eng’g Curriculum Through 3 Courses  
Source of Support: National Science Foundation  
Total Award Amount: $199,982  
Dates: 06/01/10 – 06/01/12  
Person-Months Per Year: 1 Summer Months

Support: Pending  
Title: Integrative International Undergraduate Research Experience IIURE II  
Source of Support: National Science Foundation  
Total Award Amount: $150,000  
Dates: 09/01/10 – 09/01/12  
Person-Months Per Year: 0 Summer Months

Support: Pending  
Title: Sustainable Community Oriented Research & Education (SCORE)  
Source of Support: National Science Foundation  
Total Award Amount: $3,200,000 (preproposal)  
Dates: 07/01/11-06/30/16  
Person-Months Per Year: 0 Summer Months

Support: Pending  
Title: EFRI-SEED: BUILD - Barriers, Understanding, Integration – Life cycle Development  
Source of Support: National Science Foundation  
Total Award Amount: $2,000,000  
Dates: 01/01/11 – 01/01/15  
Person-Months Per Year: 1 Summer Months
## Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Dunbar P. Birnie, III</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
</tr>
</thead>
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### Support: Current

<table>
<thead>
<tr>
<th>Project/Proposal Title: Synthesis and Characterization of Nanoscale Transition Metal Phosphates as a New Class of Electrocatalysts</th>
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<tbody>
<tr>
<td>Source of Support: NSF</td>
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<tr>
<td>Total Award Amount: $298,501</td>
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<tr>
<td>Total Award Period Covered: 9/1/2007 – 8/31/2010</td>
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<tr>
<td>Location of Project: Rutgers University</td>
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<tr>
<td>Person-Months Per Year Committed to the Project.</td>
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### Support: Pending

<table>
<thead>
<tr>
<th>Project/Proposal Title: Advanced Neutrally Buoyant Rechargeable Batteries Based on Ceramic Electrolyte Separators</th>
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<tbody>
<tr>
<td>Source of Support: subcontract from Technology Holdings Inc, as part of their SBIR from the Navy.</td>
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<tr>
<td>Total Award Amount: $150,000</td>
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<tr>
<td>Location of Project: Rutgers University</td>
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<tr>
<td>Person-Months Per Year Committed to the Project.</td>
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### Support: Submission Planned in Near Future

<table>
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<tr>
<th>Project/Proposal Title: DOE Solar Decathlon: Team New Jersey, eNJoy! New Jersey’s Solar House</th>
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<tbody>
<tr>
<td>Source of Support: DOE (co-investigator with Clint Andrews from Rutgers and with NJIT)</td>
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<tr>
<td>Total Award Amount: $100,000</td>
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<tr>
<td>Total Award Period Covered: 4/30/2010 – 11/1/2011</td>
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<td>Location of Project: Rutgers University</td>
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<tr>
<td>Person-Months Per Year Committed to the Project.</td>
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<td>Cal: 0  Acad: 0  Sumr: 0</td>
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</table>

### Support: *Transfer of Support*

<table>
<thead>
<tr>
<th>Project/Proposal Title: Rutgers Integrated Scholarship for Engineers (RISE) -- (with several other Rutgers Engineering faculty. Kim Cook-Chenault is PI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source of Support: NSF</td>
</tr>
<tr>
<td>Total Award Amount: $600,000</td>
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<tr>
<td>Total Award Period Covered: 7/1/2010 – 6/30/2015</td>
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<tr>
<td>Location of Project: Rutgers University</td>
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<tr>
<td>Person-Months Per Year Committed to the Project.</td>
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<td>Cal: 0  Acad: 0  Sumr: 0</td>
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</table>

### Support: *Transfer of Support*

<table>
<thead>
<tr>
<th>Project/Proposal Title: EFRI-RESTOR Preliminary Proposal: Transformative Solutions to Chemical Energy Storage to Couple with Intermittent Renewable Electricity Generation (DB is PI, with Chuck Dismukes and Moncef Tayahi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source of Support: NSF</td>
</tr>
<tr>
<td>Total Award Amount: $2,000,000</td>
</tr>
<tr>
<td>Total Award Period Covered: 9/1/2010 – 8/31/2014</td>
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<tr>
<td>Location of Project: Rutgers University</td>
</tr>
<tr>
<td>Person-Months Per Year Committed to the Project.</td>
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<td>Cal: 0  Acad: 0  Sumr: 0.5</td>
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</tbody>
</table>

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
### Current and Pending Support

*See GPG Section II.D.8 for guidance on information to include on this form.*

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Dunbar P. Birnie, III</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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<tbody>
<tr>
<td><strong>Support:</strong></td>
<td>□ Current  ☑ Pending  □ Submission Planned in Near Future  □ *Transfer of Support</td>
</tr>
<tr>
<td><strong>Project/Proposal Title:</strong></td>
<td>$5M to Rutgers as subcontract from Northwestern team (w/ Dismukes, Asefa, Goldman, and Case at Rutgers)</td>
</tr>
<tr>
<td><strong>Source of Support:</strong></td>
<td>DOE</td>
</tr>
<tr>
<td><strong>Total Award Amount:</strong></td>
<td>$5M</td>
</tr>
<tr>
<td><strong>Location of Project:</strong></td>
<td>Rutgers University</td>
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<tr>
<td><strong>Total Award Period Covered:</strong></td>
<td>1/1/2011 – 12/31/2015</td>
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<tr>
<td><strong>Person-Months Per Year Committed to the Project.</strong></td>
<td>Cal: 0  Acad: 0  Sumr: 1.5</td>
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| **Support:** | □ Current  ☑ Pending  □ Submission Planned in Near Future  □ *Transfer of Support |
| **Project/Proposal Title:** | Highly Sensitive glass scintillating optical fibers |
| **Source of Support:** | DOE – subcontract from Western Texas A&M University (Shiquan Tao is PI) |
| **Total Award Amount:** | $344,613 |
| **Location of Project:** | Rutgers University |
| **Total Award Period Covered:** | 1/1/2011 – 12/31/13 |
| **Person-Months Per Year Committed to the Project.** | Cal: 0  Acad: 0  Sumr: 0.5 |
Current and Pending Support
Seth A. Blumsack – The Pennsylvania State University

CURRENT

“Load Deliverability Assessment Support for PJM Using Tools from Complex Networks (Phase 2)
Funding Agency: PJM Interconnect
Amount: $67,885
PI: Seth Blumsack
Period: 1/1/09 – 12/31/10
Annual Support: 0.05 person-months

“Penn State Electricity Markets Initiative,"
Funding Agency: Consortium of Electric Utilities
Amount: $240,000
PI: Andrew Kleit (Blumsack Co-PI)
Period: 1/1/10 – 12/31/11
Annual Support: 0.05 person-month

“Cyber-Security in the Smart Grid,"
Funding Agency: Penn State Institutes of Energy and the Environment
Amount: $50,000
PI: Seth Blumsack
Period: 1/1/10 – 12/31/10

“The Economic Impacts of Marcellus Shale Natural Gas Development,"
Funding Agency: Marcellus Shale Commission
Amount: $100,000
PI: Turgay Ertekin
Period: 2/1/10 – 12/31/10
Annual Support: 1.08 person-month

“Impacts of Electricity Restructuring on Rural Pennsylvania,"
Funding Agency: Center for Rural Pennsylvania
Amount: $100,000
PI: Andrew Kleit
Period: 1/1/08-5/31/10, $100,000.
Annual Support: 1 person-month

“Wilson Research Initiation Grant: Measuring the Impact of Utility-Scale Wind Integration,"
Funding Agency: College of Earth and Mineral Sciences, Penn State University
Amount: $10,000
PI: Seth A. Blumsack
Annual Support: 7/1/09-6/30/10

PENDING

“Water Sustainability and Climate, Category 1: Decision and Risk Analysis for Water Management in the Marcellus Shale Region”
Funding Agency: National Science Foundation
Amount: $150,000
PI: Seth A. Blumsack
Period: 9/1/10 – 8/31/12
Annual Support: 1 person-month
“Managing Complexity in the Smart Grid”
  Funding Agency: Lockheed Martin
  Amount: $600,000
  PI: Seth A. Blumsack
  Period: 9/1/10-8/31/12
  Annual Support: 1 person-month

“Collaborative Research: A Complex Systems Approach to Identifying and Mitigating Vulnerabilities in Power Grids”
  Funding Agency: National Science Foundation
  Amount: $316,587
  PI: Seth A. Blumsack
  Period: 6/1/10-5/31/13
  Annual Support: 1 person-month

“Critical Peak Pricing in Vermont,”
  Funding Agency: Central Vermont Public Service Corporation
  Amount: $250,000
  PI: Seth A. Blumsack
  Period: 6/1/10 – 9/1/12
  Annual Support: 1 person-month

“SunFuels Energy Innovation Hub”
  Funding Agency: U.S. Department of Energy
  Amount: $122,000,000
  PIs: Tom Mallouk, Seth Blumsack, Chunshan Song, John Kitchin, Mike Hickner, Robert Collins
  Period: 6/1/10 – 5/31/15
  Annual Support: 3 person-months

  Funding Agency: Marcellus Initiative for Outreach and Research
  Amount: $50,000
  PI: Zhen Lei
  Period: 6/1/10 – 5/31/11

“Sustainability Seed Grant: China’s Monopoly on Rare Earth Elements and the Impacts on Green Technologies”
  Funding Agency: Penn State Institutes of Energy and the Environment
  Amount: $70,000
  PI: Andrew Kleit (Blumsack Co-PI)
  Period: 6/1/10 – 5/31/11

“Sustainability Seed Grant: Best Practice Charging Infrastructure and use of Pluggable Vehicles in the Penn State University Park Fleet”
  Funding Agency: Penn State Institutes of Energy and the Environment
  Amount: $70,000
  PI: Joel Anstrom (Blumsack Co-PI)
  Period: 6/1/10 – 5/31/11
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<tr>
<th>Investigator: Jeffrey Borggaard</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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<td><strong>Support:</strong></td>
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<tr>
<td><strong>Project/Proposal Title:</strong></td>
<td>Reduced-Order Modeling for Optimization and Control of Complex Flows</td>
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<td><strong>Person-Months Per Year Committed to the Project:</strong></td>
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| Support: | ☐ Current  ☐ Pending  ☐ Submission Planned in Near Future  ☐ *Transfer of Support |
| Project/Proposal Title: | Improved Parametrization of Groundwater Flow Models Using Interferograms and Adjoint Sensitivity Analysis |
| Source of Support: | The National Science Foundation |
| Total Award Amount: | $ 260,000  |
| Total Award Period Covered: | 01/01/10 - 12/31/12  |
| Location of Project: | Virginia Tech |
| Person-Months Per Year Committed to the Project: | Cal: 0.00  Acad: 0.00  Sumr: 0.00 |

| Support: | ☐ Current  ☒ Pending  ☐ Submission Planned in Near Future  ☐ *Transfer of Support |
| Project/Proposal Title: | FRG: Collaborative Research: Reduced-Order Modeling for Data Assimilation of Ocean Flows |
| Source of Support: | The National Science Foundation |
| Total Award Amount: | $ 950,459  |
| Total Award Period Covered: | 05/01/10 - 04/30/13  |
| Location of Project: | Virginia Tech |
| Person-Months Per Year Committed to the Project: | Cal: 0.00  Acad: 0.00  Sumr: 1.00 |

| Support: | ☐ Current  ☒ Pending  ☐ Submission Planned in Near Future  ☐ *Transfer of Support |
| Project/Proposal Title: | High Performance Computing for Simulation, Control and Optimization of High Performance Energy Efficient Buildings: A Research Initiative Towards Solving the Energy Crisis in |
| Source of Support: | US AID |
| Total Award Amount: | $ 150,070  |
| Total Award Period Covered: | 07/01/10 - 06/30/13  |
| Location of Project: | Virginia Tech |
| Person-Months Per Year Committed to the Project: | Cal: 0.00  Acad: 0.00  Sumr: 0.00 |

| Support: | ☐ Current  ☒ Pending  ☐ Submission Planned in Near Future  ☐ *Transfer of Support |
| Project/Proposal Title: | Transcending POD: Model Reduction for Complex Fluid Flows |
| Source of Support: | The National Science Foundation |
| Total Award Amount: | $ 661,950  |
| Total Award Period Covered: | 07/01/10 - 06/30/13  |
| Location of Project: | Virginia Tech |
| Person-Months Per Year Committed to the Project: | Cal: 0.00  Acad: 0.00  Summ: 1.00 |

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
Current and Pending Support
(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Jeffrey Borggaard

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<tr>
<th>Investigator: A.J. Both</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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**Support:**

- **Current**
- **Pending**
- **Submission Planned in Near Future**
- **Transfer of Support**

**Project/Proposal Title:**

**IGERT: Solutions for renewable and sustainable fuels in the 21st Century (PI: E. Lam)**

- **Source of Support:** NSF
- **Total Award Amount:** $3,198,175
- **Total Award Period Covered:** 08/09-08/14
- **Location of Project:** Rutgers University
- **Person-Months Per Year Committed to the Project:** Cal: 0.5 Acad: Sumr:

**Support:**

- **Current**
- **Pending**
- **Submission Planned in Near Future**
- **Transfer of Support**

**Project/Proposal Title:**

**SCRI: Developing LED lighting technology and practices for sustainable specialty crop production (PI: C. Mitchell)**

- **Source of Support:** USDA/CSREES
- **Total Award Amount:** $5,458,644
- **Total Award Period Covered:** 09/10-08/14
- **Location of Project:** Rutgers University
- **Person-Months Per Year Committed to the Project:** Cal: 2 Acad: Sumr:

**Support:**

- **Current**
- **Pending**
- **Submission Planned in Near Future**
- **Transfer of Support**

**Project/Proposal Title:**

**SCRI: Partial saturation ebb&flow watering to improve quality and prevent disease in potted plants (PI: M. Gent)**

- **Source of Support:** USDA/CSREES
- **Total Award Amount:** $2,084,589
- **Total Award Period Covered:** 09/10-08/13
- **Location of Project:** Rutgers University
- **Person-Months Per Year Committed to the Project:** Cal: 2 Acad: Sumr:

**Support:**

- **Current**
- **Pending**
- **Submission Planned in Near Future**
- **Transfer of Support**

**Project/Proposal Title:**

**SCRI: Sustainable and competitive controlled environment plant production systems (CEPPS) (PI: M. Kacira)**

- **Source of Support:** USDA/CSREES
- **Total Award Amount:** $49,998
- **Total Award Period Covered:** 09/10-08/11
- **Location of Project:** Rutgers University
- **Person-Months Per Year Committed to the Project:** Cal: 0.5 Acad: Sumr:

**Support:**

- **Current**
- **Pending**
- **Submission Planned in Near Future**
- **Transfer of Support**

**Project/Proposal Title:**

**Evaluating HEC: Controlled environment plant production technology/engineering course module development (PI: P. Ling)**

- **Source of Support:** USDA
- **Total Award Amount:** $976,388
- **Total Award Period Covered:** 09/10-08/13
- **Location of Project:** Rutgers University
- **Person-Months Per Year Committed to the Project:** Cal: 1 Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
### Current and Pending Support

*(See GPG Section II.D.8 for guidance on information to include on this form.)*

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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<td>Evaluating LEDs for photoperiodic lighting of floriculture crops (PI: E. Runkle)</td>
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| Support:                | □ Current  □ Pending  □ Submission Planned in Near Future  □ *Transfer of Support |
| Project/Proposal Title: |                                                                                   |
| Source of Support:      |                                                                                   |
| Total Award Amount:     |                                                                                   |
| Total Award Period Covered: |                                                               |
| Location of Project:    |                                                                                   |
| Person-Months Per Year Committed to the Project: | Cal: 0.5  Acad:      Sumr: |

| Support:                | □ Current  □ Pending  □ Submission Planned in Near Future  □ *Transfer of Support |
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| Location of Project:    |                                                                                   |
| Person-Months Per Year Committed to the Project: | Cal: 0.5  Acad:      Sumr: |

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| Support:                | □ Current  □ Pending  □ Submission Planned in Near Future  □ *Transfer of Support |
| Project/Proposal Title: |                                                                                   |
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| Person-Months Per Year Committed to the Project: | Cal: 0.5  Acad:      Sumr: |

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
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**Current and Pending Support**

*See GPG Section II.D.8 for guidance on information to include on this form.*

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Margaret Brennan</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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**Support:**
- [x] Current
- [ ] Pending
- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support*

**Project/Proposal Title:**
Hydrogen, Natural Gas, Electricity, and Heat from Landfill Gas: Integration of Emerging Technologies for a Quad-Generation Demonstration Project (D. Specca, PI; M. Mazurek, 1 of 8 co-Is)

**Source of Support:** Northeast Sun Grant Initiative

**Total Award Amount:** $253,677

**Total Award Period Covered:** 09/09-08/10

**Location of Project:** Rutgers, EcoComplex Center, Bordentown, NJ

**Person-Months Per Year Committed to the Project:**
- Cal: 1
- Acad: 
- Sumr: 

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<th>[ ] Pending</th>
<th>[ ] Submission Planned in Near Future</th>
<th>[ ] <em>Transfer of Support</em></th>
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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
**Current and Pending Support**

*(See GPG Section II.D.8 for guidance on information to include on this form.)*

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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<tr>
<th>Investigator: Lee Roy Bronner</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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**Support:** ☑ Current  ☐ Pending  ☐ Submission Planned in Near Future  ☐ *Transfer of Support

### Project/Proposal Title:

**MOMS Knowledge Management System**

**Source of Support:** Honeywell Technology Solutions - NASA  
**Total Award Amount:** $49,952.00  
**Total Award Period Covered:** November, 2009 to April 30, 2010  
**Location of Project:** NASA Goddard Space Flight Center, Greenbelt, Maryland  
**Person-Months Per Year Committed to the Project:** Cal: 2.0  
**Support:** ☑ Current  ☐ Pending  ☐ Submission Planned in Near Future  ☐ *Transfer of Support

### Social Psychological Study on International Culture

**Source of Support:** Army  
**Total Award Amount:** $98,239.85  
**Total Award Period Covered:** February 1, 2010 to July 31, 2010  
**Location of Project:**  
**Person-Months Per Year Committed to the Project:** Cal: 1.5  
**Support:** ☐ Current  ☐ Pending  ☐ Submission Planned in Near Future  ☐ *Transfer of Support

**Source of Support:**  
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**Total Award Period Covered:**  
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**Support:** ☐ Current  ☐ Pending  ☐ Submission Planned in Near Future  ☐ *Transfer of Support

**Source of Support:**  
**Total Award Amount:** $  
**Total Award Period Covered:**  
**Location of Project:**  
**Person-Months Per Year Committed to the Project:** Cal:  
**Support:** ☐ Current  ☐ Pending  ☐ Submission Planned in Near Future  ☐ *Transfer of Support

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*

NSF Form 1239 (10/98)

USE ADDITIONAL SHEETS AS NECESSARY
Current and Pending Support
Jeffrey R. S. Brownson – The Pennsylvania State University

CURRENT
None

PENDING

“She Cycle Assessment for Materials and Sustainability in Transformative Environmental Reservoirs (LCA MaSTER)” PSIEE Seed Grant, Penn State University, PI: Jeffrey R. S. Brownson, 6/1/2010-5/31/2011, $39,373, pending. (0.03 person-month)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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<td>Investigation and Implementation of Sparse Grids</td>
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<td>Source of Support: Sandia National Laboratories</td>
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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*

NSF Form 1239 (10/98) USE ADDITIONAL SHEETS AS NECESSARY
# Current and Pending Support

*(See GPG Section II.D.8 for guidance on information to include on this form.)*

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: John Burns</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted: DOE</th>
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**Support:**
- [x] Current
- [ ] Pending
- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support

**Project/Proposal Title:**

**REU Modeling and Simulation in Systems Biology #0755322**

**Source of Support:** NSF
- **Total Award Amount:** $269,193.00
- **Total Award Period Covered:** 1 May 2008- 30 April 2011
- **Location of Project:** Virginia Tech
- **Person-Months Per Year Committed to the Project:** 0 Cal: 0 Acad: 0 Sumr: 0

**Support:**
- [x] Current
- [ ] Pending
- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support

**Project/Proposal Title:**

**Computer Design Tool for Building Models, Simulation and Sensitivity Analysis Tools**

**Source of Support:** DoD
- **Total Award Amount:** $375,018.00
- **Total Award Period Covered:** 1 August 2009-31 July 2011
- **Location of Project:** United Technologies
- **Person-Months Per Year Committed to the Project:** 1 Cal: 1 Acad: Sumr: 0

**Support:**
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- [x] Pending
- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support

**Project/Proposal Title:**

**Computational Methods for Design, Estimation and Real-time Control of PD**

**Source of Support:** AFOSR
- **Total Award Amount:** $600,000
- **Total Award Period Covered:** 15 May 2010-14 May 2013
- **Location of Project:** Virginia Tech
- **Person-Months Per Year Committed to the Project:** 1 Cal: 1 Acad: Sumr: 0

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- [ ] Current
- [ ] Pending
- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support

**Project/Proposal Title:**

**Source of Support:**
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- **Total Award Period Covered:**
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- **Person-Months Per Year Committed to the Project:** Cal: 0 Acad: Sumr: 0

**Support:**
- [ ] Current
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- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support

**Project/Proposal Title:**

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- **Person-Months Per Year Committed to the Project:** Cal: 0 Acad: Sumr: 0

**Support:**
- [ ] Current
- [ ] Pending
- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support

**Project/Proposal Title:**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
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<td>Federal Aviation Administration</td>
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<td>Measurement and simulations of outdoor contaminant dispersions around and into built environment</td>
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<td>Developing a risk paradigm for volatile organic compounds from ozone reactions in aircraft</td>
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<td>Reliable computational models for respiratory contaminant sources released by passengers and crew in air cabins</td>
<td>Boeing Commercial Airplane Group</td>
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**Current and Pending Support**
William W. Clark, MEMS Dept., University of Pittsburgh

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<td><strong>Dates:</strong></td>
<td>10/01/10-09/30/13</td>
</tr>
<tr>
<td><strong>Person-Months Per Year:</strong></td>
<td>0.75 Summer Months per year</td>
</tr>
</tbody>
</table>
### Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Eugene M. Cliff</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
<th>DOE</th>
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<tbody>
<tr>
<td><strong>Support:</strong></td>
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<td>☐ Pending</td>
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<tr>
<td><strong>Project/Proposal Title:</strong></td>
<td>Motion Planning For Underwater Gliders</td>
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Source of Support: Office of Naval Research
Total Award Amount: $268,083.00  
Total Award Period Covered: 1 Oct 2007-31 Dec 2010
Location of Project: Virginia Tech
Person-Months Per Year Committed to the Project: 0  
Cal: 0  
Acad: 0  
Sumr: 0

| **Support:** | ☑ Current | ☐ Pending | ☐ Submission Planned in Near Future | ☐ *Transfer of Support |
| **Project/Proposal Title:** | Computer Design Tool for Building Models, Simulation and Sensitivity |

Source of Support: DoD
Total Award Amount: $375,018.00  
Total Award Period Covered: 1 August 2009-31 July 2011
Location of Project: United Technologies
Person-Months Per Year Committed to the Project: Cal:  
Acad:  
Sumr: |

| **Support:** | ☑ Current | ☐ Pending | ☐ Submission Planned in Near Future | ☐ *Transfer of Support |
| **Project/Proposal Title:** | Computational Methods for Design, Estimation and Real-time Control of PE |

Source of Support: AFOSR
Total Award Amount: $600,000  
Total Award Period Covered: 15 May 2010-14 May 2013
Location of Project: Virginia Tech
Person-Months Per Year Committed to the Project: 1  
Cal: 1  
Acad:  
Sumr: 1

| **Support:** | ☐ Current | ☐ Pending | ☐ Submission Planned in Near Future | ☐ *Transfer of Support |
| **Project/Proposal Title:** |

Source of Support:  
Total Award Amount: $  
Total Award Period Covered: |
Location of Project: |
Person-Months Per Year Committed to the Project: Cal:  
Acad:  
Sumr: |

| **Support:** | ☐ Current | ☐ Pending | ☐ Submission Planned in Near Future | ☐ *Transfer of Support |
| **Project/Proposal Title:** |

Source of Support:  
Total Award Amount: $  
Total Award Period Covered: |
Location of Project: |
Person-Months Per Year Committed to the Project: Cal:  
Acad:  
Sumr: |

*If this project has previously been funded by another agency, please list and furnish information for immediately.
Current Support

Adam Cohen

Adam Cohen serves as Deputy Director for Operations at Princeton Plasma Physics Laboratory. He is fully supported by the Department of Energy, under Contract Number DE-AC02-09CH11466 between Princeton University and the U.S. Department of Energy for operating the Princeton Plasma Physics Laboratory.
Current and Pending Support
Daniel G. Cole, MEMS Dept., University of Pittsburgh

Support: Current
Title: Development of Adaptive Magnetic Traps for Surface Force and Interface Science
Source of Support: University of Pittsburgh
Total Award Amount: $15,750  Dates: 09/01/08–08/31/11
Person-Months Per Year: none

Support: Current
Title: Nanoscale Hysteresis Modeling and Control in Precision Equipment
Source of Support: Aerotech
Total Award Amount: $124,938  Dates: 10/01/08–09/30/10
Person-Months Per Year: 1.0 Summer Month

Support: Current
Title: GOALI: Nanoscale Hysteresis Modeling and Control in Precision Equipment
Source of Support: NSF
Total Award Amount: $300,000  Dates: 07/01/09–06/30/12
Person-Months Per Year: 1.0 Summer Month

Support: Current
Title: Dynamic Maskless Holographic Lithography
Source of Support: NSF
Total Award Amount: $300,000  Dates: 07/01/09–06/30/12
Person-Months Per Year: 0.63 Summer Months

Support: Pending
Title: River Device for Recovering Energy with Active Materials Morphing Proof of Principle
Source of Support: Bayer MaterialScience
Total Award Amount: $76,476  Dates: 09/01/10-08/31/11
Person-Months Per Year: 1.0 Summer Months
1. Current Projects

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<tr>
<th>PI and Co-PI</th>
<th>Project Title</th>
<th>Funding Source</th>
<th>Funding Dates</th>
<th>Total Funding Support</th>
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<tbody>
<tr>
<td>PI</td>
<td>Building GPS/WIFI Board</td>
<td>TEDCO</td>
<td>2009-2010</td>
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<td>PI</td>
<td>Context Aware Mobile Goggles</td>
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2. Pending Projects

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<th>Project Title</th>
<th>Funding Source</th>
<th>Funding Dates</th>
<th>Total Funding Support</th>
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</thead>
<tbody>
<tr>
<td>PI</td>
<td>Energy Demand Response</td>
<td>Evans LLC</td>
<td>2010</td>
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<td>PI</td>
<td>CAARS</td>
<td>NSF</td>
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<td>PI</td>
<td>Intelligent Inverter</td>
<td>Helios Technology</td>
<td>2010-2011</td>
<td>$50,000</td>
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The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Deane Evans</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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<tbody>
<tr>
<td>Support: Current</td>
<td>Pending</td>
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<tr>
<td>Project/Proposal Title: BPU – Operations and Maintenance Pilot Program</td>
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Source of Support: Board of Public Utilities
Total Award Amount: $200,000
Total Award Period Covered: January 1, 2009 – December 31, 2010
Location of Project: New Jersey
Person-Months Per Year Committed to the Project. Cal: 1.14, Acad: .34

Support: Current | Pending | Submission Planned in Near Future | *Transfer of Support |
| Project/Proposal Title: BPU Energy Efficiency Online Academy |

Source of Support: Board of Public Utilities
Total Award Amount: $25,000
Total Award Period Covered: November 1, 2008 – December 31, 2010
Location of Project: New Jersey
Person-Months Per Year Committed to the Project. Cal: 1.52, Acad: .7

Support: Current | Pending | Submission Planned in Near Future | *Transfer of Support |
| Project/Proposal Title: Retro-Commissioning Pilot Program |

Source of Support: PSEG
Total Award Amount: $235,598
Total Award Period Covered: September 28, 2009 – December 31, 2010
Location of Project: New Jersey
Person-Months Per Year Committed to the Project. Cal: .75, Acad: Sumr:

Support: Current | Pending | Submission Planned in Near Future | *Transfer of Support |
| Project/Proposal Title: Technical Support & NJ Schools Database Development |

Source of Support: NJ Schools Development Authority
Total Award Amount: $235,000
Total Award Period Covered: December 2, 2009 - December 31, 2010
Location of Project: New Jersey
Person-Months Per Year Committed to the Project. Cal: .76, Acad: Sumr:

Support: Current | Pending | Submission Planned in Near Future | *Transfer of Support |
| Project/Proposal Title: Oak Ridge Weatherization Assistant Online Training Program |

Source of Support: Building Media, Inc
Total Award Amount: $107,500
Total Award Period Covered: December 15, 2009 - January 15, 2011
Location of Project: New Jersey and Tennessee
Person-Months Per Year Committed to the Project. Cal: 1.52, Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.
### Current and Pending Support

*(See GPG Section II.D.8 for guidance on information to include on this form.)*

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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<tr>
<th>Investigator: F. A. Felder</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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<td>Project/Proposal Title:</td>
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<td>Source of Support:</td>
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<td>Project/Proposal Title:</td>
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<td>Project/Proposal Title:</td>
<td>Energy Policy Analysis</td>
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<td>Support:</td>
<td>□ *If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.</td>
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</tbody>
</table>

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY
### Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: James Garrett</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted</th>
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<table>
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<tr>
<th>Support:</th>
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<th>Transfer of Support</th>
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<tbody>
<tr>
<td>Project/Proposal Title: Requirements for Creating and Measuring Computer-Processable Versions of Engineering Codes and Standards</td>
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<td>Location of Project: Carnegie Mellon University, Pittsburgh, PA</td>
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<td>Person-Months Per Year Committed to the Project:</td>
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<table>
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<th>Support:</th>
<th>Current</th>
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<th>Transfer of Support</th>
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<tr>
<td>Project/Proposal Title: Requirements for Creating and Measuring Computer-Processable Versions of Engineering Codes and Standards</td>
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<tr>
<td>Project/Proposal Title: Development of a Framework for Evaluating and Fusing Different Data Capturing Technologies to Support Continuous Construction Productivity Analyses and Improvement</td>
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<td>Source of Support: Concurrent Technologies</td>
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<td>Project/Proposal Title:</td>
<td>Indoor Positioning System Using inertial Navigation to Recalibrate Ambient RF Signaling</td>
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<td>Person-Months Per Year Committed to the Project.</td>
<td>Cal:</td>
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</tbody>
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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
# Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Support:</th>
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<th>Submission Planned in Near Future</th>
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Investigator: Anthony Girifalco

| Other agencies (including NSF) to which this proposal has been/will be submitted. |

| Project/Proposal Title: Spurring Innovation Through Advanced Data Visualization Tools |
| Source of Support: NSF |
| Total Award Amount: $299,788 |
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| Total Award Period Covered: |
| Location of Project: |

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.
## Current and Pending Support

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

**Investigator: Patrick L. Gurian**

### Support:

- **Current**
- **Pending**
- **Submission Planned in Near Future**
- **Transfer of Support**

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<td>Fellowship Program in Microbial Risk Assessment for Public Security, Safety and Health</td>
<td>Department of Homeland Security</td>
<td>$491,000</td>
<td>9/1/07-8/30/10</td>
<td>Drexel University</td>
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<tr>
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<td>Water Environment Research Foundation</td>
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<td>July 1, 2008-August 31, 2010</td>
<td>Drexel University</td>
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<td>Center for Advancing Microbial Risk Assessment (CAMRA) Project IV: The Assessment-Analysis Interface</td>
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<td>Sept. 2009-August 2012</td>
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**Current and Pending Support**

**Investigator: Patrick L. Gurian**

### Support:

- **Current**
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<td>Sept. 2009-August 2012</td>
<td>Drexel University</td>
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Investigator: Patrick L. Gurian

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<th>Support:</th>
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<th>☐ Pending</th>
<th>☐ Submission Planned in Near Future</th>
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**Project/Proposal Title: The Learning Bridge**

Source of Support: National Science Foundation  
Total Award Amount: $275,000  
Total Award Period Covered: 9/1/09-8/30/11  
Location of Project: Drexel University  
Person-Months Per Year Committed to the Project.  
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**Project/Proposal Title: NUE: Integrated Approach to Environmentally Responsible Nanotechnology Education**

Source of Support: NSF  
Total Award Amount: $200,000  
Total Award Period Covered: Jan. 2010-Dec. 2011  
Location of Project: Drexel University  
Person-Months Per Year Committed to the Project.  
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**Project/Proposal Title: RAPID: Supporting Haitian Infrastructure Reconstruction Decisions with Local Knowledge**

Source of Support: NSF  
Total Award Amount: $199,854  
Total Award Period Covered: May 2010-April 2011  
Location of Project: Drexel University  
Person-Months Per Year Committed to the Project.  
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Sumr: 1

**Project/Proposal Title: The Multi-Domain Impacts of Green Infrastructure in Changing Urban Ecosystems**

Source of Support: NSF  
Total Award Amount: $3,200,000  
Total Award Period Covered: Oct. 2010-Sept. 2015  
Location of Project: Drexel University  
Person-Months Per Year Committed to the Project.  
Cal:  
Sumr: 1
Current and Pending Support
Paul Hallacher
May 2010

Support: Current
Project/Proposal Title: National Center for Nanotechnology Applications and Career Knowledge
Source of Support: National Science Foundation
Total Award Amount: $4,500,000
Award Period Covered: 9/01/08 – 8/30/12
Location of Project: Pennsylvania State University
Person-Months Per Year: Cal: 4.00 Acad: 0.00 Sumr: 0.00

Support: Current
Project/Proposal Title: Leveraging Advanced Research University Knowledge for Innovation in Legacy Industrial Era Regions: Pennsylvania’s I-99 Corridor
Source of Support: National Science Foundation
Total Award Amount: $720,000
Award Period Covered: 8/01/08 – 7/31/10
Location of Project: Pennsylvania State University
Person-Months Per Year: Cal: 1.00 Acad: 0.00 Sumr: 0.00
### Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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| Support: | ☐ Current ☐ Pending ☑️ Submission Planned in Near Future ☐ *Transfer of Support ☐ |
| Project/Proposal Title: | EFRI-SEED Preliminary Proposal: Multi Model Based Design of New and Renovated Sustainable Commercial Buildings |
| Source of Support: | NSF |
| Total Award Amount: | 1,643,000 |
| Total Award Period Covered: | 7/1/10-6/30/14 |
| Location of Project: | Carnegie Mellon University |
| Person-Months Per Year Committed to the Project: | Cal: | Acad: 1.0 | Sumr: 1.0 |

| Support: | ☐ Current ☐ Pending ☑️ Submission Planned in Near Future ☐ *Transfer of Support ☐ |
| Project/Proposal Title: | Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings |
| Source of Support: | DOE |
| Total Award Amount: | $5,501,231 |
| Total Award Period Covered: | 9/10-9/15 |
| Location of Project: | Carnegie Mellon University |
| Person-Months Per Year Committed to the Project: | Cal: | Acad: | Sumr: 1 |

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY
# Current and Pending Support

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<th>Investigator: William D. Henshaw</th>
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**Support:**  
- **Current**  
- **Pending**  
- **Submission Planned in Near Future**  
- *Transfer of Support*

**Project/Proposal Title:**

*Domain-Adaptive High-Order Accurate Algorithms for PDEs in Moving Geometry*

Source of Support: DOE Office of Science, Office of ASC

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**Project/Proposal Title:**

*CgWind: A Parallel High-Order Accurate Simulation Tool for Wind Turbines and Wind Farms*

Source of Support: LLNL LDRD

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**Project/Proposal Title:**

*CgWind: Enhanced Aerodynamic Simulation Capabilities for Wind Farms*

Source of Support: EERE/WHTP Office of the DOE

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NSF Form 1239 (10/98) USE ADDITIONAL SHEETS AS NECESSARY

4-312
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### Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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<thead>
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<th>Investigator: Joseph Houldin</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
**Current and Pending Support**

*(See GPG Section II.D.8 for guidance on information to include on this form.)*

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
**Current and Pending Support:  Kevin Houser**

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**Effect of Bright Light Treatment on Depression of Elders in Long-term Care.**

Source of Support: Penn State University Clinical and Translational Science Institute (CTSI) Pilot Project Grant

Total Award Amount: $50,000

Total Award Period Covered: August 2009 – July 2010

Location of Project: State College and Hershey, Pennsylvania

Person-Months Per Year Committed to the Project. Cal: N/A  Acad: 1.5  Sumr: 0

**Project CANDLE: A project to Create an Alliance to Nurture Design in Lighting Education**


Total Award Amount: $750,000

Total Award Period Covered: July 2008 – June 2012

Location of Project: State College, PA

Person-Months Per Year Committed to the Project. Cal: N/A  Acad: 1.35  Sumr: 0.75

**Current and Pending Support:**

**Project/Proposal Title: Effect of Bright Light Treatment on Depression of Elders in Long-term Care.**

**Source of Support:** Penn State University Clinical and Translational Science Institute (CTSI) Pilot Project Grant

**Total Award Amount:** $50,000

**Total Award Period Covered:** August 2009 – July 2010

**Location of Project:** State College and Hershey, Pennsylvania

**Person-Months Per Year Committed to the Project.** Cal: N/A  Acad: 1.5  Sumr: 0

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<td>Person-Months Per Year Committed to the Project.</td>
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Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Jianghai Hu

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NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY
Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: James G. Hunter

| Project/Proposal Title: Evaluating Hydrologic Response and Ecosystem Service Outcomes of Low Impact Development |
| Source of Support: National Science Foundation |
| Total Award Amount: $400,000 | Total Award Period Covered: 2011-2016 |
| Location of Project: Morgan State University |
| Person-Months Per Year Committed to the Project: 2.5 | Cal: | Acad: | Sumr: |

Support: ☐ Current ☐ Pending ☑ Submission Planned in Near Future ☐ *Transfer of Support

If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/98) USE ADDITIONAL SHEETS AS NECESSARY
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<td>Person-Months Per Year Committed to the Project:</td>
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<td>Pending</td>
<td>Submission Planned in Near Future</td>
<td>*Transfer of Support</td>
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<tr>
<td>Project/Proposal Title:</td>
<td>Transcending POD: Model Reduction for Complex Fluid Flow</td>
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<td>Source of Support:</td>
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</tbody>
</table>

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.
## Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator:</th>
<th>Mohsen Jafari</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Support:</strong></td>
<td><strong>Current</strong></td>
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<tr>
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<tr>
<td><strong>Source of Support:</strong></td>
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<td><strong>Total Award Period Covered:</strong></td>
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<tr>
<td><strong>Location of Project:</strong></td>
<td>Rutgers, The State University</td>
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<tr>
<td><strong>Person-Months Per Year Committed to the Project:</strong></td>
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| **Support:** | **Current**   |
| **Project/Proposal Title:** | A multi-layer web based software for traffic accident analysis and traffic safety planning |
| **Source of Support:** | FHWA/NJDOT |
| **Total Award Amount:** | $2,000,000 |
| **Total Award Period Covered:** | 04/01/04 - 03/31/10 |
| **Location of Project:** | Rutgers, The State University |
| **Person-Months Per Year Committed to the Project:** | Cal: 0.00, Acad: 0.50, Sumr: 0.50 |

| **Support:** | **Current**   |
| **Project/Proposal Title:** | Long Term Bridge Performance (LTBP) Program |
| **Source of Support:** | Federal Highway Administration (FHWA) |
| **Total Award Amount:** | $500,000 |
| **Total Award Period Covered:** | 04/02/08 - 04/01/13 |
| **Location of Project:** | Rutgers, The State University |
| **Person-Months Per Year Committed to the Project:** | Cal: 0.00, Acad: 0.00, Sumr: 0.50 |

| **Support:** | **Pending**   |
| **Project/Proposal Title:** | NSF Engineering Research Center for Critical Infrastructure Systems Management and Sustainable Communities |
| **Source of Support:** | NSF |
| **Total Award Amount:** | $18,500,000 |
| **Total Award Period Covered:** | 10/01/10 - 09/30/15 |
| **Location of Project:** | Rutgers, The State University |
| **Person-Months Per Year Committed to the Project:** | Cal: 0.00, Acad: 0.00, Sumr: 1.00 |

| **Support:** | **Pending**   |
| **Project/Proposal Title:** | Long‐Term Roadside Crash Data Collection Program |
| **Source of Support:** | The National Academies - NCHRP |
| **Total Award Amount:** | $1,000,000 |
| **Total Award Period Covered:** | 01/01/10 - 12/31/13 |
| **Location of Project:** | Rutgers, The State University |
| **Person-Months Per Year Committed to the Project:** | Cal: 0.00, Acad: 0.00, Sumr: 0.50 |

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
Current and Pending Support
(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Mohsen Jafari</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
</tr>
</thead>
</table>

**Support:**
- **Current**
- **Pending**
- **Submission Planned in Near Future**
- **Transfer of Support**

**Project/Proposal Title:**
- Roadway Information Database Development and Technical Coordination and Quality Assurance of The Mobile Data Collection Project
- Safety Analysis of Crash and Inspection Data for Commercial Vehicles
- [Additional entries]

**Source of Support:**
- The National Academies - SHRP 2
- New Jersey Department of Transportation

**Total Award Amount:**
- $1,000,000
- $121,675
- Additional amounts

**Total Award Period Covered:**
- 01/01/10 - 03/31/11
- 11/01/09 - 10/31/10
- [Additional periods]

**Location of Project:**
- Rutgers, The State University

**Person-Months Per Year Committed to the Project:**
- Cal: 0.00
- Acad: 0.00
- Sumr: 0.00
- Cal: 0.00
- Acad: 0.00
- Sumr: 0.50
- Additional commitents

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

### Current and Pending Support

*(See GPG Section II.C.2.h for guidance on information to include on this form.)*

<table>
<thead>
<tr>
<th>Investigator:</th>
<th>Niraj Jha</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Support:</strong></td>
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<tr>
<td><strong>Project/Proposal Title:</strong></td>
<td>CSR--SMA: Thermal Modeling, Management, and Characterization of Chip Multiprocessors (no-cost extension till 5/31/10)</td>
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<tr>
<td><strong>Source of Support:</strong></td>
<td>National Science Foundation</td>
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<td><strong>Total Award Period Covered:</strong></td>
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<td><strong>Location of Project:</strong></td>
<td>Princeton University</td>
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<tr>
<td><strong>Person-Months Per Year Committed to the Project.</strong></td>
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| **Support:**  | □ Current | □ Pending | □ Submission Planned in Near Future | □ "Transfer of Support" |
| **Project/Proposal Title:** | Energy-efficient Network Architectures for On-die Interconnects (PI) |
| **Source of Support:** | Intel Corporation |
| **Total Award Amount:** | $82,500 |
| **Total Award Period Covered:** | 09/01/06 - 08/31/12 |
| **Location of Project:** | Princeton University |
| **Person-Months Per Year Committed to the Project.** | Cal: 0.00 | Acad: 0.00 | Sumr: 0.00 |

| **Support:**  | □ Current | □ Pending | □ Submission Planned in Near Future | □ "Transfer of Support" |
| **Project/Proposal Title:** | Thermal Modeling, Management, and Optimization for High Performance Integrated Circuit Testing (PI)(Includes subcontracts) |
| **Source of Support:** | Semiconductor Research Corporation |
| **Total Award Amount:** | $300,000 |
| **Total Award Period Covered:** | 04/01/07 - 05/31/10 |
| **Location of Project:** | Princeton University |
| **Person-Months Per Year Committed to the Project.** | Cal: 0.00 | Acad: 0.00 | Sumr: 0.00 |

| **Support:**  | □ Current | □ Pending | □ Submission Planned in Near Future | □ "Transfer of Support" |
| **Project/Proposal Title:** | CSR-EHS: Non-volatile Carbon Nanotube RAM based FPGA Architectures |
| **Source of Support:** | National Science Foundation |
| **Total Award Amount:** | $300,000 |
| **Total Award Period Covered:** | 08/01/07 - 07/31/10 |
| **Location of Project:** | Princeton University |
| **Person-Months Per Year Committed to the Project.** | Cal: 0.00 | Acad: 0.00 | Sumr: 0.50 |

| **Support:**  | □ Current | □ Pending | □ Submission Planned in Near Future | □ "Transfer of Support" |
| **Project/Proposal Title:** | CSR---EHS: Hardware/Software Architectures for Secure Embedded Systems |
| **Source of Support:** | National Science Foundation |
| **Total Award Amount:** | $406,875 |
| **Total Award Period Covered:** | 08/01/07 - 07/31/10 |
| **Location of Project:** | Princeton University |
| **Person-Months Per Year Committed to the Project.** | Cal: 0.00 | Acad: 0.00 | Sumr: 0.50 |

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
**Current and Pending Support**

*(See GPG Section II.C.2.h for guidance on information to include on this form.)*

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

- **Investigator:** Niraj Jha
- **Support:**
  - Current
  - Pending
  - Submission Planned in Near Future
  - *Transfer of Support

### Support: Current

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<tr>
<th>Project/Proposal Title</th>
<th>Source of Support</th>
<th>Total Award Amount: $</th>
<th>Total Award Period Covered:</th>
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<tr>
<td>Token Flow Control: Towards An Ideal On-chip Interconnection Fabric for Multi-core Systems (PI)(Includes all PI's)</td>
<td>Semiconductor Research Corporation</td>
<td>300,000</td>
<td>04/01/08 - 03/31/11</td>
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<td>CSR:Small:Preventing the Exploitation of Software Vulnerabilities and Execution of Malicious Software on Embedded Systems</td>
<td>National Science Foundation</td>
<td>499,807</td>
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<td>SHF:Small:Investigating New FinFET RAM Designs</td>
<td>National Science Foundation</td>
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<td>07/01/10 - 06/30/13</td>
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<td>TC:Small:Collaborative Research:Attack-resistant and Trustworthy Design of Personal Healthcare Systems</td>
<td>National Science Foundation</td>
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<td>FinFET Circuit Design Methodologies under Process Variations</td>
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- **Submission Planned in Near Future**

- **Pending**

- **Transfer of Support**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*

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USE ADDITIONAL SHEETS AS NECESSARY
**Current and Pending Support**

(See GPG Section II.C.2.h for guidance on information to include on this form.)

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<thead>
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<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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<td>Source of Support: Semiconductor Research Corporation</td>
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<td>Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.00 Sumr: 0.50</td>
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<td>Source of Support: Semiconductor Research Corporation</td>
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<td>Acad:</td>
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<td>Summ:</td>
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</tr>
</tbody>
</table>

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
Dr. Yu Jiao  
Principal Investigator  
PPG Industries, Inc. | Glass Business & Development Center | 400 Guys Run Road | Cheswick, PA 15024  
(412) 820-8752 | jiao@ppg.com

Dr. Ali Rashid  
PPG Industries, Inc. | Glass Business & Development Center | 400 Guys Run Road | Cheswick, PA 15024  
(412) 820-8511 | arashid@ppg.com

Current and Pending Support

<table>
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<tr>
<th>Key Personnel</th>
<th>Contract</th>
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<th>Award Period</th>
<th>Commitment Level</th>
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<tr>
<td>Yu Jiao</td>
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<tr>
<td>Ali Rashid</td>
<td>None</td>
<td></td>
<td></td>
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<td>Project/Proposal Title</td>
<td>Source of Support</td>
<td>Total Award Amount</td>
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<td>Location of Project</td>
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<td>Development of mixed-mode low-energy cooling systems with embedded intelligence to</td>
<td>Purdue Research Foundation</td>
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<td>8/16/10 - 8/15/11</td>
<td>Purdue University</td>
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<td>enable high performance buildings</td>
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<tr>
<td>Sustainable building design and construction</td>
<td>Start-up funds</td>
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<td>8/17/09 - 8/15/12</td>
<td>Purdue University</td>
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<td>Investigation of wind effects on buildings with sustainable technologies</td>
<td>Natural Sciences and Engineering Research Council of Canada (Individual Discovery</td>
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<td>4/1/08 - 4/1/12</td>
<td>University of Western Ontario, Canada</td>
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<tr>
<td>Solar Energy Utilization in Buildings</td>
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<td>1/1/09 - 8/30/10</td>
<td>University of Western Ontario, Canada</td>
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<td>Upgrade of a 2D Particle Image Velocimetry (PIV) system to a 3D PIV system</td>
<td>Natural Sciences and Engineering Research Council of Canada (Research Tools and</td>
<td>$126,178</td>
<td>4/1/09 - 3/30/11</td>
<td>University of Western Ontario, Canada</td>
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<td>Solar Collection Device for Studying Building Integrated Photovoltaic – Thermal Systems</td>
<td>Academic Development Fund (University of Western Ontario)</td>
<td>$8,364</td>
<td>1/1/09 - 31/12/09</td>
<td>University of Western Ontario, Canada</td>
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<td>□ Submission Planned in Near Future</td>
<td>□ *Transfer of Support</td>
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<tr>
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</table>

Project/Proposal Title: **Design Wind-loads for Residential Photovoltaic Systems**

Source of Support: Canada Mortgage and Housing Corporation (External Research Program)

Total Award Amount: $25,000  
Total Award Period Covered: 4/1/09 – 3/30/10

Location of Project: University of Western Ontario, Canada

Person-Months Per Year Committed to the Project:  
Cal:  
Acad: 0  
Sumr: 0
Support: Current
Title: Environmental Impact and Energy Efficiency of Liquid Cooled Data Centers
Source of Support: Mascaro Center for Sustainable Innovation
Total Award Amount: $34,280  Dates: 07/01/2009 – 06/30/2010
Person-Months Per Year: 0.0 Academic Months

Support: Current
Title: Thermal and Acoustic Studies of a Piezoelectric Blower
Source of Support: Murata Manufacturing Co., Ltd.
Total Award Amount: $154,552  Dates: 09/01/2009 – 08/31/2010
Person-Months Per Year: 1.0 Academic Months

Support: Current
Title: Experimental Characterization of Thermal Fatigue Loads in Nuclear Reactors
Source of Support: Nuclear Regulatory Commission (NRC)
Total Award Amount: $75,000  Dates: 08/01/2008 – 07/31/2011
Person-Months Per Year: 1.0 Academic Months

Support: Pending
Title: Energy Efficient Thermal Management from Coordinated Microscale Cantilevers
Source of Support: NSF
Total Award Amount: $472,854  Dates: 09/01/2010 – 08/31/2013
Person-Months Per Year: 1.0 Academic Months

Support: Pending
Title: Thermal Oscillations caused by Turbulent Mixing in Confined and Unconfined Jets
Source of Support: NSF
Total Award Amount: $391,587  Dates: 09/01/2010 – 08/31/2013
Person-Months Per Year: 1.0 Academic Months

Support: Pending
Title: Nanostructured Surfaces for Boiling Enhancement
Source of Support: Mascaro Center for Sustainable Innovation
Total Award Amount: $84,838  Dates: 07/01/2010 – 06/30/2012
Person-Months Per Year: 0.0 Academic Months
Current and Pending
Andrew N. Kleit
April 28, 2010

“Effect of FDA Boxed Warnings and Public Information on Pharmaceutical Use,”
Agency for Healthcare Quality Research and Quality (September 2007 to August 2011),
12% commitment per year.

“The Use of Convective Forecast in Air Traffic Management.” (PI Young, Co-PI Kleit)
($90,741 for AY 2010). June 2009 to June 2012, 10% commitment per year.
The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Bruce Krogh, Professor</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support:</td>
<td>☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support</td>
</tr>
<tr>
<td>Project/Proposal Title: ITR – (CNS) – (ecs): Toward a Multi-Layered Architecture for Reliable and Secure Large-Scale Networks</td>
<td></td>
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Source of Support: NSF  
Total Award Amount: $1,508,311  
Total Award Period Covered: 8/1/04-9/30/10  
Location of Project: Carnegie Mellon University  
Person-Months Per Year Committed to the Project. Cal: 0.5  
Acad: 0.25  
Sumr: 1.0

| Support: | ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support |
| Project/Proposal Title: Frameworks and Tools for High-Confidence Design of Adaptive, Distributed Embedded Control Systems  
Source of Support: Vanderbilt University / AFOSR  
Total Award Amount: $458,498  
Total Award Period Covered: 5/1/06-4/30/11  
Location of Project: Carnegie Mellon University  
Person-Months Per Year Committed to the Project. Cal: 0.25  
Acad: 1  
Sumr: 1.25

| Support: | ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support |
| Project/Proposal Title: CSR-EHCS(CPS), TM: Architectures, Abstractions and Algorithms for Cyber-Physical Networks  
Source of Support: NSF  
Total Award Amount: $300,000  
Total Award Period Covered: 9/1/08-8/31/10  
Location of Project: Carnegie Mellon University  
Person-Months Per Year Committed to the Project. Cal: 0.25  
Acad: 0.25  
Sumr: 0.5

| Support: | ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support |
| Project/Proposal Title: GOALI: Models, Metrics, and Control Strategies for Energy Efficient Data Centers  
Source of Support: NSF  
Total Award Amount: $485,973  
Total Award Period Covered: 9/1/09-8/31/12  
Location of Project: Carnegie Mellon University  
Person-Months Per Year Committed to the Project. Cal: 0.5  
Acad: 0.5  
Sumr: 1

| Support: | ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support |
| Project/Proposal Title: Collaborative Research: Next-Generation Model Checking and Abstract Interpretation with a Focus on Embedded Control and Systems Biology ($519,037 – B. Krogh allocation)  
Source of Support: NSF  
Total Award Amount: $3,375,950  
Total Award Period Covered: 8/1/09-7/31/14  
Location of Project: Carnegie Mellon University  
Person-Months Per Year Committed to the Project. Cal: 0.5  
Acad: 0.5  
Sumr: 1
### Current and Pending Support

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<td>7/1/10-6/30/13</td>
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*If this project has previously been funded by another agency please list and furnish information for immediately preceding funding period.*

NSF Form 1239 (10/99)  
USE ADDITIONAL SHEETS AS NECESSARY
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<td>Project/Proposal Title: Barriers, Understanding, Integration – Life Cycle Development (BUILD)</td>
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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
Current and Pending Support
Amy Landis, CEE Dept., University of Pittsburgh

Support: Current
Title: Bioenergy crops on marginal lands
Source of Support: NSF
Total Award Amount: $293,991  Dates: 09/01/09-08/31/12
Person-Months Per Year: 1.0 Summer

Support: Current
Title: Curriculum Development: Beyond Design for the Environment – Improving Products, Processes, and Actions
Source of Support: NCIIA
Total Award Amount: $36,130  Dates: 07/01/08-06/30/11
Person-Months Per Year: 0.1 Summer

Support: Current
Title: Connecting Research and Teaching Through Product Realization: The Pittsburgh Quality of Life RET Site
Source of Support: NSF
Total Award Amount: $489,700  Dates: 06/01/08-05/30/12
Person-Months Per Year: 1.0 Summer

Support: Current
Title: Use of Treated Municipal Wastewater in Power Plant Cooling Systems: Tertiary Treatment versus Expanded Chemical Regimen for Water Quality Management
Source of Support: DOE
Total Award Amount: $740,551  Dates: 07/01/09-06/30/12
Person-Months Per Year: 0.5 Summer

Support: Current
Title: Environmental Impacts of Next Generation Biofuels
Source of Support: NSF
Total Award Amount: $277,438  Dates: 09/01/09-08/31/12
Person-Months Per Year: 1.0 Summer

Support: Pending
Title: Integrating Sustainability into the Civil Engineering Curriculum Through Three Courses at the University of Pittsburgh
Source of Support: NSF
Total Award Amount: $199,982  Dates: 06/01/10-05/30/12
Person-Months Per Year: 1.0 Summer
Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
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<tr>
<th>Investigator: Seong W. Lee</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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- **Support:**
  - [ ] Current
  - [x] Pending
  - [ ] Submission Planned in Near Future
  - [ ] *Transfer of Support

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<td>The Innovative Design &amp; Simulation of the Flat-Plate Solar Collector for the Efficient Solar Heating System and Educational Program</td>
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- **Support:**
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<td>Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:</td>
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NSF Form 1239 (10/98) USE ADDITIONAL SHEETS AS NECESSARY
## Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

**Investigator:** Stephen R. Lee

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### Source of Support: DOE

- **Total Award Amount:** $5,501,231
- **Total Award Period Covered:** 9/10-9/15
- **Location of Project:** Carnegie Mellon University
- **Person-Months Per Year Committed to the Project:** Cal: 3, Acad: , Sumr: 

### Source of Support: NSF

- **Total Award Amount:** $2,000,000
- **Total Award Period Covered:** 7/10-6/14
- **Location of Project:** Carnegie Mellon University
- **Person-Months Per Year Committed to the Project:** Cal: 1, Acad: , Sumr: 

### Source of Support: (continued)

- **Total Award Amount:** *
- **Total Award Period Covered:** *
- **Location of Project:** *
- **Person-Months Per Year Committed to the Project:** Cal: , Acad: , Sumr: 

### Project/Proposal Title Barriers, Understanding, Integration – Life Cycle Development (BUILD)

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*

NSF Form 1239 (10/99)

USE ADDITIONAL SHEETS AS NECESSARY
The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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<th>Investigator: Christine Liaukus</th>
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Source of Support: MaGrann Associates
Total Award Amount: $52,919  Total Award Period Covered: January 1, 2010 - December 31, 2010
Location of Project: New Jersey
Person-Months Per Year Committed to the Project. Cal: 5.29  Acad:  □  Sumr:  |

| Support: | □ Current  □ Pending  □ Submission Planned in Near Future  □ *Transfer of Support |
| Project/Proposal Title: BPU Energy Efficiency Online Academy |

Source of Support: Board of Public Utilities
Total Award Amount: $25,000  Total Award Period Covered: November 1, 2008 - December 31, 2010
Location of Project: New Jersey
Person-Months Per Year Committed to the Project. Cal: 12.71  Acad:  □  Sumr:  .7 |

| Support: | □ Current  □ Pending  □ Submission Planned in Near Future  □ *Transfer of Support |
| Project/Proposal Title: Oak Ridge Weatherization Assistant Online Training Program |

Source of Support: Building Media, Inc
Total Award Amount: $107,500  Total Award Period Covered: December 15, 2009 - January 15, 2011
Location of Project: New Jersey and Tennessee
Person-Months Per Year Committed to the Project. Cal: 1.52  □  Acad:  □  Sumr:  |

| Support: | □ Current  □ Pending  □ Submission Planned in Near Future  □ *Transfer of Support |
| Project/Proposal Title: |

Source of Support: |
Total Award Amount: $|
Location of Project: |
Person-Months Per Year Committed to the Project. Cal:  □  □  □  Sumr: |

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NSF Form 1239 (10/99)  USE ADDITIONAL SHEETS AS NECESSARY
### Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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**Project/Proposal Title:** Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings

**Source of Support:** DOE
**Total Award Amount:** $5,501,231
**Total Award Period Covered:** 9/10-9/15
**Location of Project:** Carnegie Mellon University
**Person-Months Per Year Committed to the Project:**
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**Support:** [ ] Current | [x] Pending | [ ] Submission Planned in Near Future | [ ] *Transfer of Support |

**Project/Proposal Title:** Passive Energy and Building Systems Finance, Design, Engineering, Construction, and Operations

**Source of Support:** NSF
**Total Award Amount:** $1,975,769
**Total Award Period Covered:** 7/10-6/14
**Location of Project:** Carnegie Mellon University
**Person-Months Per Year Committed to the Project:**
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**Support:** [ ] Current | [x] Pending | [ ] Submission Planned in Near Future | [ ] *Transfer of Support |

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
CURRENT AND PENDING SUPPORT – MADHAV MARATHE

Note: The statements of effort are estimates only and are not accounted for by the University so do not constitute voluntary committed cost sharing.

Current:

Project Title: Collaborative Research: Capacity Estimation And Cross-Layer-Aware Protocols For Wireless Networks
PI: Madhav Marathe
Co-PIs: Christopher Barrett, Anil Vullikanti
Source of Support: NSF Nets
Total Amount Awarded: $360,000
Total Award Period Covered: 06/14/06-08/31/10
Effort: 0.3 months cy

Project Title: Collaborative Research: Modeling Interaction Between Individual Behavior, Social Networks And Public Policy To Support Public Health Epidemiology
PI: Madhav Marathe
Co-PIs: Christopher Barrett, Stephen Eubank, Richard Beckman, Anil Vullikanti
Source of Support: NSF HSD
Total Amount Awarded: $540,000
Total Award Period Covered: 07/01/07-09/30/10
Effort: 0.12 months cy

Project Title: Collaborative Research: NECO: A Market-Driven Approach to Dynamic Spectrum Sharing
PI: Samir R. Das
Co-PIs: Anil Vullikanti, Achla Marathe, Madhav Marathe, Himanshu Gupta, Milind M. Buddhikot
Source of Support: NSF
Total Amount Awarded: $1,311,969 (VBI Portion: $490,000)
Total Award Period Covered: 09/01/08-08/31/12
Effort: 0.24 months cy

Project Title: High Performance Computing Methods for Inference State Assessment and Course of Action Analysis in Large Socio-Technical Methods
PI: Christopher Barrett
Co-PIs: Richard Beckman, Henning Mortveit, Madhav Marathe
Source of Support: DTRA
Total Amount Awarded: $1,425,000
Total Award Period Covered: 03/11/09-02/28/11
Effort: 1.2 months cy

Project Title: Integrating Network Based Epidemic Simulations With Syndromic Surveillance Data To Develop Improved Models For Community Response And Economic Impact
PI: David Ebert
Co-PIs: Christopher Barrett, Madhav Marathe, Stephen Eubank
Source of Support: Purdue University (DHS)
Total Amount Awarded: $56,250
Total Award Period Covered: 07/01/09-06/30/10
Effort: 0.12 months cy
Project Title: Collaborative Research: Coupled Models of Diffusion and Individual Behavior Over Extremely Large Social Networks
PI: Madhav Marathe
Co-PIs: Keith Bisset, Xizhou Feng, Dimitris Nikolopoulos
Source of Support: NSF
Total Amount Awarded: $1,450,000 (VBI Portion: $1,182,798)
Total Award Period Covered: 07/01/09-06/30/13
Effort: 0.5 months cy

Project Title: Modeling Disease Dynamics On Large, Detailed, Co-Evolving Networks
PI: Stephen Eubank
Co-PIs: Christopher Barrett, Madhav Marathe
Source of Support: NIH-NIGMS MIDAS network
Total Amount Awarded: $1,572,740
Total Award Period Covered: 09/01/09-08/31/11
Effort: 1.2 months cy

Pending:
Project Title: Wireless Cloud Computing
PI: Madhav Marathe
Co-Pls: S.M. Shajedul Hasan, Jeffrey Reed, Anil Vullikanti
Source of Support: SPAWAR Systems Center Pacific (ONR)
Total Amount Requested: $2,038,479
Total Award Period Covered: 10/01/10-09/30/13
Effort: 2.5 months cy

Project Title: ARI-MA: Collaborative Research: A network integrated approach to the design of nuclear threat monitoring systems
PI: Chris Barrett
Co-PIs: Anil Vullikanti, Madhav Marathe
Source of Support: NSF
Total Amount Requested: $749,997
Total Award Period Covered: 10/01/10-09/30/15
Effort: 0.5 months cy

Project Title: Fault Tolerant Wireless Distributed Computing
PI: Jeffrey Reed
Co-Pls: S.M. Shajedul Hasan, Madhav Marathe, Jung-Min Park
Source of Support: DARPA
Total Amount Requested: $499,943
Total Award Period Covered: 05/17/10-03/17/11
Effort: 0.6 months cy

Project Title: A Course in Decision and Policy Informatics for Complex, Socially Coupled Systems for DTRA Analyst & DoD Decision Makers
PI: Chris Barrett
Co-Pls: Anil Vullikanti, Madhav Marathe, Stephen Eubank, Henning Mortveit, Keith Bisset, Bryan Lewis, Richard Beckman, Achla Marathe, Jiangzhou Chen
Source of Support: DTRA
Total Amount Requested: $674,999
Total Award Period Covered: 01/01/11-12/31/13
Effort: 0.5 months cy

Project Title: Inference and Prediction of Evolutionary Behavior in Multi-theory, Multi-layered Networks
PI: Madhav Marathe
Co-PIs: Chris Barrett, Anil Vullikanti, Richard Beckman
Source of Support: DOD
Total Amount Requested: $7,499,591
Total Award Period Covered: 08/01/10-07/31/15
Effort: 0.7 months cy

Project Title: SDCI HPC: EcoPower: Empowering End Users with an Easy-to-Use (and Green) Cyberinfrastructure Ecosystem
PI: Wu Feng
Co-PI: Madhav Marathe, Keith Bisset
Source of Support: NSF
Total Amount Requested: $1,500,000
Total Award Period Covered: 08/01/10-07/31/13
Effort: 0.2 months cy

Project Title: SDCI NMI New: From Desktops to Clouds -- A Middleware for Next Generation Network Science
PI: Madhav Marathe
Co-PI: Keith Bissett, Richard Alo, Geoffrey Fox and Edward Fox
Source of Support: NSF
Total Amount Requested: $1,499,998
Total Award Period Covered: 08/01/10-07/31/13
Effort: 0.57 months cy

Project Title: Theories and Models for Decentralized Cognitive Radio Networks
PI: Madhav Marathe
Co-PIs: Charles Bostain, Henning Mortveit and Maleq Khan
Source of Support: NSF
Total Amount Requested: $511,292
Total Award Period Covered: 08/01/10-07/31/12
Effort: 0.2 months cy

Project Title: Modeling Immunity to Enteric Pathogens
PI: Josep Bassaganya-Riera
Source of Support: NIH
Total Amount Requested: $9,991,857
Total Award Period Covered: 10/01/10-09/30/15
Effort: 0.84 months cy

Project Title: NetSE:Large:Collaborative Research: Contagion in large socio-communication networks
PI: Madhav Marathe
Co-PIs: Anil Vullikanti, Stephen Eubank, Chris Barrett
Source of Support: NSF
Total Amount Requested: $2,998,238 (VBI Portion: $1,544,998)
Total Award Period Covered: 05/01/10-04/30/15
Effort: 0.5 months cy

Project Title: Theoretical Foundations for Computational Representation of Co-evolving Irregular Socio-Technical Networks
PI: Madhav Marathe
Co-PIs: Chris Barrett, Stephen Eubank, Aravind Srinivasan
Source of Support: DTRA
Total Amount Requested: $825,000
Total Award Period Covered: 01/01/09-12/31/11
Effort: 0.5 months cy

Project Title: The Mid-Atlantic Petascale Partnership TeraGrid Center
PI: Madhav Marathe
Source of Support: University of Maryland (NSF)
Total Amount Requested: $365,626
Total Award Period Covered: 01/01/10-12/31/13
Effort: 1.2 months cy
## Current and Pending Support

*(See GPG Section II.D.8 for guidance on information to include on this form.)*

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator</th>
<th>Support</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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<tbody>
<tr>
<td>Monica A. Mazurek</td>
<td>☑ Current</td>
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### Project/Proposal Title:

**Developing Chemical Emission Profiles for Motor Vehicles in the Northeastern U.S., (M. Mazurek, PI)**

- **Source of Support:** Federal Transit Administration
- **Total Award Amount:** $30,000
- **Total Award Period Covered:** 09/07-08/09
- **Location of Project:** Rutgers, New Brunswick
- **Person-Months Per Year Committed to the Project:** 0.5

**Support:**

- ☑ Current
- □ Pending
- □ Submission Planned in Near Future
- □ *Transfer of Support

### Project/Proposal Title:

**Combustion-Derived and Secondary Organic Compounds in New York State Ambient Fine Particles (M. Mazurek, PI)**

- **Source of Support:** New York State Energy Research and Development Authority (NYSERDA)
- **Total Award Amount:** $350,000
- **Total Award Period Covered:** 06/09-05/11
- **Location of Project:** Rutgers, New Brunswick
- **Person-Months Per Year Committed to the Project:** 1.0

**Support:**

- ☑ Current
- □ Pending
- □ Submission Planned in Near Future
- □ *Transfer of Support

### Project/Proposal Title:

**Hydrogen, Natural Gas, Electricity, and Heat from Landfill Gas: Integration of Emerging Technologies for a Quad-Generation Demonstration Project (D. Specca, PI; M. Mazurek, 1 of 8 co-Is)**

- **Source of Support:** Northeast Sun Grant Initiative
- **Total Award Amount:** $253,677
- **Total Award Period Covered:** 09/09-08/10
- **Location of Project:** Rutgers, EcoComplex Center, Bordentown, NJ
- **Person-Months Per Year Committed to the Project:** 0.2

**Support:**

- ☑ Current
- □ Pending
- □ Submission Planned in Near Future
- □ *Transfer of Support

### Project/Proposal Title:

**Lifecycle Carbon Footprint Analysis of Transportation Capital Projects, (R. Noland, PI; M. Mazurek, 1 of 4 cols)**

- **Source of Support:** NJ Department of Transportation
- **Total Award Amount:** $302,938
- **Total Award Period Covered:** 08/09-12/10
- **Location of Project:** Rutgers, New Brunswick
- **Person-Months Per Year Committed to the Project:** 0.7

**Support:**

- ☑ Current
- □ Pending
- □ Submission Planned in Near Future
- □ *Transfer of Support

### Project/Proposal Title:

**Environmental System Management for Transportation Maintenance Operations (T. Marhaba, PI; M. Mazurek, 1 of 4 cols)**

- **Source of Support:** NJ Department of Transportation
- **Total Award Amount:** $285,204
- **Total Award Period Covered:** 08/09-07/11
- **Location of Project:** Rutgers, New Brunswick
- **Person-Months Per Year Committed to the Project:** 1.0

**Support:**

- ☑ Current
- □ Pending
- □ Submission Planned in Near Future
- □ *Transfer of Support

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
### Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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<td>Development of a Renewable Fuel (Hydrogen) Generating Facility for Transportation Infrastructure (M. Mazurek, PI)</td>
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<td><strong>Project/Proposal Title:</strong></td>
<td>NSF Rutgers University Research Experience for Teachers in Engineering (K. Cook-Chenault, PI; M. Mazurek, 1 of 6 coPIs)</td>
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<td>Cyber-Enabled Discovery in a Digital Airshed (D. Hill, PI; M. Mazurek, col)</td>
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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
Current and Pending Support
Ali Memari – The Pennsylvania State University

CURRENT

Date: February 2010 – September 2010
Sponsor: Bolt-A-Block, Inc.
Amount: $60,000
(PI)

Date: August 2007 – July 2010
Title: “Design and Experimental Evaluation of a Panelized Brick Veneer Wall System for Serviceability and Safety Performance”
Sponsor: National Science Foundation
Amount: $269,142
(PI)

PENDING

Date: August 1, 2010 – July 31, 2013
Title: “Development of a Transparent Sustainable PV-Integrated Wall System for Building Construction”
Sponsor: National Science Foundation
Amount: $549,446
(PI)
John I. Messner, Ph.D.

Current Support:

September 2009-August 2011, "Virtual Construction Simulator 3D: A Simulation Game for Construction Engineering Education," The National Science Foundation, $150,000 – PI.


July 2008-June 2010, "Integrating Information: Bridging the Gap between Geographic information Systems and Building Information Modeling," The Raymond A. Bowers Fund, $19,700 - Co-PI

March 2008-December 2010, "Project Execution Planning for Building Information Modeling," The Charles Pankow Foundation (CPF), Construction Industry Institute (CII), Penn State OPP, and PACE, $289,000 - PI.


Current and Pending Support
Rick Mistrick – The Pennsylvania State University

CURRENT

Title: Effect of Bright Light Treatment on Depression of Elders in Long-term Care – A Pilot Study.
Sponsor: Clinical and Translational Science Institute,
Amount: $50,000.
1 person-week.

PENDING

None
Current and Pending Support
See GPG Section II.D.8 for guidance on information to include on this form.

<table>
<thead>
<tr>
<th>Investigator: Satish Narayanan</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted</th>
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Support: **Current** Pending Submission Planned in Near Future *Transfer of Support

Project/Proposal Title: A Systems Approach to High Performance Buildings – A Computational Systems Engineering R&D Program to Increase DoD Energy Efficiency

Source of Support: ESTCP/SERDP (DOD)
Total Award Amount: $3229K  
Total Award Period Covered: Aug. 2009-July 2011  
Location of Project: E. Hartford, CT  
Person-Months Per Year Committed to the Project: 4  
Cal: Acad: Sumr:

Support: **Current** Pending Submission Planned in Near Future *Transfer of Support

Project/Proposal Title: Wireless Platform for Energy-Efficient Building Control Retrofits

Source of Support: ESTCP/SERDP (DOD)
Total Award Amount: $1700K  
Total Award Period Covered: Aug. 2009-July 2011  
Location of Project: E. Hartford, CT  
Person-Months Per Year Committed to the Project: 2  
Cal: Acad: Sumr:

Support: **Current** Pending Submission Planned in Near Future *Transfer of Support

Project/Proposal Title: Model Predictive Controls

Source of Support: DOE-EERE (Prime: Lawrence Berkeley National Laboratory)
Total Award Amount: $145K  
Total Award Period Covered: Oct. 2008-June 2010  
Location of Project: Merced, CA  
Person-Months Per Year Committed to the Project: 0.5  
Cal: Acad: Sumr:

Support: **Current** Pending Submission Planned in Near Future *Transfer of Support

Project/Proposal Title: Occupancy Based Energy Management

Source of Support: DOE-EERE (Prime: Lawrence Berkeley National Laboratory)
Total Award Amount: $131K  
Total Award Period Covered: Oct. 2008-June 2010  
Location of Project: Merced, CA  
Person-Months Per Year Committed to the Project: 0.5  
Cal: Acad: Sumr:

Support: **Current** Pending Submission Planned in Near Future *Transfer of Support

Project/Proposal Title: Real-Time Energy Performance Visualization System

Source of Support: DOE-EERE (Prime: Lawrence Berkeley National Laboratory)
Total Award Amount: $146K  
Total Award Period Covered: Oct. 2008-June 2010  
Location of Project: Merced, CA  
Person-Months Per Year Committed to the Project: 0.5  
Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
Current and Pending Support
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Kofi Nyarko</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
</tr>
</thead>
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**Support:**
- [x] Current
- [ ] Pending
- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support

**Project/Proposal Title:**
Chesapeake Based Aeronautics Consortium

**Source of Support:** Congressional Earmark

- **Total Award Amount:** $19,000,000.0
- **Total Award Period Covered:** 2003-2010
- **Location of Project:** Morgan State University

**Person-Months Per Year Committed to the Project:**
12 Cal: Acad: Sumr:

**Support:**
- [ ] Current
- [ ] Pending
- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support

**Project/Proposal Title:**

**Source of Support:**

- **Total Award Amount:** $
- **Total Award Period Covered:**

**Location of Project:**

**Person-Months Per Year Committed to the Project:**
Cal: Acad: Sumr:

**Support:**
- [ ] Current
- [ ] Pending
- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support

**Project/Proposal Title:**

**Source of Support:**

- **Total Award Amount:** $
- **Total Award Period Covered:**

**Location of Project:**

**Person-Months Per Year Committed to the Project:**
Cal: Acad: Sumr:

**Support:**
- [ ] Current
- [ ] Pending
- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support

**Project/Proposal Title:**

**Source of Support:**

- **Total Award Amount:** $
- **Total Award Period Covered:**

**Location of Project:**

**Person-Months Per Year Committed to the Project:**
Cal: Acad: Sumr:

**Support:**
- [ ] Current
- [ ] Pending
- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support

**Project/Proposal Title:**

**Source of Support:**

- **Total Award Amount:** $
- **Total Award Period Covered:**

**Location of Project:**

**Person-Months Per Year Committed to the Project:**
Cal: Acad: Sumr:

**Support:**
- [ ] Current
- [ ] Pending
- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support

**Project/Proposal Title:**

**Source of Support:**

- **Total Award Amount:** $
- **Total Award Period Covered:**

**Location of Project:**

**Person-Months Per Year Committed to the Project:**
Cal: Acad: Sumr:

**Support:**
- [ ] Current
- [ ] Pending
- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support

**Project/Proposal Title:**

**Source of Support:**

- **Total Award Amount:** $
- **Total Award Period Covered:**

**Location of Project:**

**Person-Months Per Year Committed to the Project:**
Cal: Acad: Sumr:

**Support:**
- [ ] Current
- [ ] Pending
- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support

**Project/Proposal Title:**

**Source of Support:**

- **Total Award Amount:** $
- **Total Award Period Covered:**

**Location of Project:**

**Person-Months Per Year Committed to the Project:**
Cal: Acad: Sumr:

**Support:**
- [ ] Current
- [ ] Pending
- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support

**Project/Proposal Title:**

**Source of Support:**

- **Total Award Amount:** $
- **Total Award Period Covered:**

**Location of Project:**

**Person-Months Per Year Committed to the Project:**
Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*

NSF Form 1239 (10/98) USE ADDITIONAL SHEETS AS NECESSARY
Current and Pending Support
See GPG Section II.D.8 for guidance on information to include on this form.

<table>
<thead>
<tr>
<th>Investigator: Stella Maris Oggianu</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submit-ted: None</th>
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<tr>
<td>Support: Current Pending Submission Planned in Near Future *Transfer of Support</td>
<td>Project/Proposal Title: Distributed Power systems for Sustainable Energy</td>
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<tr>
<td>Source of Support: DoD ESTCP Program</td>
<td>Total Award Amount: $2.017M Total Award Period Covered: August 2009- August 2011</td>
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<td>Location of Project: McGuire AFB, NJ</td>
<td>Person-Months Per Year Committed to the Project: 0.5 Cal: Acad: Sumr:</td>
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| Support: Current Pending Submission Planned in Near Future *Transfer of Support | Project/Proposal Title: |
| Source of Support: | Total Award Amount: $ Total Award Period Covered: |
| Location of Project: | Person-Months Per Year Committed to the Project: Cal: Acad: Sumr: |

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.
Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings

Appendix 9. Current and Pending Support

Brian Orland Current:


Brian Orland Pending:
Source of funds: U.S. Army Engineer Research and Development Center (ERDC) Cooperative Ecosystem Studies Unit. Title: Site Planning Solutions for Military Communities. Sub-contract, $154,000 to University of Illinois at Urbana-Champaign. The Transforming Military Community: An Analysis of Community–Installation Relationships to 2030. Role: Co-PI; Sub-contract Amount: $150,000; Full Amount: $2,015,764; Duration: 2009-2011; Salary Support: 1/2 month; Location: Penn State.

Source of funds: U.S. Department of Education. Title: National Resource Center and Foreign Language and Area Studies program focusing on Africa. Role: Co-Investigator; Amount: $2,225,457; Duration: 2010-2015; Salary Support: none; Location: Penn State.

Source of funds: Rural Development Administration, Republic of Korea. Title: Landscape and Land Use Planning for Korean National Parks. Role: Co-PI; Amount: $to be determined; Duration: 20010-2013; Salary Support: 1/2 month; Location: Penn State.

Martin Sliwinski Current:
Source of Funds: National Institutes of Health (Aging). Title: The daily lives of older adults: developing measures of daily cognitive function and behaviors for population based surveys. Role: Co-PI; Amount $54,000; Duration: 2010-2012; Salary Support: .45 months academic, .15 months summer.

Source of Funds: National Institutes of Health (Aging). Title: Tools for articulating within-person dynamic models of interpersonal interactions”. Role: Investigator; Amount $500,000; Duration: 2010-2012; Salary Support: .45 months academic, .15 months summer.

Source of Funds: National Institutes of Health (Aging). Title: Stress, Aging and Working Memory”. Role: Investigator; Amount $482,000; Duration: 2006-2011; Salary Support: 1.35 months academic, 1.5 months summer.
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<td>$75,000.00</td>
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<td>FI State Uni</td>
<td>Electric Ship Research and Development Consortium</td>
<td>$409,440.00</td>
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<td>P C Krause</td>
<td>Numerical Tools to model High-speed Aircraft Generators with/without Skew</td>
<td>$75,000.00</td>
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<td>UofIll - C-U</td>
<td>Multi-Disciplinary 4D Design Tools for Naval Electromechanical Devices</td>
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<td>EPA</td>
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# Current and Pending Summers for Steven Pekarek

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## Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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<th>Investigator: Avis Ransom</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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**Support:**  
- [x] Current  
- [ ] Pending  
- [ ] Submission Planned in Near Future  
- [ ] *Transfer of Support

**Project/Proposal Title:**
Knowledge Integration and Management Center of Excellence

**Source of Support:** U.S. DOD
**Total Award Amount:** $12000000.00  
**Total Award Period Covered:** 9/01/2005-6/01/2010

**Location of Project:** Morgan State University
**Person-Months Per Year Committed to the Project:** Cal: 5  
Acad: 0  
Sumr: 0

| Support:  
- [ ] Current  
- [ ] Pending  
- [ ] Submission Planned in Near Future  
- [ ] *Transfer of Support

**Project/Proposal Title:**

**Source of Support:**
**Total Award Amount:** $  
**Total Award Period Covered:**

**Location of Project:**
**Person-Months Per Year Committed to the Project:** Cal:  
Acad:  
Sumr:

| Support:  
- [ ] Current  
- [ ] Pending  
- [ ] Submission Planned in Near Future  
- [ ] *Transfer of Support

**Project/Proposal Title:**

**Source of Support:**
**Total Award Amount:** $  
**Total Award Period Covered:**

**Location of Project:**
**Person-Months Per Year Committed to the Project:** Cal:  
Acad:  
Sumr:

| Support:  
- [ ] Current  
- [ ] Pending  
- [ ] Submission Planned in Near Future  
- [ ] *Transfer of Support

**Project/Proposal Title:**

**Source of Support:**
**Total Award Amount:** $  
**Total Award Period Covered:**

**Location of Project:**
**Person-Months Per Year Committed to the Project:** Cal:  
Acad:  
Sumr:

| Support:  
- [ ] Current  
- [ ] Pending  
- [ ] Submission Planned in Near Future  
- [ ] *Transfer of Support

**Project/Proposal Title:**

| Source of Support:  
**Total Award Amount:** $  
**Total Award Period Covered:**

**Location of Project:**
**Person-Months Per Year Committed to the Project:** Cal:  
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Sumr:

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- [ ] Pending  
- [ ] Submission Planned in Near Future  
- [ ] *Transfer of Support

**Project/Proposal Title:**

| Source of Support:  
**Total Award Amount:** $  
**Total Award Period Covered:**

**Location of Project:**
**Person-Months Per Year Committed to the Project:** Cal:  
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- [ ] Pending  
- [ ] Submission Planned in Near Future  
- [ ] *Transfer of Support

**Project/Proposal Title:**

| Source of Support:  
**Total Award Amount:** $  
**Total Award Period Covered:**

**Location of Project:**
**Person-Months Per Year Committed to the Project:** Cal:  
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- [ ] Submission Planned in Near Future  
- [ ] *Transfer of Support

**Project/Proposal Title:**

| Source of Support:  
**Total Award Amount:** $  
**Total Award Period Covered:**

**Location of Project:**
**Person-Months Per Year Committed to the Project:** Cal:  
Acad:  
Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
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<td>&quot;A Mid-Atlantic Solar Resource &amp; Training Center&quot;</td>
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<td>Technical Subtopic 3.3: High Performance Building Envelopes-Plus: Roof-Integrative Photovoltaics at the Philadelphia Navy Yard</td>
<td>Department of Energy</td>
<td>$1,716,777</td>
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<td>The transformational application of an open source protocol (OSP) to a home area network (HAN) featuring the dynamic interaction of self-organizing &amp; managing control structures.</td>
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**Current and Pending Support**

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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<thead>
<tr>
<th>Investigator:</th>
<th>Paul Romano</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted:</th>
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| Project/Proposal Title: | BPU - Operations and Maintenance Pilot Program |

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| Project/Proposal Title: | Retro-Commissioning Pilot Program |

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| Project/Proposal Title: | Technical Support & NJ Schools Database Development |

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| Project/Proposal Title: | |

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

4-357
CURRENT AND PENDING SUPPORT


Current and Pending Support
Laura Schaefer, MEMS Dept., University of Pittsburgh

Support: Current
Title: University of Pittsburgh Engineering Sustainability Program
Source of Support: NSF: IGERT
Total Award Amount: $3,386,647 Dates: 07/01/05-06/30/10
Person-Months Per Year: 0.5 Academic Months

Support: Current
Title: Environmentally Sound: High Performance, Compact Thermoacoustic Refrigeration
Source of Support: NSF: CBET
Total Award Amount: $300,000 Dates: 09/01/07-08/31/10
Person-Months Per Year: 0.5 Summer Months

Support: Current
Title: US-Brazil International Research Experience for Students
Source of Support: NSF: IRES
Total Award Amount: $150,000 Dates: 08/01/06-7/31/10
Person-Months Per Year: 0 Months

Support: Pending
Title: Sustainable Community Oriented Research & Education (SCORE)
Source of Support: NSF: IGERT
Total Award Amount: $3,200,000 Dates: 07/01/11-06/30/16
Person-Months Per Year: 0.5 Summer Months

Support: Pending
Title: Interfacing Thermoacoustic Devices with the Environment
Source of Support: NSF: CBET
Total Award Amount: $426,547 Dates: 09/01/10-08/31/13
Person-Months Per Year: 1.0 Academic Months

Support: Pending
Title: BUILD - Barriers, Understanding, Integration - Life Cycle Development
Source of Support: NSF: EFRI
Total Award Amount: $2,000,000 Dates: 09/01/10-08/31/14
Person-Months Per Year: 1.0 Summer Months

Support: Pending
Title: Acquisition of a Hybrid Computer Cluster for Large-Scale Modeling and Simulation
Source of Support: NSF: MRI
Total Award Amount: $386,541 Dates: 12/01/10-11/30/13
Person-Months Per Year: 0 Months
Current and Pending Support  
(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: RACHAEL L. SHWOM

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### Between State and Profit: An Analysis of Changes in Nonprofit Interorganizational Networks and Tactics in the Energy Efficiency Field 1973-2006 (NSF Award # 0947791)

Source of Support: NSF  
Total Award Amount: $175,000  
Total Award Period Covered: 09/07-09/10  
Location of Project: Rutgers University  
Person-Months Per Year Committed to the Project: Cal: | Acad: | Sumr: 2

### Project/Proposal Title: ULTRA-Ex: Connectivity Along Urban Rivers: A Keystone Process for Urban Ecosystems – Co-PI (NSF Award # 0948896)

Source of Support: NSF  
Total Award Amount: $290,000  
Total Award Period Covered: 10/09-10/11  
Location of Project: Rutgers University  
Person-Months Per Year Committed to the Project: Cal: | Acad: | Sumr: |

### Project/Proposal Title: Between Economic Distress and Technological Change: Builders and GHG Emissions in an American Metropolis (Co-PI)

Source of Support: NSF  
Total Award Amount: $230,000  
Total Award Period Covered: 09/10-08/12  
Location of Project: Rutgers University  
Person-Months Per Year Committed to the Project: Cal: | Acad: | Sumr: 2

### Project/Proposal Title:

Source of Support:  
Total Award Amount: $  
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Location of Project:  
Person-Months Per Year Committed to the Project: Cal: | Acad: | Sumr: |

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Source of Support:  
Total Award Amount: $  
Total Award Period Covered:  
Location of Project:  
Person-Months Per Year Committed to the Project: Cal: | Acad: | Sumr: |

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.
**Martin Sliwinski Pending:**

Source of Funds: National Institutes of Health (Aging). Title: The Einstein Aging Study”. Role: Investigator; Amount $52,000; Duration: 2011-2016; Salary Support: 1.35 months academic, 1.0 months summer.

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**Mallika Bose Current:**

Source of funds: United States Department of Agriculture (USDA as part of PA TRACKS Program). Title: Investigating the nutrition environment in two West Philadelphia neighborhoods. Role: PI; Full Amount: $30,985; Duration: 2000-2010; Salary Support: 1/2 month summer; Location: Penn State.

Source of funds: National Institutes of Health (R21 grant program). Title: Physical Education, Recreation and Community Partners: Promoting Physical Activity. Role: Co-Investigator; Full Amount: $275,000; Duration: 2007-2009 (on no cost extension); Salary Support: none; Location: Penn State.

Source of funds: World University Network Research Development Fund. Title: Immigrants, Place, and Cross-Cultural Understanding: Global-Local Perspectives and Processes. Role: Co-Investigator; Full Amount: $51,479; Duration: 2010-2011; Salary Support: none; Location: University of Washington

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**Stuart Echols Current:**

None

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**Stuart Echols Pending:**

None
## Current and Pending Support: Jelena Srebric

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<td>Source of Support</td>
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<td>Total Award Amount</td>
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<td>The Pennsylvania State University</td>
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<tr>
<td>Person-Months Per Year Committed to the Project</td>
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<td>Person-Months Per Year Committed to the Project</td>
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**Current and Pending Support**

*(See GPG Section II.D.8 for guidance on information to include on this form.)*

<table>
<thead>
<tr>
<th>Investigator: James C. Sturm</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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<thead>
<tr>
<th>Support:</th>
<th>Current</th>
<th>Pending</th>
<th>Submission Planned in Near Future</th>
<th>*Transfer of Support</th>
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**Project/Proposal Title:** Materials Research Science and Engineering Center (MRSEC, Co-PI)

- **Source of Support:** National Science Foundation
- **Total Award Amount:** $62,112
- **Total Award Period Covered:** 09/01/2007-08/31/2010
- **Location of Project:** Princeton University
- **Person-Months Per Year Committed to the Project:** Cal: Acad: Sumr:  

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**Project/Proposal Title:** Thin Film Solid State Organic Energy Conservation Devices

- **Source of Support:** University of Michigan
- **Total Award Amount:** $45,325
- **Total Award Period Covered:** 01/01/2009-04/30/2014
- **Location of Project:** Princeton University
- **Person-Months Per Year Committed to the Project:** Cal: Acad: Sumr:  

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**Project/Proposal Title:** Harnessing Quantum Entanglement in Semiconductor Circuits

- **Source of Support:** DARPA
- **Total Award Amount:** $304,540
- **Total Award Period Covered:** 12/29/2009-12/28/2011
- **Location of Project:** Princeton University
- **Person-Months Per Year Committed to the Project:** Cal: Acad: Sumr: 0.5  

---

**Project/Proposal Title:** Technologies for Digital Control of Exchange Interaction in a Spin-based Silicon Quantum Computer

- **Source of Support:** Purdue University
- **Total Award Amount:** $407,500
- **Total Award Period Covered:** 12/29/2009-12/28/2011
- **Location of Project:** Princeton University
- **Person-Months Per Year Committed to the Project:** Cal: Acad: Sumr: 0.5  

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**Project/Proposal Title:** Explosive Evolution Under Stress: The Driving Forces of Cancer Dynamics (Co-PI)

- **Source of Support:** National Institutes of Health
- **Total Award Amount:** $1,925,617
- **Total Award Period Covered:** 09/01/2009-08/31/2014
- **Location of Project:** Princeton University
- **Person-Months Per Year Committed to the Project:** Cal: Acad: Sumr:  

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*

NSF Form 1239 (10/99)  
USE ADDITIONAL SHEETS AS NECESSARY
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<th>Investigator: James C. Sturm</th>
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<td>Project/Proposal Title: Center for Flexible Systems</td>
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<td>Source of Support: Arizona State University/NSF</td>
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<td>Project/Proposal Title: ARRA: STTR Phase I: Novel method for dewatering using lateral displacement array</td>
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<td>Source of Support: Phycal, LLC</td>
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<td>Project/Proposal Title:</td>
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NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

4-364
The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Charles Tong, PhD</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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### Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

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<thead>
<tr>
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<tr>
<td>Source of Support: DOE NNSA</td>
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<tr>
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<tr>
<td>Total Award Period Covered: ongoing</td>
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<tr>
<td>Location of Project: LLNL</td>
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<td>Person-Months Per Year Committed to the Project: 6 Cal: X</td>
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<table>
<thead>
<tr>
<th>Support: ☒ Current</th>
</tr>
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### Current and Pending Support

Project/Proposal Title: Scalable Linear Solvers

| Source of Support: DOE NNSA                                   |
| Total Award Amount: $800K                                     |
| Total Award Period Covered: ongoing                           |
| Location of Project: LLNL                                     |
| Person-Months Per Year Committed to the Project: 1.2 Cal: X   |

<table>
<thead>
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<th>Support: ☒ Current</th>
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### Current and Pending Support

Project/Proposal Title: LDRD on Advanced Uncertainty Quantification

| Source of Support: LLNL LDRD                                   |
| Total Award Amount: $6M                                       |
| Total Award Period Covered: 10/09-9/12                         |
| Location of Project: LLNL                                     |
| Person-Months Per Year Committed to the Project: 2.4 Cal: X   |

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<th>Support: ☒ Current</th>
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### Current and Pending Support

Project/Proposal Title: Hybrid UQ Methods

| Source of Support: DOE NNSA                                   |
| Total Award Amount: $300K                                     |
| Total Award Period Covered: 10/09-10/10                        |
| Location of Project: LLNL                                     |
| Person-Months Per Year Committed to the Project: 2.4 Cal: X   |

<table>
<thead>
<tr>
<th>Support: ☒ Current</th>
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</table>

### Current and Pending Support

Project/Proposal Title: A High-Performance Embedded Hybrid Methodology for Uncertainty Quantification with Applications

| Source of Support: ASCR, DOE                                  |
| Total Award Amount: $650K                                     |
| Total Award Period Covered:                                   |
| Location of Project: LLNL                                     |
| Person-Months Per Year Committed to the Project: 4 Cal: X     |

<table>
<thead>
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<th>Support: ☒ Current</th>
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</thead>
</table>

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.
Current and Pending Support

Stephen Treado
Associate Professor
Department of Architectural Engineering
Pennsylvania State University
University Park, PA 16802

Stephen Treado
Current: US Dept. of Energy  Solar Workforce Training Center
$2M  1 pm/year
Current: US Dept. of Energy  Smart Grid Workforce Training Center
$5M  1 pm/year
Investigator: Athanasios Tzempelikos

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future
Project/Proposal Title: A Center for High Performance Buildings
Source of Support: National Science Foundation Engineering Research Program
Total Award Amount: $18,500,000 Total Award Period Covered: 10/1/10 – 9/31/15
Location of Project: Purdue University

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future
Project/Proposal Title: Development of High Performance Building Facades
Source of Support: Purdue Research Foundation
Total Award Amount: $17,000 Total Award Period Covered: 08/2009-08-2010
Location of Project: Purdue University

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future
Project/Proposal Title: Start-up funds for development of Architectural Engineering research program
Source of Support: Purdue University
Total Award Amount: $225,000 Total Award Period Covered: 08/2008-08-2011
Location of Project: Purdue University

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future
Project/Proposal Title: Energy optimization of curtain walls
Source of Support: Alcoa/Kawneer Inc.
Total Award Amount: $100,000 Total Award Period Covered: 01/2010-01-2012
Location of Project: Purdue University

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future
Project/Proposal Title: Impact of dynamic shading on thermal performance of buildings
Source of Support: Lutron Electronics Inc
Total Award Amount: $107,000 Total Award Period Covered: 01/2010-12-2010
Location of Project: Purdue University
**Current and Pending Support**  
(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Naveen Verma</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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<tr>
<td>Project/Proposal Title:</td>
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<td>Source of Support:</td>
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| Support: □ Current        | □ Pending □ Submission Planned in Near Future □ *Transfer of Support |
| Project/Proposal Title:   | Miniaturized Digital EVA Radio                                                  |
| Source of Support:        | Bennett Aerospace (Funding Agency - NASA)                                       |
| Total Award Amount:       | $ 25,000                                                                         |
| Total Award Period Covered: | 02/01/10 - 07/31/10                                                              |
| Location of Project:      | Princeton University                                                             |
| Person-Months Per Year Committed to the Project: | Cal:0.00  Acad:0.00  Sumr: 0.40                                                   |

| Support: □ Current        | □ Pending □ Submission Planned in Near Future □ *Transfer of Support |
| Project/Proposal Title:   | Ultra-Efficient Interfacing of Nano-Scale and Large-Area Electronics for Highly-Scalable and Generic Low-Power Sensing and Processing Networks |
| Source of Support:        | DARPA                                                                            |
| Total Award Amount:       | $ 300,000                                                                        |
| Total Award Period Covered: | 09/01/10 - 08/31/12                                                              |
| Location of Project:      | Princeton University                                                             |
| Person-Months Per Year Committed to the Project: | Cal:0.00  Acad:0.00  Sumr: 0.63                                                   |

| Support: □ Current        | □ Pending □ Submission Planned in Near Future □ *Transfer of Support |
| Project/Proposal Title:   | CPS:Small:Specialized Processor for Continuous Patient Monitoring (PI)(Includes Co-PI) |
| Source of Support:        | National Science Foundation                                                      |
| Total Award Amount:       | $ 600,000                                                                        |
| Total Award Period Covered: | 09/01/10 - 08/31/13                                                              |
| Location of Project:      | Princeton University                                                             |
| Person-Months Per Year Committed to the Project: | Cal:0.00  Acad:0.00  Sumr: 1.00                                                   |

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
Current and Pending Support
Jeffrey S. Vipperman, MEMS Dept., University of Pittsburgh

Support: Current
Title: GOALI: Nanoscale Hysteresis Modeling and Control in Precision Equipment
Source: National Science Foundation,
Total: $300,000 Dates: 9/1/09-8/31/11
Person-Months Per Year: 0.8 Summer Month

Support: Current
Title: Nanoscale Hysteresis Modeling and Control in Precision Equipment
Source: Aerotech, Inc.
Total: $124,938 Dates: 10/1/08-9/30/10
Person-Months Per Year: 1.0 Academic Month

Support: Current
Title: “ACT Active Combustion Throttling,”
Source: NETL
Total: $50,000 Dates: 1/1/10-12/31/10
Person-Months Per Year: 0.5 Academic Month

Support: Current
Title: Environmentally Sound: High Performance, Compact Thermoacoustic Refrigeration
Source: National Science Foundation
Total: $300,000 Dates: 9/01/07-8/31/10
Person-Months Per Year: 0.5 Summer Month

Support: Pending
Title: CPS: Medium: Multi-level Control Development Platform (CDP for CPS), with a case study on pneumatic conveying,”
Source: NSF
Total: $1,470,000 Dates: 8/1/10-7/31/13
Person-Months Per Year: 1.5 Summer Months

Support: Pending
Title: Ft. Drum Noise Monitor Deployment
Source: Army/CERL
Total: $15,000 Dates: 5/1/10-8/31/10
Person-Months Per Year: 0.25 Summer Month

Support: Pending
Title: Improved Military Noise Monitoring System
Source: SERDP/Army CERL
Total: $206,000 Dates: 8/1/10-7/31/13
Person-Months Per Year: 1.0 Summer Month
**Current and Pending Support**

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<td>Project/Proposal Title:</td>
<td>Permeation Barrier for Flexible Displays</td>
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Page G-1  USE ADDITIONAL SHEETS AS NECESSARY
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<td>Project/Proposal Title:</td>
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</table>

| Support:                  | Current  □  Pending  □  Submission Planned in Near Future  □  *Transfer of Support |
| Project/Proposal Title:   | Light Speed Solutions                                                             |
| Source of Support:        | Light Speed Solutions                                                             |
| Total Award Amount:       | $ 1,800,000                                                                        |
| Total Award Period Covered: | 09/01/10 - 08/31/15                                                                |
| Location of Project:      | Princeton University                                                               |
| Person-Months Per Year Committed to the Project. | Cal: 0.00  Acad: 0.00  Sumr: 0.50 |

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Tim Wagner</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submit-to: NONE</th>
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<tbody>
<tr>
<td>Support: Current Pending</td>
<td>Submission Planned in Near Future *Transfer of Support</td>
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<tr>
<td>Project/Proposal Title: Optimization of hybrid-water/air-cooled condenser in an enhanced turbine geothermal ORC system</td>
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<tr>
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<td>Total Award Period Covered: 02/2010 – 07/2011</td>
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<tr>
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<tr>
<td>Project/Proposal Title: 10 kW ORC for Mobile Camps</td>
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<td>Total Award Amount: $622,178</td>
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<tr>
<td>Project/Proposal Title: Biomass ORC Demonstration</td>
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<tr>
<th>Source of Support: Alaska Energy Authority</th>
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<td>Location of Project: Alaska</td>
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<th>Submission Planned in Near Future *Transfer of Support</th>
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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.
Current and Pending Support

See GPG Section II.D.8 for guidance on information to include on this form.

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Tim Wagner (con’t)</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted</th>
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<tr>
<td>支持: Current x Pending Submission Planned in Near Future *Transfer of Support</td>
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<tr>
<td><strong>Project/Proposal Title:</strong> Highly-Energy-Efficient Integrated Chiller/DOAS HVAC System for DoD Installations</td>
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<td>Source of Support: DOD - ESTCP</td>
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<td>Location of Project: CT</td>
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<tr>
<td>Person-Months Per Year Committed to the Project: 6</td>
<td>Cal: Acad: Sumr:</td>
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| Support: Current x Pending Submission Planned in Near Future *Transfer of Support | |
| **Project/Proposal Title:** High Efficiency HVAC with Independent Latent and Sensible Cooling |
| Source of Support: DOE | |
| Total Award Amount: $2,000,000 | Total Award Period Covered: est 10/2010 – 09/2012 |
| Location of Project: CT | |
| Person-Months Per Year Committed to the Project: 6 | Cal: Acad: Sumr: |

| Support: Current Pending Submission Planned in Near Future *Transfer of Support | |
| **Project/Proposal Title:** | |
| Source of Support: | |
| Total Award Amount: | Total Award Period Covered: |
| Location of Project: | |
| Person-Months Per Year Committed to the Project: | Cal: Acad: Sumr: |

| Support: Current Pending Submission Planned in Near Future *Transfer of Support | |
| **Project/Proposal Title:** | |
| Source of Support: | |
| Total Award Amount: | Total Award Period Covered: |
| Location of Project: | |
| Person-Months Per Year Committed to the Project: | Cal: Acad: Sumr: |

| Support: Current Pending Submission Planned in Near Future *Transfer of Support | |
| **Project/Proposal Title:** | |
| Source of Support: | |
| Total Award Amount: | Total Award Period Covered: |
| Location of Project: | |
| Person-Months Per Year Committed to the Project: | Cal: Acad: Sumr: |

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
Michael S. Waring

Current funded projects:
None

Pending funded projects:
2. Submitted to NSF: EFRI SEED: Indoor Ecology – Defining the Human-Building Ecosystem; dates 9/1/2010 to 8/31/2014; $1,995,428; Co-PI
## Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Damian Watkins</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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### Support:
- **Current**
- **Pending**
- **Submission Planned in Near Future**
- **Transfer of Support**

#### Project/Proposal Title:
- Behavioral Modeling and performance prediction using
- Agent Based Models

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<td>Person-Months Per Year Committed to the Project:</td>
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### Support:
- **Current**
- **Pending**
- **Submission Planned in Near Future**
- **Transfer of Support**

#### Project/Proposal Title:

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### Support:
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#### Project/Proposal Title:

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### Support:
- **Current**
- **Pending**
- **Submission Planned in Near Future**
- **Transfer of Support**

#### Project/Proposal Title:

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### Support:
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- **Pending**
- **Submission Planned in Near Future**
- **Transfer of Support**

#### Project/Proposal Title:

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<tr>
<td>Location of Project:</td>
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<td>Person-Months Per Year Committed to the Project:</td>
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</table>

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*

NSF Form 1239 (10/98)  USE ADDITIONAL SHEETS AS NECESSARY
Current and Pending Support
Lisa Weiland, MEMS Dept., University of Pittsburgh

Support: Current
Title: CAREER: High Performance, Mechanically Robust Ionomeric Sensors
Source of Support: NSF
Total Award Amount: $400,000  Dates: 05/01/08-04/30/13
Person-Months Per Year: 1.0 Summer Month

Support: Current
Title: Enabling Miniature Ionomeric Sensors
Source of Support: NSF
Total Award Amount: $270,000  Dates: 07/01/07-06/30/11
Person-Months Per Year: 1.0 Summer Month

Support: Current
Title: Metal Redox Control of Polymer Properties
Source of Support: NSF
Total Award Amount: $175,000  Dates: 09/01/09-08/31/10
Person-Months Per Year: 0 Months

Support: Current
Title: Endosome Burst Computational Study
Source of Support: Univ. of Pittsburgh Central Research Development Fund
Total Award Amount: $10,000  Dates: 07/01/09-06/30/11
Person-Months Per Year: 0 Months

Support: Pending (contract in negotiation)
Title: River Device for Recovering Energy with Active Materials Morphing Proof of Principle
Source of Support: Bayer MaterialScience
Total Award Amount: $85,000  Dates: 09/01/10-08/31/11
Person-Months Per Year: 1.0 Summer Month

Support: Submission Planned in Near Future
Title: An Integrated Investigation of Computational Inverse Mechanics and Experimental Techniques for Design and Control of Adaptive Shape-Changing Structures
Source of Support: AFOSR
Total Award Amount: $445,183  Dates: 10/01/10-09/30/13
Person-Months Per Year: 0.75 Summer Months
Current and Pending Support

Investigator: Jin Wen

Support: Current
Project/Proposal Title: Tools for Evaluating Fault Detection and Diagnostic Methods for Air-Handling Units
Source of Support: ASHRAE
Total Award Amount: $ 113,623
Total Award Period Covered: 09/01/05 - 08/31/10
Location of Project: Drexel University
Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.45 Sumr: 0.1

Support: Current
Project/Proposal Title: REU Site: SENSORS--Design to Implementation
Source of Support: NSF
Total Award Amount: $ 300,000
Total Award Period Covered: 09/01/09 – 08/31/12
Location of Project: Drexel University
Person-Months Per Year Committed to the Project. Cal: 0.0 Acad: 0.0 Sumr: 0.1

Support: Current
Project/Proposal Title: THE DREXEL UNIVERSITY GAANNS FELLOWSHIP PROGRAM: EDUCATING RENAISSANCE ENGINEERS
Source of Support: DOEd
Total Award Amount: $ 752,796
Total Award Period Covered: 9/1/2006 to 8/31/2010
Location of Project: Drexel University
Person-Months Per Year Committed to the Project. Cal: 0.0 Acad: 0.0 Sumr: 0.00

Support: Current
Project/Proposal Title: Fellowship Program in Microbial Risk Assessment for Built Environment
Source of Support: Department of Homeland Security
Total Award Amount: $304,994.00
Total Award Period Covered: 09/01/2008-08/31/2011
Location of Project: Drexel University
Person-Months Per Year Committed to the Project. Cal: 0.0 Acad: 0.0 Sumr: 0.0

Support: Current
Project/Proposal Title: Stability and Accuracy of VAV Box Control at Low Flows
Source of Support: ASHRAE
Total Award Amount: $ 99,153
Total Award Period Covered: 08/01/07 - 03/31/10
Location of Project: Drexel University
Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.50 Sumr: 0.1
Jin Wen
Support: Current
Project/Proposal Title: Framework of Assessing Building Energy Efficiency Strategies for Philadelphia Housing Authority
Source of Support: Philadelphia Housing Authority
Total Award Amount: $411,925
Total Award Period Covered: 08/01/09 - 07/30/11
Location of Project: Drexel University
Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.6 Sumr: 2.6

Support: Pending
Project/Proposal Title: Measurement Science Framework for High Performance Building Energy Monitoring and Fault Detection and Diagnosis
Source of Support: NIST
Total Award Amount: $802,006
Total Award Period Covered: 09/01/09 - 08/31/12
Location of Project: Drexel University
Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.3 Sumr: 0.3

Support: Pending
Source of Support: NSF
Total Award Amount: $461,527
Total Award Period Covered: 10/01/10 - 09/30/12
Location of Project: Drexel University
Person-Months Per Year Committed to the Project. Cal: 0.00 Acad: 0.0 Sumr: 0.3
Current Sponsored Projects: none

Pending Sponsored Projects:

1. Date submitted: December 17, 2009
   Duration: August 1, 2010 – July 31, 2012
   Title: HCC: Small: Design = (Bricolage + Participation) * Control
   Sponsor: National Science Foundation (IIS Program)
   Amount: $393,408
   Contribution: PI: Dr. Sandeep Purao (IST), co-PIs: Dan Willis (Arch), Tim Simpson (Eng.)
   Status: pending

2. Date submitted: April 30, 2010
   Duration: 1 year
   Title: Workshop Proposal: When Engineering Design Meets Architecture
   Sponsor: NSF
   Amount: $50,000 total; PSU $32,000/U.Penn $18,000
   Contribution: Dan Willis, Principal Investigator, co-PIs Tim Simpson, John Messner
   Status: pending

3. Date submitted: ?
   Duration: 5 years
   Title: Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings
   Sponsor: U.S. Department of Energy, E-RIC program
   Amount: ?
   Contribution: Investigator?
   Status: pending
Current Support

Sponsor: Wayne State University
Title: Exploratory Innovations in Biomedical Computation
Total Amount: $38,191
Start Date: 09/01/2008
End Date: 06/30/2010
Location of Project: The Pennsylvania State University
Effort (person months): (0.00 Acad 0.25 Sumr)

Sponsor: ExxonMobil Corporation
Title: Human Machine Collaboration and Data Fusion Systems
Total Amount: $45,000
Start Date: 08/13/2008
End Date: 12/31/2009
Location of Project: The Pennsylvania State University
Effort (person months): (0.00 Acad 0.00 Sumr)

Sponsor: National Science Foundation
Title: DRU: Inter-organizational Decision Making and Organization Design for Improved ICT Coordination in Disaster Relief
Total Amount: $650,000
Start Date: 01/01/2007
End Date: 12/31/2010
Location of Project: The Pennsylvania State University
Effort (person months): (0.00 Acad 0.00 Sumr)

Sponsor: National Science Foundation
Title: DRU: Inter-organizational Decision Making and Organization Design for Improved ICT Coordination in Disaster Relief (REU Supplement)
Total Amount: $6,000
Start Date: 01/01/2007
End Date: 12/31/2010
Location of Project: The Pennsylvania State University
Effort (person months): (0.00 Acad 0.00 Sumr)

Sponsor: Army Research Office
Title: MURI: Computer-aided Human Centric Cyber Situation Awareness
Total Amount: $7,033,538
Start Date: 06/01/2009
End Date: 05/31/2014
Location of Project: The Pennsylvania State University
Effort (person months): (0.00 Acad 0.00 Sumr)

Sponsor: National Science Foundation
Title: RAPID: Text Message-based Infrastructure for Emergency Response
Total Amount: $ 75,000
Start Date: 02/15/2010
End Date: 02/14/2011

Location of Project: The Pennsylvania State University
Effort (person months): (0.00 Acad 0.5 Sumr)

Pending Support

Sponsor: National Science Foundation
Title: ITEST: Integrating Information and Communication Technology (ICT) for Extreme
Events into High School Curriculum for Enhancing STEM Education in Rural
Pennsylvania
Total Amount: $ 953,697
Start Date: 02/15/2010
End Date: 02/14/2011
Location of Project: The Pennsylvania State University
Effort (person months): (0.00 Acad 0.5 Sumr)

Sponsor: Army Research Lab (through Alion Science & Technology)
Title: THINK: Multi-dimensional Human-Centric Context for Information Requirements and
Adaptive Presentation
Total Amount: $ 150,000
Start Date: 05/15/2010
End Date: 05/14/2011
Location of Project: The Pennsylvania State University
Effort (person months): (0.00 Acad 1.00 Sumr)
## Current and Pending Support

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The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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<th>Investigator: Lizette Zietsman</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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**Support:**
- **Current**
- **Pending**
- **Submission Planned in Near Future**
- **Transfer of Support**

**Project/Proposal Title:**
REU Modeling and Simulation in Systems Biology #0755322

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**Support:**
- **Current**
- **Pending**
- **Submission Planned in Near Future**
- **Transfer of Support**

**Project/Proposal Title:**
Computer Design Tool for Building Models, Simulation and Sensitivity

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**Support:**
- **Current**
- **Pending**
- **Submission Planned in Near Future**
- **Transfer of Support**

**Project/Proposal Title:**
Computational Methods for Design, Estimation and Real-time Control of PE

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**Support:**
- **Current**
- **Pending**
- **Submission Planned in Near Future**
- **Transfer of Support**

**Project/Proposal Title:**

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**Project/Proposal Title:**

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- **Submission Planned in Near Future**
- **Transfer of Support**

**Project/Proposal Title:**

*If this project has previously been funded by another agency, please list and furnish information for immediately*
Andrew Zwicker

Current Support

Project: National Undergraduate Fellowship Program in Plasma Physics and Fusion Energy Sciences
Principal Investigator: Andrew Zwicker
Period of Performance: Funded annually
Funding: $365K received in 2010

Project: Community Partnerships
Principal Investigator: Andrew Zwicker
Period of Performance: Funded annually
Funding: $245K received in 2010

Project: Plasma Physics and Fusion Energy Institute for Teachers / Contemporary Physics Education Project
Principal Investigator: Andrew Zwicker
Period of Performance: Funded annually
Funding: $170K received in 2010

Sponsor: U.S. Department of Energy – Office of Workforce Development
Project: Summer Undergraduate Laboratory Internships
Principal Investigator: Andrew Zwicker
Period of Performance: Funded annually
Funding: $207K received in 2010

Sponsor: U.S. Department of Energy – Office of Workforce Development
Project: Pre-Service Teachers
Principal Investigator: Andrew Zwicker
Period of Performance: FY 2010
Funding: $35K
Sponsor: U.S. Department of Energy – Office of Workforce Development
Project: Academies Creating Teacher-Scientists
Principal Investigator: Andrew Zwicker
Period of Performance: FY 2010
Funding: $250K

Princeton University supports approximately one and one-half months of Dr. Zwicker’s time to teach various courses. Dr. Zwicker charges approximately nine and one-half months to an indirectly funded Science Education account, and the remaining month is spread among the above projects.
## Bayer’s C&PS Statement:

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<tr>
<th>Name</th>
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## Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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<tr>
<th>Investigator: BFTP/SEP</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted: US DOE</th>
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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
**Collegiate Consortium**

**Direct Grant/Funding**

United States Department of Defense managed through the Economic Development Agency: Veterans Education Funds (Total Funds $2.2M)

**Indirect Through Participating in Training**

United States Department of Labor, ETA - Grant for Applied Engineering Technology through Delaware County Community College (Total Funds $2.4M)

US Department of Labor, ETA - Grant for Shipyard Supplier Network through the Philadelphia Shipyard Development Corporations (Total Funds Est.$600,000)

US DOD,EDA- Grant for management training for Shipyard Supplier Network through the PSDC ($465,000)
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**Appendix 10**

**Hub Facilities & Other Resources**

*Bayer MaterialScience:* With a global and regional construction business base exceeding $1.7 billion and $300 million respectively, the Pittsburgh development center is equipped to design, develop and evaluate innovative concepts brought forth by the consortium. These include materials design, component modeling, a variety of extrusion and molding processes, accelerated aging, failure mode analyses, analytical tools and lifecycle analyses.

*Carnegie Mellon University:* The Center for Building Performance and Diagnostics (CBPD) in the School of conducts research, development, and demonstrations in advanced building technologies and systems integration for high performance buildings, in improved approaches to the building delivery process, and in workplace productivity. CBPD is an unprecedented "living laboratory" of innovations in enclosure, HVAC, lighting, telecommunications and interior systems for professional education and research. The CBPD was the first NSF Industry-Industry University Cooperative Research Center dedicated to the building industry in the United States, and one of only two in the history of the NSF IU/CRC.

*Drexel University* features Drexel Smart House, an urban home that serves as a “living learning laboratory” for student-directed research and community outreach activities to local neighborhoods and high schools. The Smart House is a building that functions as a residence hall while it serves as a laboratory to conduct research on innovations for the habitable world. DSH explores the areas of environment, energy, interaction, health, and lifestyle – research areas that due to their nature require trans-disciplinary collaboration to create a higher framework of knowledge. Ultimately, the research and design will be implemented into the home and students living there will validate the effectiveness of the new, transformative ideas.

*Lawrence Livermore National Laboratory* features the National Ignition Facility, the Livermore Computing and Terascale Computing Facility, the Jupiter Laser Facility, National Atmospheric Release Advisory Center, the Program for Climate Model Diagnosis and Intercomparison, Special Engineering Facilities (supporting micro/nanotechnology, precision fabrication, materials evaluation, nondestructive analysis, and electronics manufacturing), and other facilities that focus on energy and environmental issues.

*Morgan State University:* Morgan has established the Center for Advanced Energy Systems and Environmental Controls in order to provide the next generation of environmentally responsive capabilities to commercial, industrial, and residential buildings nationwide. The recent completion of Morgan’s new library building (220,000 sq ft) with its automatic energy management/control system, its green roof, and other sustainability features, can serve as a living laboratory for engineers, architects, and other professionals in the green building field. In addition, ground was recently broken on a $60M, LEED-certified “Center for the Built environment and Infrastructure Studies” to be shared by faculty from the Schools of Architecture and Planning and the relevant engineering programs.

*University of Pennsylvania:* The mission of the T.C. Chan Center for Building and Energy Studies is to develop new knowledge, tools, processes, techniques and continuing education for professionals involved in building simulation and technology. The goal is to create healthier,
productive, energy efficient strategies that will lead to high performance buildings and sustainable environments. The Center engages in the creation (research), application (consulting) and dissemination (communication) of knowledge relating to architecture, engineering, construction, and related fields.

**Purdue University:** The NIST-funded Center for High Performance Buildings to design systems for future structures that are more environmentally and user friendly, energy efficient, and safe. The Center will provide research on topics ranging from offshore wind power and coral reef ecology to quantum physics and nanotechnology, the 12 projects will launch more than $250 million in new laboratory construction projects beginning early this year. CHPB will be housed in a new 68,000-square-foot facility upgrading Purdue's Ray W. Herrick Laboratories.

**Collegiate Consortium:** Facilities include germane buildings and laboratories at all Collegiate Consortium members, including those of Drexel University (including those listed above), Community College of Philadelphia, Delaware County Community College, Bucks County Community College, Camden County College, and Montgomery County Community College.

**IBM:** The Thomas J. Watson Research Center is headquartered in Yorktown Heights, NY 40 miles north of New York City, with additional facilities in Hawthorne, NY and Cambridge, MA. IBM research focuses primarily on IT hardware (ranging from exploratory work in the physical sciences to semiconductors and systems technology); software (including areas as diverse as security, programming, mathematics and speech technologies); and services, with a focus on applying them to transform businesses in a wide range of industries.

**University of Pittsburgh:** Facilities include the Energy Systems Laboratory, the Laboratory for NDE and SHM Studies (a 750 square feet facility), Mechanics of Active Materials Laboratory, Vibration and Control Laboratory, NanoSystems Measurement and Control Laboratory (600 square feet), Manufacturing Simulation Laboratory, Rapid Prototyping and Manufacturing Laboratory, Swanson Center for Micro and Nano Systems (including a Class 10,000 clean room), Swanson Center for Product Innovation, and campus-wide Computer and Information Systems.

**Penn State:** Facilities include Digitally Addressable Lighting Interface (DALI) Demonstration Laboratory, the Lighting Laboratory, AE Building Structures and Building Mechanical Systems Laboratory, Building Environment Simulation and Testing Facility, Building Envelope Research Laboratory, Floor Vibration Testing Laboratory, AE Computer Labs, Immersive Construction (ICon) Lab, AE Materials Laboratory, Aerosols Laboratory, and Bioaerosols Laboratory.

**United Technologies Research Center:** UTRC research facilities are located in East Hartford, Connecticut, with additional research and development centers in Shanghai, China, and Cork, Ireland.
Appendix 11: HUB Equipment

_Carnegie Mellon University:_ Computers are an integral part of educational activities in the School of Architecture. In addition to the world-class facilities maintained by the University (public computer clusters) and the College of Fine Arts (the high-end visualization lab), over fifty computers are spread throughout the studio spaces exclusively for SoArch student use. These machines are all supplied with state-of-the-art architectural software. The plot office is equipped with a high-speed plotter, color laserwriter, color tabloid inkjet, and a large-format scanner. The Digital Fabrication Lab is located in the basement of Margaret Morrison Hall. The range of equipment includes various digitally-driven additive and subtractive tools including 3D printing, laser cutting, 3-axis CNC milling, 6-axis robotic milling cell, and vacuum forming. A materials library, workshop space and CAD/CAM cluster are also part of the facility.

_Drexel University:_ Equipment at Drexel most germane for the proposed initiative includes: Hampden HVAC System Trainers: three trainers, namely, Model H-ACD-2 Recirculating Air Conditioning Trainer; Model H-CRT-2 Refrigeration Trainer; and Model H–RST-8 Heat Pump Trainer, are available for research and educational activities; and parallel and series fan powered VAV systems: two Trane fan powered VAV systems (one parallel and one series), together with necessary temperature, water flow rate, air flow rate, and control systems, are available for research and educational activities for this project.

_Lawrence Livermore National Laboratory:_ The National Ignition Facility features a 192-beam, stadium-size laser system will be used to compress fusion targets to conditions required for thermonuclear burn. Livermore Computing and Terascale Computing Facility provides terascale computers under NNSA’s Advanced Simulation and Computing (ASC) program. The Jupiter Laser Facility includes Janus, a two-beam neodymium-glass laser used for target physics and diagnostics; Titan, combining short-pulse petawatt-class and long-pulse kilojoule beams for high-energy-density physics experiments; Callisto, a testbed for high-energy petawatt science; Europe, a high-repetition-rate, ultrashort-pulse laser; and COMET, a unique table-top x-ray-laser.

_Morgan State University:_ MSU’s Engineering Visualization Laboratory, featuring interactive 3D simulation capability, will aid in the investigation of behavioral pattern analysis.

_University of Pennsylvania:_ The TC Chan Center for Building Simulation and Energy Studies has four years of data used to calibrate and verify one of the world’s most sophisticated models for building energy performance. This model is used to guide capital investment in the University’s portfolio of over 150 buildings and has generated millions of dollars in energy-related savings. The computational and modeling capacity of Chan would be fully deployed in the work of the GPIC.

_IBM:_ The Blue Gene Watson supercomputer is the 14th fastest supercomputer in the world, with a sustained performance capability of 91.29 teraflops per second on the linpack benchmark. BGW’s peak performance is approximately 114 teraflops per second. BGW consists of 20 racks of hardware conforming to the BG/L architecture. Each BGW rack consists of 1024 nodes, and each node contains two 700 MHz power 440 processors and 512 MB of memory. The 20 racks are arranged as five rows of four racks each. Blue Gene Watson’s primary mission is to perform production science computations that could not be successfully undertaken on less powerful computers. Except for periodic maintenance, it runs 24 hours a day, seven days a week, in production mode.
University of Pittsburgh: Equipment includes the Particle Image Velocimetry (PIV) System, which uses a 532 nm YAG laser (New Wave SoloIII-15Hz) diverged into a sheet and 2-two megapixel cameras (TSI Powerview Plus 2.0MP) to capture the flow field images. A synchronizer (TSI 610034) controls the timing of the PIV system. The computer dedicated to this system is a high end Dell Workstation (3 GB memory, 2 Dual-Core Intel Xeon 5140 2.33GHz processors). The infrared camera (FLIR Silver SC5200) system includes an Indium Antimonide (InSb) detector with a spectral range of 3-5 µm, a resolution of 320 x 256 pixels, and a maximum full frame capture rate of 170 Hz. Three laser displacement sensors (2-Keyence LK-G157 and 1-Keyence LK-G37) are available to measure both large and small displacements. A Zeiss Axiovert 200 microscope system includes an optical bench, lenses, mounts, rails, polarizers, filters, and waveplates, with fast steering mirrors (Newport FSM-300) and a Spatial light modulator (Holohye SLM LC-R 2500: a reflective LCOS microdisplay; 1024x768 pixel; 72 Hz frame rate; 2π phase shift). In addition, a combined materials analysis system consists of a Messphysik ME46-NG Video Extensometer, Kepco BHK1000-40MG 1000V power amplifier, Keithly 6514 Electrometer, Keison Carbolite Laboratory 300ºC Convection Oven, and Bemco Temperature/Humidity chamber.

Penn State University:

Architectural Engineering ASHRAE 52.2-Compliant Rig: Indoor Environment and Air Quality
An ASHRAE Standard 52.2 “Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size” compliant rig is housed in the IEC laboratory. The facility is a full scale, duct-based, rig testing system that allows testing of filtration, UV deactivation, or hybrid filter-UV devices in flow conditions characteristic of typical building air supply systems and at bioaerosol concentration ranges of concern in such systems. Additional sections beyond those specified in the 52.2 standard have been incorporated into the rig to allow the testing with UV-C lamps and bioaerosols. The flexible design of the facility will also allow for future research investigations of filtration and other air treatment methods for VOC contaminants.

Current use of the facility is focused on optimization of the performance of systems for capturing, destroying, or deactivating indoor bioaerosols, including the microbes that cause common infectious diseases, airborne allergens, and biological weapons. Technologies being considered include filtration and disinfection/deactivation methods utilizing germicidal ultraviolet radiation (UV-C).

The primary objectives of this research are:
1. Develop an industry acceptable method of testing filtration and UVGI devices for the removal and/or deactivation of bioaerosols;
2. Establish test standards - species and forms of bacteria, irradiance levels of UVGI field, %RH of carrier air, flow rate characteristics of carrier air, pressure drop through device, etc. - and protocols, e.g. aerosolization and capture techniques of bioaerosols before and after UVGI air treatment module, basis of reporting of module effectiveness, etc.
3. Delineate first order characteristics of UVGI air treatment devices; e.g. minimal average exposure dosages across air flow for measurable deactivation of standard bioaerosols species, expected clean air delivery ranges;
4. Outline main features of a training and certification program for air cleaner contractors and installation technicians.
Full scale testing in the controlled conditions offered by the rig using benchscale derived, fundamental bioaerosol properties will lead to methods that allow quantitative comparisons of alternative air treatment designs, implementation configurations, and operational parameters. Such testing also leads to practical, hands-on guidelines and certification procedures that can be applied in the building construction and operation industry. This facility is expected to enhance significantly the contributions to applied indoor air technology that the Penn State Indoor Environment Center can make to the building industry. With this facility it will be possible to evaluate the best approach to control of both viable and non-viable, bioaerosols in building air supply systems.
ASHRAE Standard 52.2-compliant rig downstream view

ASHRAE 52.2-Compliant Rig UVC Section

Demonstration of Parallel and Cross-flow Lamp Mounting Configurations Inside of UV Section
Architectural Engineering UVGI Lamp Depreciation Test Facilities: Indoor Air Quality

IEC Lamp depreciation test facilities support experimental investigation of the influence of various operating parameters (e.g., lamp switching and operating current) on the long term performance of UVC lamps. This experimental data is needed for the development of accurate predictive models and application guidance. Lamp depreciation test facilities are housed in a 2.13 × 3.35 m (7 × 11 ft) black room. Facilities were designed in a modular manner to allow testing of various lamp types with minimal electrical or software changes required. Lamps for the ASHRAE 52.2-compliant rig are also aged in this facility for maintaining a consistent basis when the UV section of the rig is in use. Web cameras are used to monitor the bulbs in the room.

National Instruments SCXI hardware coupled to a National Instruments PCI-6025E data acquisition board handles the data acquisition and control needs of the facility. National Instruments LabVIEW software is used to control all lamp switching and dimming operations in the room. Current lamp depreciation tests in the room follow three schedules: 7.2 times per day (180 minutes on followed by 20 minutes off), once per day (originally 12 hours on followed by 1 hour off), and always on.

A custom-built measurement box is used to measure individual lamp output in the lamp depreciation test facility. The box is 1.22 m (4 ft) deep by 0.61 m (2 ft) wide by 1.22 m (4 ft) high. Lamps are installed near the top of the black box. In the middle of the box, there is a baffle with a 5 cm (2 in.) by 1.22 m (4 ft) opening that serves to provide still air conditions during lamp measurements and to eliminate the possibility of extraneous UVC incidence on the IL 1700 sensor placed directly under this opening. The IL 1700 is coupled to a PC via a RS-232 serial interface, and a LabVIEW-based software interface is used to set-up and acquire data from the IL 1700 across the interface remotely. Dedicated air conditioning is used to maintain ambient conditions in the lamp room and measurement box.
Architectural Engineering Lamp Ambient Response Test Facility
Indoor Air Quality

A lamp ambient response testing facility was designed to determine effects of air temperature and air flow on the UVGI output of a given lamp fixture. The system design includes automated air velocity, temperature and lamp on/off control and the capability of handling multiple lamp systems simultaneously. Experimental work with the facility will result in a set of data consisting of UVGI irradiance levels at a fixed position relative to the lamp surface for a given air flow and air temperature surrounding the lamp.

To mirror the capabilities of the ASHRAE 52.2-compliant rig, ductwork for the lamp ambient response testing facility has a 0.61 x 0.61 m (2 ft x 2 ft) cross-section, and the facility was designed to produce flows of up to 85 m³/min (3000 ft³/min). Flow can be controlled from 0 to 4 m/s (0 to 760 fpm) to within 0.03 m/s (5 fpm) and from 4 to 49+ °C (40 to 120+ ºF) to within 0.5 °C (1 ºF). The facility is designed to test a single lamp at a time in either a parallel flow or cross flow lamp mounting configurations.

Ductwork can be easily reconfigured as needed to test most any UV bulb type. The major duct sections of the facility are the: (1) uv section, (2) cooling coil section, (3) fan section, (4) heater section, (5) flow straightener section, and (6) flow station section. The four ninety degree bends used to create a ductwork loop are fitted with turning vanes. The entire duct loop is on a rollaround stand that can be disconnected in between the ninety degree bends at each end of the loop to facilitate movement of the facility.

A National Instruments PCI 6259 data acquisition board coupled to an EasyDAQ E68MX enclosure is used for data acquisition and control tasks managed by the LabVIEW software interface developed for the test facility. UVC lamp output is measured with a research grade radiometer (International Light Technologies, IL 1700 fitted with a silicon photodiode detector and N254 narrow band filter accurate to 5.5% of reading. With a diffuser added to the detector, it can measure flat surface irradiance with a cosine response characteristic. Lamp cold spot location and magnitude are identified by analysis of thermographic images produced by an infrared (IR) camera (FLIR Systems InfraCAM) with an accuracy of ±2°C (3.6 °F).

Lamp ambient response test facility in operation.
Lamp ambient response test facility software.

Infrared image of lamp cold spot while under test in lamp ambient response test facility.
Architectural Engineering Indoor Aerosol Laboratory: Indoor Air Quality

Research issues investigated in the lab are centered on:

1. The aeros the aero-biological pathways of bio-contaminant aerosols – aero-allergens, vegetative and spore forms of bacteria and fungi, viruses, endotoxins and mycotoxins;

2. techniques for the capture and de-activation of these potentially harmful aerosols by UV, UV+ oxidant, filter, UV + filter, UV + Filter + oxidant technologies;

3. quantitative characterization of surface – to – air aerosolization rates and steady state aerosol partitioning between airborne and surface settled states as characterized by the so-called re-suspension factor;

4. estimating occupant exposure dosages due to re-suspension phenomena.

The indoor aerosol laboratory is concerned with the inhalation exposure, aero-biological pathways of common indoor bio-contaminants that lead to respiratory distress diseases – such as protein allergens from insects, pests, and pets – which are present on carrier particles. Re-suspension phenomena of more immediately pathogenic, bio-aerosol forms, such as bacterial and fungal spores, protein poisons such as ricin delivered in carrier particles, and mycotoxins which are also carrier particle mediated are investigated in the lab. The underlying surface chemistry, morphology, size effects and electrostatic susceptibilities that lead to surface-to-air aerosolization, re-suspension, of these very different bioaerosol contaminants lead to different effects on re-suspension for similar reservoir disturbances. A unique, controlled disturbance, re-suspension chamber is used to quantify the re-suspension characteristics of bio-contaminant particles as a function of surface vibration, aerodynamic swirl, and transient electrostatic field disturbances. Optical particle sizing, aerodynamic diameter-based impactor particle sizing, and enzyme-linked immuno-assay (ELISA) techniques are used to characterize the bio-contaminant carrier particle sizes and contaminant concentrations (allergens, protein poisons, mycotoxins).

Deactivation properties of the varying bioaerosol types are also investigated and found to vary significantly with the specifics of the chemical functionality determining the occupant health effect. A calibrated UV reactor is utilized to determine the UV deactivation susceptibility of bio-contaminants to known irradiance levels of UV light (254 nm, 310nm, 365nm). Varying oxidation field strengths can also be established.
Aerosol Lab Particle Dispersion Equipment and Temperature/Humidity Test Chamber

Indoor Aerosol Resuspension Apparatus
Aerosol Lab Indoor Dust Production Equipment

Architectural Engineering Indoor Environment Research Instrumentation

<table>
<thead>
<tr>
<th>Image</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td><img src="Image" alt="Aerosol Tower" /></td>
<td>Aerosols Tower Capable of producing highly concentrated salt aerosol from 0.1 to 10 micrometers in diameter, the Large-particle Aerosol Generator meets the requirements of the ASHRAE 52.2 test standard. Test aerosol is produced using potassium chloride (KCl).</td>
</tr>
<tr>
<td><img src="Image" alt="Alnor Balometer" /></td>
<td>The Alnor Balometer features a digital manometer that can be used with a variety of common test and balance tools, such as pitot, air foil, temperature, relative humidity probes or a 16-point velocity matrix.</td>
</tr>
<tr>
<td><strong>Anderson Cascade Impactor (Viable)</strong></td>
<td>Anderson Cascade Impactor (Viable) is designed to impinge air onto a metal collection plate at increasing velocities as the air travels through the impactor. In the initial stage of the impactor, where the velocity is the lowest, only larger particles with more thermal momentum impact on the collection plates. As the velocity of the air impinging on the surface increases smaller and smaller particles are collected. The plates can then be weighed for mass of impacted particle or sent for HPL analysis.</td>
</tr>
<tr>
<td><strong>Anderson Cyclone sampler</strong></td>
<td>Anderson Cyclone sampler which easily attaches to EPA Method 5 or other stack samplers for measuring the complete size distribution of particulate emissions.</td>
</tr>
<tr>
<td><strong>BIOS Defender Flow Calibrator</strong></td>
<td>BIOS Defender Flow Calibrator meets the highest quality assurance standards for gas flow measurement uncertainty, including industry leading ISO 17025, ANSI Z-540 and NIST 150 laboratory accreditation by the National Voluntary Laboratory Accreditation Program (NVLAP) administered by the National Institute of Standards and Technology (NIST).</td>
</tr>
<tr>
<td><strong>Biosafety Hoods (photo of one)</strong></td>
<td>Biosafety Hoods (photo of one)</td>
</tr>
<tr>
<td><strong>Climet OPC</strong></td>
<td>Climet OPC is a 0.25 CFM aerosol particle counter used to detect particles between 0.3 and 10 µm across 16 stages.</td>
</tr>
<tr>
<td>Image</td>
<td>Text</td>
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</tr>
<tr>
<td><img src="image1.png" alt="Collison Nebulizer" /></td>
<td>Collison Nebulizer used for the efficient aerosolization of liquids.</td>
</tr>
<tr>
<td><img src="image2.png" alt="Compact DAQ" /></td>
<td>Compact DAQ data acquisition Equipment provides the plug-and-play simplicity of USB to sensor and electrical measurements on the benchtop, in the field, and on the production line. By combining the ease of use and low cost of a data logger with the performance and flexibility of modular instrumentation, NI CompactDAQ delivers fast and accurate measurements in a small, and easy to use system.</td>
</tr>
<tr>
<td><img src="image3.png" alt="Compact FieldPoint" /></td>
<td>Compact FieldPoint Programmable Automation Controller Hardware offers the flexibility and ease of use of a PC and the reliability of a programmable logic controller (PLC). With Compact FieldPoint, you can embed all of the intelligence, advanced control, and analysis capabilities of NI LabVIEW software in a small modular package suitable for industrial environments.</td>
</tr>
<tr>
<td><img src="image4.png" alt="Davis Instruments" /></td>
<td>Davis Instruments Weather Station for monitoring barometric pressure, temperature, humidity, rainfall, wind speed and direction and solar radiation.</td>
</tr>
<tr>
<td><img src="image5.png" alt="IEC aerosol diluters" /></td>
<td>IEC aerosol diluters will work with any 1 cfm particle counter by placing it inline between the particle counter and the aerosol being sampled. Single stage or multiple staged diluters with varying critical orifices can be configured for dilutions from 1:1 to beyond 1,000,000:1 and will work with any type of aerosol challenge (PSL, PAO, DOP, NaCl).</td>
</tr>
<tr>
<td><img src="image6.png" alt="Easy DAQ" /></td>
<td>Easy DAQ data acquisition Hardware is a National Instruments-compatible test and Instrumentation add-on product for the NI E and M Series family of Multifunction DAQ (68 pin) cards. Connects directly to cards via a standard 68 pin I/O connector.</td>
</tr>
<tr>
<td><strong>FLIR camera</strong></td>
<td>Infrared thermal imaging camera designed especially for the build services industry. The BCAM has built in functions that allow the identification of areas with defective thermal insulation and potential condensation.</td>
</tr>
<tr>
<td><strong>Foot Operated Burner for Biosafety cabinets</strong></td>
<td>ensures highest application safety by elimination the risk of gas explosions and fires. Gas ignition is both rapid and safe it requires no lighter or matches. The triple safety system provides continuous flame monitoring with automatic reigniting, over temperature protection and maximal burning time.</td>
</tr>
<tr>
<td><strong>High Volume Small Surface Sampler</strong></td>
<td>The High Volume Small Surface Sampler is designed to test carpeted and hard floors for contaminants. It conforms to ASTM D5438-005. It is available with a wide variety of accessories to expand its capabilities.</td>
</tr>
<tr>
<td><strong>IL 1700 research radiometer</strong></td>
<td>designed specifically to measure photo detector currents, the IL1700 maintains unmatched linearity over 10 billion to 1 dynamic range.</td>
</tr>
<tr>
<td><strong>Impingers</strong></td>
<td>are glass bubble tubes designed for the collection of airborne hazards into a liquid medium. When using a personal air sampler, a known volume of air bubbles is pumped through the glass tube that contains a liquid specified in the method.</td>
</tr>
<tr>
<td>Image</td>
<td>Text</td>
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<tr>
<td><img src="image1.jpg" alt="Fisher Scientific Incubator" /></td>
<td>Fisher Scientific Incubator designed for critical use in research labs. A precision piece of laboratory gear, it can hold temperature to within 1/10 of a degree Celsius. Drift of temperature beyond 3 degrees will shut the unit down.</td>
</tr>
<tr>
<td><img src="image2.jpg" alt="Lasair II" /></td>
<td>Lasair II is a portable aerosol counter that can be used for cleanroom monitoring, facility certification, troubleshooting, trending analysis or statistical process control.</td>
</tr>
<tr>
<td><img src="image3.jpg" alt="Li-Cor CO2 Analyzers" /></td>
<td>Li-Cor CO2 Analyzers for continuous monitoring of CO₂ and H₂O over a wide range of environmental conditions, the LI-840 is an absolute, non-dispersive, infrared (NDIR) gas analyzer based on a single, interchangeable optical path, and a dual wavelength infrared detection system.</td>
</tr>
<tr>
<td><img src="image4.jpg" alt="Luzchem Reactor" /></td>
<td>Luzchem Reactor equipped with a low mercury lamps USHIO G7T5. Lab View code is used to generate digital outputs from DAQ model PCI 6025 to solid state relays to control on/off mode of a UVC lamp. Analog output was supplied to LUXMATE Control Module as variable voltage (1-10 V) for fluence rate control</td>
</tr>
<tr>
<td><img src="image5.jpg" alt="Magnetic stirrer/hot plate" /></td>
<td>Magnetic stirrer/hot plate features an exceptionally durable, chemical resistant white ceramic coated steel work surface. Advanced microprocessor controls with convenient turn knobs allow quick, precise adjustment and maintenance of speed.</td>
</tr>
<tr>
<td><img src="image6.jpg" alt="Minneapolis Duct Blaster" /></td>
<td>Minneapolis Duct Blaster is calibrated duct leakage system used to precisely measure the air leakage rate of forced air systems.</td>
</tr>
<tr>
<td><strong>Omega Anemometers</strong> is an economical air velocity meter solution for any air flow measurement application, such as, air conveyors, flow hoods, balancing, fans/motors/blowers, furnace velocities, refrigeration cases, paint spray booths and environmental testing.</td>
<td>Omega wireless receiver is a 418 MHz radio receiver designed to receive and decode packet data from all OMWT Series wireless transmitters. The OMWT-REC232 decodes the CRC-16 encoded packets and translates them to ASCII strings that are sent out the RS-232 serial port to the PC at 19200 Baud. No hardware handshaking or command protocol is required; all data packets are decoded and transmitted serially as they are received.</td>
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<tr>
<td>Omega wireless temperature and humidity probes provides Web-based monitoring of Temperature, Humidity, and Barometric Pressure in critical HVAC and Refrigeration applications. The compact wireless “End Devices” mount discretely on the wall in clean rooms, laboratories, museums, computer server rooms, warehouses, and any remote facility.</td>
<td>Omega wireless temperature transmitter is a battery operated digital temperature sensor with a microprocessor controlled 418 MHz FCC certified radio transmitter. Accuracy: ±0.5°C (±0.9°F) -10 to 85°C, (-18 to 185°F) Operating Temperature: -40 to 85°C (-40 to 185°F)</td>
</tr>
<tr>
<td>Omega wireless voltage, current transmitters have a battery operated 12-bit analog-to-digital converter with a microprocessor controlled 418 MHz, FCC certified radio transmitter. They have an on board time of day clock that allows them to spend most of the time in a low power quiescent state. At predetermined time intervals the clock will wake up the onboard microprocessor.</td>
<td>Phase Contrast Microscope The high-quality phase contrast unit consists of centerable five-position condenser; brightfield, phase 10x, 20x, 40x, and 100x oil objectives; and four basic planachromatic 10x, 20x, 40x, and 100x phase objectives.</td>
</tr>
</tbody>
</table>

4-408
Respirable CO2 and O2 pumps and analyzers Model CD-3A Carbon Dioxide Analyzer provides a continuous and accurate measurement of gases containing up to 15% CO2. It has the rapid response necessary for breath-by-breath analysis during respiration. It is also ideal for laboratory applications requiring high accuracy and sensitivity.

The Model S-3A Oxygen Analyzer continuously measures the concentration of oxygen in gases which are clean, dry, and free of combustibles. Single- or dual-channel available. High accuracy at all oxygen concentrations - from inert or reducing gases to pure oxygen. Rapid response, ideal for accurate breath-by-breath curves. High sensitivity plus exceptional stability, capable of detecting changes of 0.001% oxygen at air composition. Solid ceramic oxide sensing element for long term maintenance-free operation.

SC-2345 data acquisition equipment with configurable connectors accepts custom I/O connector panelettes for direct signal/sensor connectivity (I/O connector panelettes are sold separately)

SCXI data acquisition equipment is a rugged, low-noise chassis that can hold up to four SCXI modules. This chassis powers SCXI modules as well as handles all timing, trigger, and signal routing between your digitizer and SCXI modules.

Shortridge equipment FlowHood gives fast, accurate, direct digital readout of density-corrected airflow measurements. It reads 20 to 2500 cfm, supply or exhaust, and is available in either cfm or liters per sec.
<table>
<thead>
<tr>
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<th>Text</th>
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<tbody>
<tr>
<td><img src="image1.jpg" alt="Image" /></td>
<td>SKC Soap Film Calibrator meets the highest quality assurance standards for gas flow measurement uncertainty. With an accuracy of ± 2% and a range of 0.100-25 l/min the SKC calibrator provides a wide range of uses.</td>
</tr>
<tr>
<td><img src="image2.jpg" alt="Image" /></td>
<td>Small scale particle disperser for very small quantities of powder by lifting particles from a turntable using a venturi aspirator. The turntable rotates at variable speeds, controlling aerosol concentrations from 0.3 to 4.0 milligrams per cubic meter (up to 40 milligrams per cubic meter with optional high-speed motor). Shear forces created in the SSPD are sufficient to deagglomerate most dry particles in the size range from 0.5 to 50.</td>
</tr>
<tr>
<td><img src="image3.jpg" alt="Image" /></td>
<td>Thermotron hermetically sealed compressors provide moderate temperature change rates while allowing the chamber to consume less power than comparable chambers. Temperature/Humidity models are equipped with a reliable, accurate and efficient full range humidity system capable of simulating conditions from 10 to 98% RH.</td>
</tr>
<tr>
<td><img src="image4.jpg" alt="Image" /></td>
<td>TSI anemometer w/ pitot probes digital anemometer is a versatile instrument for measuring air velocity and calculated air volume flow. Special features include the ability to switch between Cubic Feet per Minute (CFM) and Meters per Second (MPS). The HHF751 can indicate average, minimum and maximum readings, and includes a hold button so that the display can be frozen while recording the reading.</td>
</tr>
<tr>
<td><img src="image5.jpg" alt="Image" /></td>
<td>TSI Filtered Air Supply is a vital accessory for most aerosol generators. It removes oil or other liquid droplets from the incoming air using two prefilters. It also removes any remaining moisture in the air stream by passing the air through an advanced membrane.</td>
</tr>
</tbody>
</table>
Architectural Engineering The Building Environment Simulation and Testing (BEST) Facility
BEST facility is designed for full-scale building air quality, thermal comfort and energy consumption studies. Sophisticated controls and acquisition systems enable the facility to run in a wide range of environmental conditions. The facility is used for both teaching and research activities.

Architectural Engineering Building Enclosure Test Laboratory (BeTL)
BeTL is a facility designed to conduct performance tests on building enclosure systems and their component parts. Test specimens can include: complete wall or roof assemblies or sub-assemblies, windows, and joints.

Architectural Engineering Building Envelope Research Laboratory (BERL)
The BERL Lab features unique, state of the art, full-scale test facilities to advance research on earthquakes, wind/pressure loading, windborne debris impact, and weathering of building envelope systems.

Architectural Engineering CAD/Computer Labs
The AE Department computer labs are equipped with the latest AE software, giving our students valuable hands-on experience.

Architectural Engineering Digital Addressable Lighting Interface (DALI) Lighting Laboratory
The digital addressable lighting interface (DALI) instructional laboratory in the United States.

TSI Velocicalc Anemometer - multi-function ventilation meter simultaneously measures air velocity, flow, humidity, temperature and pressure. The new 35mm Rotating Vane probe (shown) is ideal for confined spaces. Optional probes measure CO\textsubscript{2}, CO and percent outside air.

Vacuum Pumps we have a wide range of vacuum pumps at our disposal ranging from 20” of mercury to full vacuum.
Architectural Engineering Floor Vibration Research Laboratory
Research in this lab focuses on the serviceability of building floor systems (floor vibrations). The two main areas of research are: repairing light-weight floor systems prone to excessive vibration and exploring better ways to predict the expected vibration behavior before construction.

Architectural Engineering Immersive Construction Lab (ICon Lab)
The ICon Lab a joint project of the Architectural Engineering Department, Penn State's Information Technology Services (ITS), and the School of Architecture and Landscape Architecture (SALA). The purpose of the lab is to facilitate the effective use of virtual reality (VR) techniques in design, construction and other disciplines.

Architectural Engineering Structural Model Instructional Laboratory
This lab includes a number of computer-assisted structural model testing apparatuses that are used for instructor-led demonstrations and student-conducted exercises related to structural engineering concepts and structural component/system behaviors.

Materials Research Institute W.M. Keck Smart Materials Integration Laboratory
The W. M. Keck Smart Materials Integration Laboratory is designed to allow Penn State University scientists to create a new generation of smart integrated components that combine electrical, mechanical and optical functions. "Smart" materials sense a change in the environment and respond to that change in a useful way. The laboratory will enable the integration and miniaturization of "smart" materials and the fabrication of components that go beyond conventional semiconductor-based materials. This is done by utilizing both semiconductor and low temperature co-fire ceramic technologies.

The laboratory includes a class 100 cleanroom, photolithography and patterning capabilities, a 3 target magnetron sputtering tool, a complete suite of tools for low temperature co-fire ceramic technology, a micropen for direct writing of complex circuitry, a nonlinear near field scanning optical microscope, a probe station, and some electrical characterization equipment.

The laboratory was primarily supported by a generous grant from the W. M. Keck Foundation, along with a major equipment donation from Motorola, Inc., and support from Penn State University.

Materials Research Institute The Materials Characterization Lab (MCL)
The Materials Characterization Lab (MCL) is a fully staffed analytical laboratory at Penn State's Materials Research Institute that offers researchers convenient and affordable access to a wide range of state-of-the-art analytical instrumentation. More than twenty technical staff members in three locations on campus provide hands-on training for users, assist with sample analysis, and interact with the materials community at Penn State, at other universities, and from industry.
Materials Simulation Center

The Materials Simulation Center is a facility for education and research on materials simulation. It is designed to function as a hub to connect experimental and simulation activities through the organization of collaborative projects, short courses and workshops. For the experimentalist, the Center will provide the information needed to add a simulation component to their work. For groups already working on materials simulation, the Center will be a natural environment for interaction and extension of existing simulation techniques.

Nanofabrication Center

The Penn State Nanofab provides users with 24/7 open-access to facilities that enable fabrication of a wide range of devices and characterization to support fundamental and applied research in diverse fields spanning electronics to medicine.

Academic and industry users can perform research on-site using facility equipment, training, and staff support. The technical staff can also provide “remote services” in which they do your research for you.

As a member of the National Nanotechnology Infrastructure Network (NNIN), Penn State provides technical expertise in materials and chemical technologies at the molecular scale with unique strengths that include surface chemistry, self-assembly, and the fabrication and processing of complex oxide materials. NNIN, supported by the National Science Foundation, offers a geographically dispersed network of user facilities to enable rapid advancements in science, engineering, and technology at the nanoscale. The Network provides access to technological expertise and nanotechnology instrumentation that would otherwise be out of reach for many researchers in industry and academia.

Purdue University:

The Ray W. Herrick High Performance Building Laboratories at Purdue University: The Ray W. Herrick Laboratories have a long history of performing research on many topics related to buildings, including high performance equipment, intelligent controls and diagnostics, indoor environments, and high performance building envelopes. Of particular interest is the development, validation, and application of models useful for design, analysis and optimization, including modeling of components (compressors, flow control devices, heat exchangers, building envelopes), subsystems (packaged AC and heat pumps, chillers, air handling equipment, integrated envelop subsystems), indoor environments, and whole-building systems. The laboratories contain a variety of test facilities, including psychrometric chambers for testing HVAC&R equipment, a reconfigurable indoor air quality facility for evaluating air distribution systems and indoor climates, a specialized wind-tunnel for testing heat exchanges, compressor calorimeters and load stands, specialized acoustic facilities (anechoic, semi-anechoic and
reverberation chambers), and a quiet room for sound evaluation. The laboratories host three parallel conferences that attract building and equipment researchers from all over the world: International Compressor Engineering Conference, International Refrigeration and Air Conditioning Conference, and International High Performance Buildings Conference. These conferences are a unique forum for academia and industry to interact and are considered to be some of the best in the field.

The new Architectural Engineering Laboratories at Purdue consist of five different building structures: four full-scale office spaces (20 ft. x 20 ft. x 12 ft. high) placed side-by-side and a similar size two-story building (24 ft. high). All the facilities are fully reconfigurable (floor, walls, windows, roof, ceiling) so that different products, technologies and developed controls could be tested and then detached. Two of the single story buildings are used for research in commercial (office) buildings and the other two for residential construction. The office spaces have a front curtain wall façade consisting of several movable parts with different glazing materials, shading attachments, openings for natural ventilation and photovoltaic panels, and the walls are made of metal insulated panels. The buildings, which are equipped with extensive systems and testing equipment, will be used to study and evaluate a range of building systems and equipment technologies.
Rutgers University: Materials Science and Engineering is in the process of designing a research test-bed for the roof of the MSE building that would allow the measurement of energy capture for tracking arrays in balance with the energy used to run the tracking mechanisms. MSE includes a solar simulator and electrical test equipment for solar efficiency and performance testing; major electron microscopy and analytical equipment user facility; a roof-mounted solar test facility (in progress) for monitoring energy consumption/generation by solar tracking panels.; a 1.4 Megawatt fixed-tilt, land mounted solar array providing electricity to the Rutgers campus grid; and a CHP Cogeneration facility. Investigators have access to a broad range of computing resources within CCR and the School of Engineering, including 60 Sun Microsystems UltraSparc 10 computers, Two Sun E450 enterprise servers (4 CPUs each), Network Appliance - NetApp F740, 16 unit Dell Power Edge 6350 running Linux; and more.
APPENDIX 12: Statement of Conflict of Interest

May 5, 2010

Affirmation to U.S. Department of Energy

Subject: Organizational & Individual Conflict of Interest (OCI) Certification,

Re: FY2010 Energy Efficient Building Systems Regional Innovation Cluster Initiative

The Pennsylvania State University hereby affirms to the best of their knowledge the following:

(i) The Pennsylvania State University, nor any individuals within this proposal, are not providing any Scientific, Engineering, and Technical Assistance (SETA) or similar support to any DOE technical office(s) through an active contract or subcontract that would result in a conflict of interest with this proposed project.

(ii) No organizational or individual conflicts of interest have been identified by the proposed DOE HUB members within our application.

If for any reason before the Government awards a contract to The Pennsylvania State University and we discover an OCI as defined above, PSU (or the individual members) agrees to promptly notify U.S. DOE.

_______________________________________
David W. Richardson
Associate Vice President for Research
Director of Sponsored Programs
Appendix 13
DOE HUB Organizational Letters of Commitment

1. The Pennsylvania State University (Lead)
2. Bayer MaterialScience
3. Ben Franklin Technology Partners of SE PA
5. Collegiate Consortium
6. Drexel University
7. DVIRC
8. IBM Corporation
9. Lawrence Livermore National Laboratory
10. Morgan State University
11. New Jersey Institute of Technology
12. PIDC/PAID
13. PPG Industries
14. Princeton University
15. Purdue University
16. Rutgers University
17. Turner Construction
18. United Technologies Research Center
19. University of Pennsylvania/ Wharton SBDC
20. University of Pittsburgh
21. Virginia Tech
May 3, 2010

The Honorable Steven Chu
Secretary
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585

Dear Dr. Chu:

This letter is to express the very strong commitment of The Pennsylvania State University to lead the proposed Greater Philadelphia Innovation Cluster for Energy Efficient Buildings to be headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

Penn State is uniquely qualified to lead this endeavor. We are extremely pleased that Penn State was named the number one university worldwide in multidisciplinary alternative energy research according to the 2009 Elsevier Alternative Energy Research Leadership Study.

The goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings are to improve energy efficiency and operability and reduce carbon emissions of existing and new buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region, and beyond. We have assembled an extremely dynamic and diversified team of globally prominent government, industry, and educational partners with leadership from Penn State that is working together to achieve these goals.

The Navy Yard is an ideal location for this activity. Closed by the federal government in 1996, the 1,200 acre site represents one of the nation’s largest and most dynamic urban redevelopment opportunities. A key aim of the redevelopment effort is to make the Navy Yard and the region a national headquarters for clean energy research, education, and commercialization. Penn State is a major partner in this activity. In just the past year, Penn State has received three major DOE awards for Centers located at the Navy Yard. These are the DOE Mid-Atlantic Clean Energy Applications Center, the DOE Northern Mid-Atlantic Solar Training Center, and the Grid Smart Training Applications Resource (GridSTAR) Center.

We are honored to lead the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings, and we are fully committed as an institution to the success of this effort. As indicated in the proposal, more than $3 million of University funds will be contributed, and our Vice President for Research, Dr. Henry C. Foley will serve as Director. We hope that the Department of Energy and the other participating federal agencies will agree to support the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings. Thank you very much.

Sincerely,

Graham B. Spanier
Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

April 23, 2010

Regarding: Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings

Dear Dr. Foley:

As we have previously discussed, Bayer MaterialScience LLC, headquartered in Pittsburgh, PA, is prepared to support the proposed DOE Hub component of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings.

As an inventor company with sales of over $1.5 billion to the global construction market, Bayer MaterialScience has developed both enabling technologies and advanced materials which can improve the energy efficiency of buildings on either a new construction or retrofit basis. Our technologies cover a wide spectrum of building requirements including insulation solutions, daylighting solutions, artificial illumination solutions, and raw materials for advanced coatings that can improve the indoor environment of buildings.

We are convinced that these technologies and materials can make an important contribution to improving the energy efficiency of both new construction and retrofit building projects in the United States. In addition, by combining our global technology and best practices platforms with our local manufacturing capabilities, we are well-positioned to accelerate the implementation of these solutions to meet US construction industry needs.

We understand that a contract governing Bayer MaterialScience’s membership in the DOE Hub component of the Greater Philadelphia Regional Innovation Cluster would entail a commitment from our organization to locate personnel at the Hub headquarters at the Navy Yard. We share the view that this approach can accelerate the adoption of new technologies by ensuring alignment among all construction stakeholders (materials producers, system integrators, contractors, architects, etc).

While the budgeting process is still preliminary and subject to the negotiation and execution of a binding agreement, we are prepared to make significant in-kind contributions of approximately $3 million (to supplement the anticipated Hub funding) over the life of the DOE Hub to support the technical, education and workforce development projects which we have submitted.

We appreciate the opportunity to participate in this important initiative.

Sincerely,

Robert J. Kumpf  
Chief Administrative Officer
April 30, 2010

Dr. Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley:

Ben Franklin Technology Partners Southeastern Pennsylvania (BFTP/SEP) is delighted to provide this letter of support for the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings program to be headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings are to develop, demonstrate, and commercialize innovative, integrated devices, software and systems that deliver energy efficiency and operability, reduce carbon emissions, and stimulate private investment and quality job creation in energy efficiency building retrofit markets in the Greater Philadelphia region, the Mid Atlantic region, and beyond. This is consistent with the mission of BFTP/SEP which, for 27 years, has been the region's catalyst for stimulating entrepreneurial potential.

BFTP/SEP is chartered by the Commonwealth of Pennsylvania to develop and implement strategies that grow our economy through partnerships that accelerate technology development and commercialization, enterprise formation and growth, and the formation of sustainable networks. Since 1982 BFTP/SEP has provided over $130 million to grow more than 1,600 regional enterprises.

The Ben Franklin Technology Partners Network is recognized nationally and internationally and elements of its programs have been replicated nationally and internationally. One of the most highly regarded and longest running programs in the country, over the period 2002-2006 the Ben Franklin Technology Partners Network has generated more than $517 million in additional state tax revenues, and an additional 10,165 job-years to the Commonwealth. We have provided entrepreneurs and enterprises the capital, knowledge and networks to compete in the global marketplace.

BFTP/SEP is charged with developing and implementing Pennsylvania’s $10 million Alternative Energy Development Program in the Greater Philadelphia region (statewide program - $40 million). A keystone of our strategy focuses on the singular communication and cyber security. Our corporate offices are located at the Navy Yard in a restored, historic structure near the proposed Cluster for Energy Efficient Buildings Hub headquarters. BFTP/SEP will deploy personnel to work closely with Hub member personnel to achieve program objectives.
We look forward to contributing to the Regional Innovation Cluster, participating in concurrent technology and policy research, development, demonstration, and deployment, and playing a key role in other agreed upon activities that are essential to the success of the project.

Sincerely,

RoseAnn B. Rosenthal
President and CEO
19 April 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Re: Letter of Commitment for Greater Philadelphia Regional Innovation Cluster

Dear Dr. Foley:

We are delighted to provide this letter of commitment to participate as a member of the Energy Innovation Hub component proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

We anticipate making significant contributions as team members of Task 1: Tools for Integrated Design, Verification, and Modeling and Task 2: Advanced Components, Sub-Systems, Controls and Diagnostics.

We commit to locating one FTE research scientist at the Hub headquarters at the Navy Yard. In addition to locating personnel at the Navy Yard in Philadelphia, we commit eight PhD candidates in Center for Building Performance & Diagnostics to the tasks of which we are a part. The cost share for each PhD candidate is approximately $25,000 per year, or a total of $1,061,822 for the five year duration of the contract. In addition, the Head of the School of Architecture, Stephen R. Lee, will cost-share a portion of his salary and benefits over the 5 years ($313,492) for a total cost-sharing commitment of $1,375,314 (20%) from Carnegie Mellon University.

Please advise if you have need of further information.

Yours truly,

Richard D McCullough
Vice President For Research
Dear Dr. Foley,

The Collegiate Consortium for Workforce and Economic Development is pleased to provide this commitment statement on behalf of our participating colleges, university, faculty/ and staff as a member of the Energy Innovation Hub component proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The personnel listed below are committed to perform the work described in the GPIC proposal at the level and effort indicated. Our organization fully supports these commitments. We understand that membership in the DOE Hub component of the Greater Philadelphia Innovation Cluster entails a commitment by personnel from our organization to perform work at the Hub headquarters at the Navy Yard in Philadelphia and to provide outreach into our Regional community to insure inclusion in this important economic engine from our traditionally underserved communities. We intend to help develop the Hub at the Navy Yard as a locus for robust ongoing exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings.

In order to support this initiative the Collegiate Consortium will be employing a full time Program Director who will commit 100% if their time to this project for the full duration of the five year period. We will utilized education and training coordinators from 25% to 33% to coordinate the delivery of education and training to community college faculty, incumbent workers, trade members, and for participants from our One-Stop system in the Region.

I hereby commit the resources, network and personnel to fully support this initiative as the representative of our member colleges, faculty and staff of the Collegiate Consortium that includes Community College of Philadelphia, Montgomery County Community College, Delaware County Community College, and Bucks County Community College in Pennsylvania and Camden County College in New Jersey.

Regards,

Joseph P. Welsh, Esq.
CEO
Collegiate Consortium
May 4, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Re: Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings
DOE Hub Member Letter of Commitment

Dear Dr. Foley:

We are pleased to provide this letter of commitment to participate as a member of the Energy Innovation Hub component proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

Drexel University recognizes the significance of the proposed research, which is to improve energy efficiency and operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid-Atlantic region, and beyond. We are delighted to be included as a member in this activity. Drexel University strives for excellence to improve building energy efficiency and sustainability. Besides high quality building energy management and control systems (for most of our buildings), we have also implemented many unique green building technologies such as Ice Storage, Solar Panels, Restricted Flow Showerheads, Bio-wall, Green roof, and Heat Recovery Systems. Most recently, Drexel University became the first U.S. Institution to adopt Viridity Smart Grid Technology.

We understand that membership in the DOE Hub component of the Greater Philadelphia Regional Innovation Cluster entails a commitment from our organization to locate personnel at the Hub headquarters at the Navy Yard. In addition to locating personnel at the Navy Yard in Philadelphia, we intend to help develop the Hub at the Navy Yard as a locus for robust ongoing exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings.

We look forward to helping to provide leadership to the activities of Regional Innovation Cluster, and to directly participating in concurrent technology and policy research, development, demonstration, and deployment, education and workforce development, and other activities.

Sincerely,

Mark L. Greenberg
April 29, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley:

I am delighted to provide this letter of commitment to participate as a partner in the proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings are to improve energy efficiency, operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region, and beyond.

The Delaware Valley Industrial Resource Center (DVIRC) is an economic development organization dedicated to providing help and support to small to mid-sized manufacturers in the Greater Philadelphia region. Towards that end, DVIRC recognizes the importance E-RIC will have on our region and our clients. DVIRC is committed to developing and expanding innovative energy efficient building systems technologies. We are committed to investing our time and personnel to this project. We look forward to working within the Consortium and collaborating with other E-RIC Partners. We understand that the GPIC will provide ongoing opportunities for organizations like ours to propose and participate in co-funded projects to advance the stated goals, and we look forward to contributing to the Cluster through such co-funded projects.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous.

We are extremely pleased to be a partner in this undertaking.

Bernadine Hawes  
DVIRC Board Chair
April 30, 2010

The Pennsylvania State University
304 Old Main
University Park, PA 16802-1504

Attention: Paul Hallacher, Director, Res Pgm Dev, Office of the Sr VP for Research

Subject: IBM Proposal in response to DOE FOA ERIC2010

In response to the subject FOA, IBM T. J. Watson Research Center is pleased to enclose its Cost Proposal and Representation of Limited Rights Data.

In the event that our proposal is successful, we commit to perform and support the program in accordance with our Cost Proposal and mutually agreed upon terms and conditions.

IBM has invested substantial amounts of its own private funds in the development of certain technologies embodied by the proposed program, and IBM has an established, commercial, non-governmental trade reputation in these fields of technology. Therefore, any technical data/computer software delivered to the Government under the proposed program in the following areas of technology shall be delivered to the Government with Limited/Restricted Rights respectively as those terms are defined in the Federal Acquisition Regulations. Details of which are provided in the Representation of Limited Rights Data document accompanying this letter.

Pursuant to FOA Section IV.E.j, the individual at IBM responsible for complying with national policies prohibiting discrimination is Tanya Delany, Human Resources, Global Selection and Assessment, EO and Compliance, 972-561-6785 or tdelany@us.ibm.com.

In the event that you have any technical questions regarding our proposal, please contact Dr. Jane Snowdon at (914) 945-2422 or snowdonj@us.ibm.com. Any other questions should be directed to Carl E. “Ed” Taylor at (713) 797-4625 or cetaylor@us.ibm.com.

Thank you for the opportunity to participate in this important program.

Very truly yours,

Carl E. Taylor
Senior Governments Contracts & Negotiations Manager
Business & Government Relations
Dr. Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

SUBJECT: Lawrence Livermore National Security, LLC (LLNS) - Commitment to Support Pennsylvania State University Energy Innovation Hub Proposal to DOE

Dear Dr. Foley:

The Lawrence Livermore National Laboratory (LLNL), operated by the Lawrence Livermore National Security, LLC (LLNS), is pleased to support The Pennsylvania State University on the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings. LLNL is a world leader in high performance computing, computational science, and modeling and simulation and will provide key support to this project in these areas. This project will play an important role in providing innovations in the building energy technology and supports the Laboratory’s energy and environment research strategy to develop energy efficiency technologies.

I assure you that in your role as Hub Director for the project, you will have access to all appropriate LLNS people, technical expertise, and other resources. I have assigned John Grosh as your primary point of contact at LLNS. He holds decision-making authority for the commitment of our company resources, and has access directly to me on all matters related to the Hub.

We look forward to extending our longstanding, successful working relationship with The Pennsylvania State University and with the Department of Energy as we deliver on this critical project.

Sincerely,

George H. Miller  
Director  
President, LLNS, LLC.

Copy:  
John Grosh, LLNL  
Patrick Dempsey, LLNL
April 16, 2010

Dr. Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802  

Dear Dr. Foley:

It is my pleasure to submit this letter of commitment, on behalf of Morgan State University, to participate as a member of proposed Greater Philadelphia Regional Energy Innovation Hub for Energy Efficient Buildings, to be headquartered at the Clean Energy Campus at the Philadelphia Navy Yard.

The stated goals of the Innovation Cluster for Energy Efficient Buildings, "to improve energy efficiency and operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in the Greater Philadelphia and Mid Atlantic regions," dovetail well with Morgan's programmatic commitments in the Greater Baltimore area. As a full partner in this activity we look forward to helping to provide leadership to the activities of Regional Innovation Cluster. Along with our interest in promoting meaningful changes in technology and policy research, we have a deep commitment to fostering education and workforce development activities throughout a diverse client pool.

As a requirement of membership in this DOE Hub we pledge our commitment to locate personnel at the Hub headquarters at the Navy Yard. In addition to locating personnel at the Navy Yard in Philadelphia, we intend to provide in additional resources designed to fulfill our obligation as an effective member of the Cluster. It is anticipated that these resources will come in the form of services provided by members of our administration, faculty, and staff, financial support for our students, and relevant services from friends of our University who have an interest in achieving the goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings.

Improving energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. As one of our nation's Historically Black Universities, who continue to contribute unique services to our society, we eagerly look forward to doing all that we can to ensure the success of this forward reaching endeavor.

Sincerely,

Earl S. Richardson  
President
Dear Dr. Foley:

We are very pleased to provide this letter of commitment to participate as a member of the Energy Innovation Hub component of the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

NJIT is New Jersey’s science and technology university. Our mission is to prepare our graduates for positions of leadership as professionals and as citizens; to provide educational opportunities for a broadly diverse student body; to respond to the needs of large and small businesses, state and local governmental agencies, and civic organizations; and to advance the uses of technology as a means of improving the quality of life. The core goals of the Energy Innovation Hub - to improve the energy efficiency and operability of existing buildings and to stimulate private investment in the energy efficiency retrofit market in the Mid Atlantic region and beyond – are entirely consistent with this mission and with the specific goals and activities of NJIT’s Center for Building Knowledge (CBK).

CBK’s substantial expertise in the technical aspects of energy efficient retrofits for residential and commercial buildings, combined with its knowledge of the energy efficient building products industry, make the Center well suited for active participation in the Hub. As a consequence, we are pleased the NJIT is included as a core member of the Hub team and we look forward to working with other team members at the Navy Yard on the comprehensive R, D, D and D activities described in the accompanying proposal.

Dramatically improved energy efficiency in buildings will require substantial advances in technology, policy, business practices and education. NJIT – and its Center for Building Knowledge – are extremely pleased to be part of a team with the creativity, dedication, knowledge and skills to create these advances and to achieve the dynamic new paradigm in building energy efficiency that the country – and the world – so clearly need.

Sincerely

Donald H. Sebastian
Provost (Interim) and Sr. VP for Research and Development
April 30, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

We are delighted to provide this letter of commitment to participate as a member of the Energy Innovation Hub component proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at The Navy Yard in Philadelphia.

Understanding that the goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings are to improve energy efficiency and operability and reduce carbon emissions of existing buildings, we believe that PIDC is in a particularly effective position to assist in the overriding effort. With direct relationships as landlord to many and as master-owner to all of the more than 90 businesses within The Navy Yard, PIDC looks forward to serving as one of the important catalysts in making the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings an unparalleled success, in particular due to our focus on commercialization.

We understand that membership in the DOE Hub component of the Greater Philadelphia Regional Innovation Cluster entails a commitment from our organization to maintain our existing staff at The Navy Yard and we intend to provide significant assistance as the remaining Hub members transition their staffs to the proposed Hub building. In addition to locating personnel at The Navy Yard in Philadelphia, we intend to assist in developing the Hub at The Navy Yard as a locus for robust ongoing exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. We are extremely pleased to be a member in this undertaking and are fully committed to it as an institution.

Sincerely,

John Grady
Executive Vice President

The Navy Yard
April 16, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

If the proposed Greater Philadelphia Regional Innovation Cluster (RIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia is selected for award by the DOE, PPG Industries, Inc. is delighted to provide this letter of commitment to participate as a member of the Energy Innovation Hub component of the RIC subject to final negotiations and acceptance of the Hub contract terms and conditions.

The goals of the Greater Philadelphia RIC for Energy Efficient Buildings are to improve energy efficiency and operability, reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid Atlantic region, and beyond. We are extremely pleased to be included as a member in this activity and we look forward to helping to provide leadership to the activities of RIC. We also look forward to the energy efficiency research, demonstration, deployment, and sustainable employment opportunities the Hub will provide to scientists at our research facilities in the Pittsburgh area and to manufacturers in our Carlisle and Allentown facilities.

We understand that membership in the DOE Hub component of the Greater Philadelphia RIC entails a commitment from our organization to frequently interact with personnel at the Hub headquarters at the Navy Yard. We intend that our frequent presence along with other Hub members will develop the Hub at the Navy Yard into a locus for robust ongoing exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia RIC for Energy Efficient Buildings.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. We are extremely pleased to be a member in this undertaking and are fully committed to it as a corporation.

Sincerely,

Charles F. Kahle, II

Charles F. Kahle, II
May 4, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley,

We are pleased to provide this commitment statement on behalf of our participating personnel as a member of the Energy Innovation Hub component proposed Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

We are committed to perform the work described in the GPIC proposal at the level and effort indicated. Our organization fully supports these commitments. We understand that membership in the DOE Hub component of the Greater Philadelphia Innovation Cluster entails a commitment by personnel from our organization to perform work at the Hub headquarters at the Navy Yard in Philadelphia. We intend to help develop the Hub at the Navy Yard as a locus for robust ongoing exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings.

Please keep us informed of the status of this proposal.

Sincerely,

Adam B. Cohen
Deputy Director for Operations
Dr. Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Subject: “Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings” – Professor David August, Princeton University Principal Investigator

Dear Dr. Foley:

Princeton University is pleased to submit the above referenced subcontract proposal in response to FY2010 Energy Efficient Building Systems Regional Innovation Cluster Initiative for the period beginning October 1, 2010 and ending September 30, 2015 in the amount of $2,997,000 as a member the above referenced project, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of this unique project are to improve energy efficiency of existing buildings while stimulating private sector investment in the rapidly expanding building energy efficiency retrofit market in our area. Princeton is delighted to be included as a member in this activity and we look forward to participating in the leadership, development, education and all other activities related to this initiative.

Princeton University intends to be an active partner to help develop the Hub at the Navy Yard as the center for dynamic exchange between industry personnel, university faculty/students, economic/workforce development professionals, and all others with interest in achieving the goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings.

Princeton University is excited to be a vital member of this consortium and we fully support the project. Thank you for your consideration of this research proposal. Should you require additional information, please feel free to contact me.

Sincerely,

Jeffrey Friedland
April 28, 2010

Henry C. Foley, Ph.D.
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

Purdue University is pleased to commit to be a member of the Energy Innovation Hub component of the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

Purdue has a long history of performing industrially-relevant research for improving energy efficiency in buildings that aligns well with the goals of the Cluster. We understand that membership in the DOE Hub entails a commitment from our organization to have personnel spend time at the headquarters at the Navy Yard and participate in continuous exchanges. These exchanges are with industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the overall goals.

We are extremely pleased to be included as a member in this activity and are fully committed to it as an institution.

Sincerely,

Richard O. Buckius
Vice President of Research
April 27, 2010

Henry C. Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley,

The purpose of this letter is to convey the full support and commitment of Rutgers University to participate as a member of the Energy Innovation Hub component proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings.

We are extremely pleased to be included as a member in this activity and we look forward to providing expertise in building-integrated photovoltaic (BIPV) systems, energy efficiency decision support tool design, integrated passive/hybrid system solutions for buildings in Thrust 2, and effects of human behavior on building performance, energy efficiency economics and policy, and electric power system and smart grid modeling in Thrust 3.

Rutgers stands ready to fortify its research base in energy and associated disciplines and to provide well-deserved recognition to those faculty members who commit significant time and energy to the project. The university is deeply dedicated to the success of this project and will commit resources from throughout the university to execute the strategies of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings being proposed.

I hope this clearly demonstrates our institutional commitment to the project, our great enthusiasm to address its goals, and our confidence that they will be achieved.

Sincerely yours,

Michael J. Pazzani
April 22, 2010

Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Dr. Foley;

On behalf of Turner Construction Company, I am delighted to offer our commitment to participate as a member of the Energy Innovation Hub component of the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

As one of the leading Construction Companies in the Nation we are delighted to be a member of this team and to support the goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings. We support the goals to improve energy efficiency and operability and reduce carbon emissions of existing buildings; and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond. We look forward to helping to provide leadership to the activities of Regional Innovation Cluster, and support or to participate in concurrent technology and policy research, development, demonstration, and deployment, education and workforce development, and other activities.

As a member of DOE Hub we recognize a commitment from our organization to locate personnel at the Hub headquarters at the Navy Yard. Additionally, we intend to help develop the Hub at the Navy Yard as a locus for exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings.

We are extremely pleased to be a member in this undertaking and are fully committed to supporting the vision of the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings.

Sincerely,

Turner Construction Company

Michael J. Kuntz  
Senior Vice President
April 30, 2010

The Pennsylvania State University
304 Old Main
University Park, PA 16802

Attention: Henry C. Foley, Vice President for Research
Phone: (814) 863-9580
Email: hcf2@psu.edu

Subject: Greater Philadelphia Innovation Cluster for Energy Efficient Buildings – HUB Member Letter of Commitment

The United Technologies Research Center (UTRC), a division of United Technologies Corporation (UTC), is pleased to present this letter to Pennsylvania State University (PSU) indicating our intention to participate as a member of the Energy Innovation Hub component proposed Greater Philadelphia Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings are to improve energy efficiency and operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and beyond. UTRC is excited to be a part of this proposed activity; we are fully committed to providing leadership to the activities of the Innovation Cluster and to directly participating in concurrent technology and policy research, development, demonstration, and deployment, education and workforce development.

With the understanding that the Hub at the Navy Yard is planned as a locus for exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the proposed program, UTRC is poised to locate personnel at the Hub headquarters as a part of its membership in the Greater Philadelphia Innovation Cluster. In addition, UTRC intends to support the Hub development with a commitment of 33% cost share for its proposed role during the 5 years of the planned program.

UTRC is extremely pleased to be a part of this innovative and historic undertaking. Achieving the vision of dramatically improved energy efficiency in both retrofit and new buildings presents great challenges for technologies, public policies, human behavior, business models, and education and workforce development. However, the potential rewards in terms of energy savings, environmental protection, and quality job creation are worth the investment.

Sincerely,
UNITED TECHNOLOGIES RESEARCH CENTER

Dr. David Parekh
VP, Research & Director, UTRC
April 30, 2010

Henry C. Foley, PhD
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Dr. Foley:

I am greatly pleased to provide this letter of commitment affirming the University of Pennsylvania’s participation in the Greater Philadelphia Innovation Cluster for Energy Efficient Buildings (GPIC).

Numerous University of Pennsylvania faculty and staff have been engaged in the cluster’s planning and development process and we are greatly excited by the GPIC’s potential to be a major focus for innovative energy efficient building research and discoveries across the region. Speaking from a personal standpoint, I too have been engaged and am committed to taking an active role in the GPIC executive management team.

The GPIC goals and objectives are aligned with the strategic interests of the University of Pennsylvania, offering our institution opportunities to engage in collaborative, multi-disciplinary, and cutting edge research projects; produce applicable solutions to real world problems; and provide community and economic development opportunities for our region.

We look forward to building a successful cluster in partnership with Pennsylvania State University and others. As such, we recognize the need to co-locate University of Pennsylvania personnel at the GPIC headquarters at the Philadelphia Navy Yard, and our committed to the overall success of the project in the way of participation from our faculty, students, and staff.

Working together, I am sure we can build a viable and sustainable innovation cluster that will help fulfill U.S. Department of Energy Secretary Chu’s laudable and imperative goal to “make significant near-term carbon reductions through energy efficiency.”

Regards,

[Signature]

Steven J. Fluharty, PhD
Senior Vice Provost for Research
Henry C. Foley  
Vice President for Research  
The Pennsylvania State University  
304 Old Main  
University Park, PA 16802

Dear Hank:

On behalf of the University of Pittsburgh faculty involved in this proposal I am delighted to provide this letter of commitment for the University of Pittsburgh to participate as a member of the Energy Innovation Hub component of the proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the Navy Yard in Philadelphia.

The goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings include improving energy efficiency and operability and reducing carbon emissions of new and existing buildings. These goals are well aligned with much of the building-related research being conducted at University of Pittsburgh. Accordingly, we are very pleased to be included as a member of this Regional Innovation Cluster by directly participating in concurrent technology research, development, and other activities.

We understand that membership in the DOE Hub component of the Greater Philadelphia Regional Innovation Cluster entails a commitment from our organization to conduct research projects that are directed at achieving the goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings. Some projects may involve short- or extended-term residence at the Hub headquarters at the Navy Yard.

In order to achieve the vision of dramatically improving energy efficiency in both new and retrofit buildings, it will be necessary to implement changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. Indeed, the potential rewards are enormous in terms of energy savings, environmental sustainability, and job creation. We are extremely pleased to be a member in this undertaking and are fully committed to it as an institution.

Sincerely,

George E. Klinzing  
Vice Provost for Research
April 26, 2010

Henry C Foley
Vice President for Research
The Pennsylvania State University
304 Old Main
University Park, PA 16802

Dear Mr. Foley:

Virginia Tech is committed to participate as a member of the Energy Innovation Hub component proposed Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings, headquartered at the Clean Energy Campus at the navy Yard in Philadelphia. Dr. John A Burns, Professor in Mathematics will serve as Principal Investigator on our behalf.

The goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings are to improve energy efficiency and operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond. We are extremely pleased to be included as a member in this activity and we look forward to helping to provide leadership to the activities of Regional Innovation Cluster, and to directly participating in concurrent technology and policy research, development, demonstration, and deployment, education and workforce development, and other activities.

We understand that membership in the DOE Hub component of the Greater Philadelphia Regional Innovation Cluster entails a commitment from our organization to locate appropriate personnel at the Hub headquarters at the Navy Yard. In addition to locating personnel at the Navy Yard in Philadelphia, we intend to help develop the Hub at the Navy Yard as a locus for robust ongoing exchange between industry personnel, university faculty members and students, economic and workforce development professionals, and others with interest in achieving the goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings.

Achieving the vision of dramatically improved energy efficiency in both new and retrofit buildings will require changes in technologies, public policies, human behavior, business models, education and workforce development, and other areas. The potential rewards in terms of energy savings, environmental protection, and quality job creation are enormous. We are extremely pleased to be a member in this undertaking and are fully committed to it as an institution.

Sincerely,

John C Rudd
Acting Assistant Vice-President for Sponsored Programs Administration

Attachments: Assurances and Certifications
GPIC | Greater Philadelphia Innovation Cluster for Energy Efficient Buildings

Proposal to: U.S. Department of Commerce – Economic Development Administration
U.S. Department of Commerce – National Institute of Standards and Technology
U.S. Department of Energy
U.S. Small Business Administration

Date: May 6, 2010

FOA: Fiscal Year 2010 Energy Efficient Building Systems Regional Innovation Cluster Initiative

EDA CO-APPLICATION
GREATER PHILADELPHIA INNOVATION CLUSTER
EDA CO-APPLICATION

HUB/GPIC ENERGY INNOVATION HEADQUARTERS INTRODUCTION

The goals of the Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings are to improve energy efficiency and operability and reduce carbon emissions of new and existing buildings, focusing on full spectrum retrofit of existing average-size commercial and multi-family residential buildings, and to stimulate private investment and quality job creation in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond.

Greater Philadelphia is an interconnected, well-defined and historically recognized region comprising ten contiguous counties situated in Southeastern Pennsylvania and Southwestern New Jersey with the City of Philadelphia at its heart and occupying in excess of 3800 square miles. The location for the DOE HUB/GPIC is the Clean Energy Campus at the Navy Yard in Philadelphia. The Navy Yard, which was closed by the federal government in 1996, represents one of the nation’s largest and most dynamic redevelopment opportunities. The 1,200 acre site currently houses more than 90 companies with more than 7,000 employees and is poised for continued strategic investment and growth in the years ahead.

A cornerstone of the Navy Yard redevelopment effort is the Clean Energy Campus, aimed at making the Navy Yard a national center of excellence for energy research, education, and commercialization. The Clean Energy Campus currently houses the DOE Mid Atlantic Clean Energy Applications Center, the DOE Northern Mid Atlantic Solar Training Center, and the DOE Grid Smart Training Applications Resource (GridSTAR) Center.

The DOE HUB comprises a uniquely dynamic and diversified team of 11 prestigious academic institutions including a historically black university, two DOE laboratories, five high profile global industry partners, regional economic development agencies, and community colleges.
DOE HUB activities are organized into five tasks, which are: 1) tools for integrated design, verification, and modeling; 2) components, diagnostics, sub-systems, and controls; 3) public policy, behavior, economics, and business; 4) education and workforce development; and 5) demonstration, deployment, and IP management.

DOE HUB headquarters facilities will include two buildings at the Navy Yard which will house HUB personnel. A historic building will undergo a major retrofit and a new advanced integrated building sciences laboratory will be constructed. These facilities will function as living laboratories from design, through construction, commissioning and operation for developing tools and methods to transform the industry’s current fragmented serial process into system performance driven, integrated, parallel, team processes. The Commonwealth of Pennsylvania has committed $30 million of new capital funding to support these facilities.

The GPIC is the culmination of many years of dedicated team building effort. More than 60 GPIC partners from government, industry, education and workforce development, banking and finance, labor, and philanthropic foundations have made commitments to the GPIC. The DOE HUB and the GPIC are tightly integrated. The EDA, NIST, and SBA Co-Applicants all are represented on the DOE HUB/GPIC Executive Board, and all serve as DOE HUB members.

The management of the DOE HUB/GPIC utilizes state-of-the-art communications and information technology and blends hierarchical control with decentralization, promoting day-to-day teamwork but also providing authoritative decision-making when needed. The heart of the enterprise is the collaborative Operating Committee comprising the five DOE HUB task leaders (two from industry, two from academia, one from a regional economic development agency), the Navy Yard test bed facilities manager, and the Deputy Director. Ultimate decision making authority, however, rests with the DOE HUB/GPIC Director and the Executive Board.

GPIC/HUB ENERGY INNOVATION HEADQUARTERS PROJECT SUMMARY
(Including components of the Engineering Report)

Introduction to The Navy Yard, Philadelphia

The Philadelphia Authority for Industrial Development (PAID) acquired approximately 1200 acres at the site of the former U.S. Navy Yard from the federal government in March 2000. The Philadelphia Industrial Development Corporation (PIDC) manages the planning, development and operation of these real estate assets on behalf of PAID.

Larger in area than Center City Philadelphia and located at the foot of historic Broad Street, 3.5 miles south of City Hall, The Navy Yard presents an extraordinary opportunity for economic development. The 1200 acre site contains 282 existing buildings of which 233 are historic structures, over six miles of waterfront open to a broad reach of the Delaware and Schuylkill rivers, and an active Navy Reserve Basin. Direct connections from The Navy Yard to the interstate highway system (both I-95 and I-76), the regional labor pool, the national rail network, and the Port of Philadelphia, in addition to close proximity to a regionally important professional sports stadium complex, ensure both excellent accessibility and high visibility of projects at this historic site.

A comprehensive Master Plan, published in September 2004, guides development at The Navy Yard. The plan proposes a dynamic, mixed-use development designed to accommodate 12 to 15
million square feet of office, R&D, and industrial real estate and over 30,000 workers in a vibrant, 24-hour community based on the principles of smart growth, historic preservation, expanded mass transit and sound sustainable practices. Ultimately, the development will leverage more than $2 billion of private investment; and will substantially diversify and expand the employment, productivity, and tax base of the city and region.

Redevelopment activity to date can be described by primary use:

- Industrial development includes 3.3 million square feet of real estate (1 million square feet of Navy owned space, 2.3 million square feet of privately owned space).
- Office space includes a wide variety of opportunities, ranging from renovated historic warehouses and officers’ quarters in the 167-acre Historic Core to 235,000 square feet of “Class A,” brand new office buildings in the Corporate Center (185,000 sf of which is LEED Gold- and Platinum-Certified). Additional buildings are planned.
- Research & Development (Note: This is a targeted area for additional growth.)
  - Research and development includes 750,000 square feet of occupied real estate consisting of 650,000 square feet of Navy owned space and 100,000 square feet of privately owned space. Currently, there is a 400,000 square foot Photovoltaic facility in development, expected to break ground in 2010.

The Navy Yard Clean Energy Campus

The Navy Yard in Philadelphia represents one of the nation’s largest and most dynamic urban redevelopment opportunities. In particular, its mix of densely concentrated historic structures from a period spanning the late 19th century through the present and its remaining capacity for brownfield redevelopment are unique in close proximity to urban areas in the U.S. The Navy’s NAVSEA Warfare Center - Carderock Division (NSWCCD) is a $500 million per year, 1700-employee Navy laboratory focusing on propulsion, energy, acoustics, communications, and materials engineering, and remains a key anchor activity on site.

A key aim of the redevelopment effort to date has been to make The Navy Yard a national center of excellence for energy research, education, and commercialization focused specifically on clean and efficient energy production, storage, and management. The centerpieces of this strategy are the combined education, research and commercialization strengths of government, industry, and universities in the Greater Philadelphia region.

In 2004, The Navy Yard was designated a Keystone Innovation Zone as part of a program of the Commonwealth of Pennsylvania designed to foster unique public-private partnerships and to support entrepreneurship in economically challenged geographic areas. Founding sponsors of this designation included Pennsylvania State University (Penn State), Ben Franklin Technology Partners of Southeastern Pennsylvania, the City of Philadelphia, the Delaware Valley Industrial Resource Center (DVIRC - the NIST-MEP Center in Philadelphia), PIDC, private industry, and the Navy’s federal research lab mentioned above.

The KIZ designation provided the catalyst for a thorough assessment of the regional strengths in research and technology as drivers of economic development, and led to the formation of the Navy Yard Clean Energy Campus partnership, a growing group of public and private partners focused on creating economic opportunity by leveraging the complementary activities of education, research & development, and technology commercialization, specifically in the power
and energy industry. The Navy Yard Clean Energy Campus was conceived as a unifying thrust for development of the Navy Yard real estate assets, physical infrastructure, and public and private tenant organizations’ capacity to serve as a unique national model for sustainable development and clean energy technology research, development, demonstration and deployment. In addition to the real estate assets and Clean Energy Campus partnership, the utility infrastructure presents a unique opportunity nationally. As a former Navy base, the electrical grid, steam and gas distribution systems, and several distributed generation facilities are, like the majority of the land, owned by PAID and managed by PIDC.

- In July 2009, the U.S. Department of Energy established the DOE Mid Atlantic Clean Energy Application Center (CEAC) at The Navy Yard. The CEAC is operated by the Penn State College of Engineering at The Navy Yard with the mission of promoting the adoption of clean energy technology by industry and government in the six Mid Atlantic states through education and technical assistance, with an emphasis on net zero building technologies, combined heat and power (CHP), district energy management, and smart grid technology. The DOE Mid Atlantic CEAC at The Navy Yard will be a key asset for disseminating technologies in these and other areas to energy producers, distributors, and users in the Mid Atlantic region and across the nation.

- A second 2009 DOE grant that was awarded in September 2009 provides $2 million to establish the DOE Mid Atlantic Solar Resource and Training Center, aimed at developing the solar energy industry in the Mid Atlantic region through technical assistance and workforce development. The center is part of a national network of solar education and training centers newly established in 2009 through the DOE Solar Energy Technologies Program, and is supported by American Recovery and Reinvestment Act (ARRA) funds.

- A third 2009 DOE grant was also awarded in April 2010 that provides $5 million to establish the Grid Smart Training Applications Resource (GridStar) Center at The Navy Yard is focusing on the training of a new set of skilled workers to install and maintain distributed meters and controllers that would allow shifting of electric power among end users to meet transient peak load requirements on a systems optimization basis. Given the fact that The Navy Yard grid is owned by PAID and managed by PIDC, The Navy Yard District is an ideal location for training and demonstration of the a new generation of smart grid professional engineers and technical staff.

These three most recent awards demonstrate DOE’s recognition of the excellence of the Penn State University Department of Architectural Engineering's strategic focus on High Performance Green Buildings. The strength of the additional Consortium members recruited to support this application for the DOE Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings, augments the capability and prestige already present. The DOE HUB/GPIC will continue the progression of substantial and successful investment in the programming and renovation of physical space necessary to fully realize the potential of the assets already in place at The Navy Yard.

The GPIC will utilize DOE Energy Innovation HUB funding and other funding to develop technologies and policies to accelerate the retrofit of existing commercial and residential buildings of average size (approximately 10,000-20,000 square feet). The goals of the GPIC for Energy Efficient Buildings are to improve energy efficiency and operability and reduce carbon emissions of new and existing buildings, focusing on deep retrofit of existing average-size
commercial and multi-family residential buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond.

The GPIC for Energy Efficient Buildings is led by four co-applicants with a shared history in collaborative regional technology based economic development. The DOE co-applicant is Penn State. The EDA co-applicant is the PIDC. The NIST co-applicant is the DVIRC, and the SBA co-applicant is the Wharton Small Business Development Center at the University of Pennsylvania.

PIDC will be represented on the Executive Board of the GPIC, and in addition to being a co-applicant; PIDC is also a funded DOE HUB member participating in the demonstration, deployment, and commercialization activities of the GPIC.

Further supporting the work of the GPIC, the City of Philadelphia was recently awarded an Energy Efficiency and Conservation Block Grant Program (EECBG) “to deploy the most cost effective and reliable energy technologies available in renovating urban housing units in the City for the purpose of reducing associated fossil fuel emission, total energy use by the units, and create and maintain jobs via the renovation processes themselves.” This application award directly relates to the central mission of the GPIC and the specific Research, Development, Demonstration and Deployment (RDD&D) focus of the GPIC HUB.

The technical, policy, workforce and economic issues encountered in the retrofit and renovation site applications of the EECBG program in Philadelphia will provide excellent, specific data and defined problem parameter constraints to the HUB interdisciplinary team. The innovations of the HUB team in each of these issues areas will be developed in the context of actual implementation in Philadelphia and have an immediate application space. The EECBG application and the HUB RDD&D interactions will facilitate the formulation of technology, policy, workforce training and economic modes that will be easily translatable to other regions and conditions.

The proposed renovation and retrofitting of Building 661 at The Navy Yard as an integrated, systems performance focused retrofit makes it an ideal fit for the HUB team to use as its first challenge. Lessons learned from the project would then guide on-going redevelopment of The Navy Yard’s large set of historically significant buildings that could be deeply retrofitted in a sustainable manner.

It is improbable that a better retrofit and property development environment could be found anywhere for the location and activities of the proposed DOE HUB/GPIC for Energy Efficient Buildings.

HUB/GPIC Energy Innovation Headquarters at The Navy Yard – Project Description

The $5M EDA grant requested here, in conjunction with a portion of the DOE HUB award will provide for the renovation of an historic gymnasium building into a sustainably designed, high-
performance facility called the HUB/GPIC Energy Innovation Headquarters. This building will house the DOE HUB/GPIC on Energy Efficient Buildings convening researchers from a spectrum of educational institutions and private companies as well as economic development organizations, education providers in science, technology and math (STEM). Their research, education, and commercialization activities will focus on clean and efficient energy technologies related to high-performance building renovation and construction.

*Figure 1: Aerial View and Master Plan of The Philadelphia Navy Yard*

*Figure 2: Selected Views of the Existing Building*
Despite an increasing number of LEED certified buildings in the United States, buildings still account for 40% of natural resource consumption and 76% of electricity consumption.¹ One of the focuses of this proposal is the demonstration of an integrated, sustainable design process for building retrofits that is both innovative and commercially relevant. The process and strategies will be adaptable to multiple building morphologies and eras, and replicable as a commercial industry standard. Consortium members have deliberately selected an historic structure as the primary renovation base for the project because of the more stringent regulatory and physical requirements that exist in historic structures.

The process by which this facility’s renovation will be planned and executed will serve as a living laboratory for best practices in commercial building design, historic adaptive re-use, and energy efficiency innovation providing opportunities for data to the building owners and occupants (researchers and private industry) and to building owners of future renovated office and lab space. The building will itself be uniquely designed and monitored to enable it to function as an active laboratory providing constant feedback regarding its energy performance. While the first iteration and major renovation will draw on leading principles in sustainable design and cutting-edge technologies in energy efficiency and management, the building configuration will allow for future technology advances. Like the ideal commercial building of the future, which will be increasingly adaptable, the HUB/GPIC Energy Innovation Headquarters will be adaptable in its energy infrastructure systems as well as its tenant program without impacting the operating performance of the building.

Finally, driving innovation toward commercial application to promote investment, jobs and economic recovery will also be a primary objective for the facility and its collaborating partners. Given the existing building energy related DOE projects at the site noted above and the recent EECBG program awarded to the City of Philadelphia that focused on urban housing renovation, the Navy Yard site for the HUB is unique in the opportunities it presents to transform the building industry in this economic region.

**Project Scope and Requirements**

The HUB/GPIC Energy Innovation Headquarters is conceived as an ongoing, integrated demonstration of replicable building strategies for future commercial renovations, particularly office and lab spaces, that improve energy efficiency and operability and reduce carbon emissions. The specific process elements that will facilitate the project concept are:

1. Allowing for a documented, fully integrated approach to building sciences design and research of existing commercial buildings through intentional and intelligent collaboration including the traditional design team, the building owners, the researchers and the commercial users;
2. Designing for flexibility and sustainability to inhibit physical and functional obsolescence;
3. Integrating multiple energy system strategies to provide a broader spectrum of tested strategies for future commercial endeavors;
4. Considering sustainable water strategies for both potable and storm water control as a method of using less treated water while reducing the amount of water requiring treatment contributing to both energy savings and reducing carbon emissions;
5. Creating an environmentally sensitive workplace with improved indoor air quality, enhanced natural light, and thermal comfort;
6. Delivering to industry research results, cost/benefit analysis, and education and training through the specific design features;
7. Affording real-time results through case studies, white papers and online building performance of the Center from design, construction, commissioning and continuing operation of the building as a fully instrumented test bed;
8. Providing for an “Energy Park Integration” feature. Designing for an interface with the local Smart Grid infrastructure will allow for integration of the facility’s energy and water systems into The Navy Yard’s planned supply systems in the future;
9. Integrating DOE’s and EPA’s Laboratories for the 21st Century (Labs21) Environmental Performance Criteria (EPC) regarding design, construction, and operation of specific technologies that contribute toward sustainability in the laboratory portions of the building;
10. Taking advantage of existing building structure and systems to enhance sustainable strategies (e.g.: narrow floor plate, clerestory, and window for natural daylighting; existing pool for rainwater collection);
11. Using durable, long lasting, locally available materials to contribute to the building life and reduce carbon emission impact;

**Facility Program**

The new HUB/GPIC Energy Innovation Headquarters is expected to include general office space, research labs and a high bay testing lab with supporting offices, and meeting facilities.
The facility will be located in an existing 2-story, 30,000 square foot building that was once a gymnasium.

The project has been designed to accommodate the following areas:

**General Office Space (10,000 sf)** – The two story portion of the existing building is optimal for this use given the narrow floor plate, multiple window openings and floor to floor heights. These offices will initially be used for housing researchers from Penn State and other research institutions with the future intention to lease to private, commercial entities whose emphasis is related to building and energy efficiency. The facility will house offices for the Directory, Deputy Director and the interdisciplinary set of researchers from each of the HUB Member organizations. To encourage frequent informal and spontaneous discussions among the researchers, the internal office space areas will be arranged to include open work spaces and “water cooler/coffee/brown bag lunch room” areas that are easily accessible from the private offices. The facility itself is located next to a planned green space that will encourage researchers to gather informally for discussion in the park-like setting next to the facility. The
office layouts and construction will be re-configurable to test various sustainable strategies and allow for flexibility of future occupants.

The remainder of the program is located in the existing high ceiling spaces that are naturally daylit from above to best support lab and conference room needs.

**Lab, Lab Support and Lab Office Space (4,000 sf)** - The development of robust, reliable, cost-effective, dynamic control technologies – sensors, actuators, embedded microprocessors - are seen as critical to energy efficient buildings. The laboratories are to be configured to do environmentally controlled testing of these technologies on an on-going basis.

**High Bay Testing Labs and Office Support (4,400 sf)** - The high bay areas will be designed to implement large scale experimental assemblies. This facility area will have high power electrical and natural gas connections to allow advanced testing and characterization of heating, cooling and air filtration equipment as well as small scale, distributed power systems applicable in combined heat and power applications. Fan facilitated combustion system exhaust capability will be required, but it is anticipated that the bay area will be used for characterization of advanced distributed power technology for buildings of all types – fuel cells, photo-voltaic solar, Sterling engines, etc.

Part of the bay area will be configured to develop and test advanced building lighting systems such as LED, daylight integrated LED, daylight + automatic shading + LED systems and the associated dynamic controls (see above) required to optimize performance. This space will have a designed external wall with a high degree of re-configurable fenestration area to allow change out of different glazing materials. Situated next to the HVAC equipment testing facility, the development of advanced, dynamically optimized cooling and lighting technology strategies could be developed using the two facilities in a coupled manner.

*Figure 5: Axonometric View of Proposed Facility*
Conference/Symposium Space (5,400 sf) – The common areas create opportunities for testing, monitoring and training energy principles within the nearby research community already housed at The Navy Yard. This space will be the outlet to the research, design, and construction industry for theories and technologies being developed within the building. It will provide high end conferencing capabilities including video conference space and multi-configurable seminar rooms.

Formal conference rooms will be equipped with the latest in telecommunications and display equipment for live streamed interactions with research colleagues around the world. The HUB will have frequent technical interactions with the Lund University energy efforts in Sweden and the Tsinghai University Building Energy Efficiency Center in China (as noted in the DOE HUB application).

The Design Methodology: Maximizing Energy Efficiency

Recognizing that there is a lack of a quantitative and science based design methodology for sustainable buildings, particularly for existing building renovations, part of the assembled project team’s approach will be to apply and document an integrated design process. In addition the project focuses on renovating a building whose framework and systems support the concept of a “living laboratory” with particular emphasis on energy-efficient building strategies, research and applied projects of the institutions within the space initially. This effort also concentrates on monitoring the facilities’ energy use, educating the users on their essential role in energy performance, and integrating emerging technologies and strategies for improvements. An emphasis of the process will be to create and document strategies that are scalable and replicable in terms of both the technology applied and the methodologies used for designing and constructing the renovation project.

Drawing from best practices for energy efficiency in existing facilities and historic renovations, the methodology for project delivery takes a holistic approach to facility design that includes an integrated design process, energy load reduction, renewable energy sources and integrated systems, user interface including monitoring and education, and other sustainability considerations beyond those related specifically to energy. The details of this layered approach are outlined below.

1. Integrated Renovation Design Process and Documentation:

The integrated design process will include the following components; a building design charrette, an integrated project team, and implementation of sustainable laboratory guidelines from Labs 21/EPC, LEED-NC and existing case studies.

As defined by the US Department of Energy, integrated design is a “process of design in which multiple disciplines and seemingly unrelated aspects of design are integrated in a manner that permits synergistic benefits to be realized.”

Integrated design reinvents the traditional linear design process in which individuals work in isolation on discrete project parts. In the design and development world, the standard process begins with a planner or architect interfacing with a client or owner’s representative and then creating conceptual designs which are handed off to a series of sub-consultants (mechanical, electrical, plumbing, structural, civil, landscape, etc) to

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“make it work.” This model suffers from two main problems: 1) a breakdown of communication akin to the child’s game of “whisper down the lane”; 2) treating a building or community as a sum of parts rather than a complex and inter-connected system. The result is that team members end up working in isolation and are more likely to create project components that work cross-purposes. Understanding entire systems and their opportunities for change requires many perspectives and technical areas of expertise.

A specific design methodology used to tap into an interdisciplinary team’s collective intelligence is the Integrated Design Charrette. An Integrated Design Charrette is a facilitated, multi-day design event that involves all of the project consultants and key stakeholders in generating preliminary designs so that decisions reflect the expertise brought by many disciplines. Cross-pollination of ideas and expertise is key to achieving quality designs in a condensed timeframe. Team members in an Integrated Design Charrette work in small, interdisciplinary teams to generate concepts. By having the team and project stakeholders design together in real-time, the building is treated as a system instead of a kit of unrelated parts.

Decades of change theory and learning research strongly support the value of integrated design approaches in fostering better cooperation among the disciplines involved, and interdisciplinary-learning which leads to increased efficiency, higher performance at a lower cost, improved sustainability outcomes and other significant breakthroughs during project design and implementation.

“Siloing” rather than integrating information is cited as one of seven common “sustainability blunders” by Bob Doppelt in *Leading Change Toward Sustainability* (2003). The integrated design charrette breaks down information silos that impede high-performance, cost-effective projects. As a simple example, a typical process tasks a lighting designer with providing a certain lumen/sf so they specify artificial lighting that generates an enormous amount of heat, causing the mechanical engineer to increase the size of the cooling system. By working together in the integrated design charrette, the architect, mechanical engineer, and lighting designer could greatly reduce the project’s artificial lighting and cooling through early decisions about building orientation and massing.

As part of the training on integrated design best practices, the participants in this process will not only include the design team (architect, lab consultant, mechanical engineer, structural engineer, civil engineer), the developer and non-profit developing agency, and the occupants (researchers) but also representatives from the architectural and engineering departments of the relevant research institutions. The documentation will include a pre-charrette workbook and a post-charrette publication for reference use by the building team and the greater design community.

2. **Energy Minimization and Management Strategies**

The design process will first test options for minimizing utility loads through passive strategies, particularly those which limit east and west exposure and allow for greater, controlled southern exposure. This approach also allows for the greatest amount of natural daylight which then reduces the demand for artificial lighting. Additional daylighting strategies will be assessed as well, such as the size of glazed openings and control of the exiting clerestory lighting. Daylight and solar gain will be passively controlled with external and internal solar shading devices. Synergies among strategies will be given greater consideration. One such example would be to install shutters that provide sun shading during the day and thermal insulation when the building is closed up at night.
The project design will seek to aggressively limit un-wanted envelope loads in order to have a significant impact on reducing the building’s demand for energy. Beyond the insulating materials of the individual materials and reducing infiltration, the building design process will allow for integration of energy efficient wall systems.

The key to minimizing lab energy will be in keeping exhaust air flow to the bare minimum and using non-air, low energy systems to handle the majority of room sensible loads. Typically, lab air flows are over designed and minimum air change rates are set too high. This ends up requiring more make-up air which requires significant reheat and uses a lot of energy. The goal is to limit air flow and reheat as much as possible but still protect the health and safety of the occupants. Some strategies for consideration will include: locating heat producing equipment in centralized locations where rejected heat can be captured by exhaust air rather than allowing it to enter conditioned room; utilizing shared support equipment across multiple labs where possible to limit the quantity required; setting minimum air change rates as low as possible and utilizing VAV fume hood systems to limit the amount of exhaust and make-up air; using low-flow, laminar type hoods where feasible to reduce exhaust and make-up requirements; handling room sensible loads by low-energy systems such as chilled beams rather than air systems thereby limiting the amount of reheat needed; sizing exhaust and supply air ductwork and systems to limit system losses due to friction and fitting losses and keep transport energy needs to a minimum; and using heat recovery to pre-condition outside air brought in for ventilation and make-up.

For the non-lab spaces there is more latitude on strategies to limit internal loads given program and code requirements. Some strategies for consideration will include: investigating mixed mode (natural / mechanical) ventilation with operable windows, good air flow pathways and possibly low energy ceiling fans to expand the comfort zone by providing air movement; earth tube preconditioning; limiting the resistance and pressure drop in the air pathways to limit transport energy needs as with the lab systems; looking at low-energy systems such as chilled beams or radiant systems with dedicated outside air; and utilizing heat recovery for capturing heat from code required exhaust systems such as toilet rooms.

Controls and sensors in all program spaces will also be key factors in optimal energy use minimization. Approaches for investigation will include: daylight sensors and time clocks; occupancy sensors to control light levels but also to reset air flow minimums if the lab is unoccupied; occupancy sensors at work stations to cut power to all devices (monitor, task light, etc.) except the computer when the work station is not occupied; demand control ventilation using IAQ sensors, CO₂ sensors and / or occupancy sensors.

The inter-relationships between various construction details will be evaluated through building energy and daylight models. The daylight model will evaluate the qualitative and quantitative performance of the daylighting systems to optimize beneficial daylight to the spaces served and to establish the contribution of the daylighting schemes to overall building energy use optimization. The building energy model will be used to test the performance and impact of various design strategies and system alternatives with the goal of minimizing annual energy use. The model results will also be used to establish targets for annual renewable energy harvesting and will help inform the size and scope of energy harvesting systems. An integral part of modeling building energy use will be predicting occupant use and behavior in the building. Occupant behavior will be the major factor in annual energy use and much effort will be put into gaining an understanding of how this will occur in the finished building.
The theoretical results of both the daylighting analysis and energy modeling will be verified against actual building energy use and performance. Assumptions made in the building modeling will be back checked against actual operations. The energy model will be calibrated to the actual building use on a continuing basis based on feedback from the building energy monitoring and measurement systems. The model will be maintained and will continue to serve as a predictive tool to project energy use of varying operating strategies. In this way, the energy model will become an operational tool in addition to being a design phase tool. Similarly, daylighting factors will be evaluated post-construction and compared to predicted values in order to determine whether the researchers recommend changes to the modeling tools for improved accuracy. This facility project will also contribute to a larger body of work about sustainable building design and predictive modeling tools in particular. The intent is that this on-going research can be shared with institutions and industries engaged in energy efficiency technologies.

Figure 6: Section Perspective of Proposed Facility

3. Potential Energy Sources and Systems for Building Integration:

The process for finalizing source and system options will include the building charrette coupled with technical research on emerging technologies and systems. In particular, the project will prioritize technologies that have potential for mass replicability. In order to achieve broad data results of the performance data and the determination of best practice for similar, future renovation projects, the inclusion of multiple system types will be considered. System designs that accommodate on-going research and advances in technology, particularly as related to energy sources, will also be considered.
The following are some of the sources and systems optimal for inclusion in the project:

- **Photovoltaics (PV):** Some opportunities will include roof top installation of varied panel types and building integrated PV on south façade (wall and external shading devices) that’s detachable to allow for testing new systems.

- **Ground Source Heat Pumps (GSHP):** The site is optimal for GSHP because of the high water table and the hydrology of the site. Ground source heat pumps provide ducted heating and cooling for lower ceiling office spaces. Wells for GSHP system can be located under the terrace & parking lot.

- **Solar Thermal Coupled with Absorption Chiller:** The solar thermal can provide radiant heating for the high ceiling spaces (in-floor, ceiling panels and wall radiators). An innovative approach couples solar thermal heating with an absorption chiller in order to turn heat (energy) into cooling then distributed through ducts. Historically, absorption chillers have been effectively used on very large scales and this project would be used to test, evaluate, and demonstrate their viability on a small-scale. This technology is especially appropriate for the DOE GPIC HUB project because the building will have a high cooling load and has the capacity to generate more solar hot water than demand will require.

- **Wind:** Small scale wind turbines integrated with light fixtures are shown on the site plan.

- **Ventilation:** Mixed mode allowing for maximizing natural ventilation strategies, to minimize energy demand, in conjunction with ERVs for mechanical displacement (low-velocity) ventilation for improved air quality.

- **Rainwater Re-use/Stormwater Management:** The project plans to take advantage of the existing pool to store rainwater and reuse it for sewage conveyance, thus reducing the use of potable water. The remainder of the stormwater, including the parking lot, the water will be directed to on-site bio-swales planted with native / adapted native vegetation.
Envelope: Minimizing infiltration while maximizing thermal insulation is the best first strategy in energy use reduction. This project will implement different options at various locations, particularly at the High Bay Lab and Offices, and will study its effectiveness through on-going blower tests and wall monitors. Opportunities for studying shading and varied window glazing types are included as well.

Other Energy Systems for Consideration: Co-generation, Flywheel Energy Storage and Thermal Storage Systems (ice and mass) in conjunction with radiant cooling and/or chilled beams, Earth Tubes to passively temper ventilation air.

4. User Interface:

a. Behavior Charrette: A key to achieving high energy performance is understanding occupant behavior and finding ways for users to reduce their energy use once in the building. In order to address occupant usage, an important component of the design process will be a “Behavior Charrette” to help the project team and sample building occupants fine-tune building systems and right size renewable energy harvesting systems. The purpose of the charrette will be to investigate how the building will likely be used by the occupants, benchmark expected annual energy requirements based on anticipated user needs, identify behavioral changes that can be implemented to reduce annual energy requirements, determine the meaningful motivating factors that can be applied to the energy monitoring and feedback systems and help develop the protocols for operating the building in the most efficient and effective manner.

An expected outcome of the behavior charrette will be the formation of user groups aimed at establishing protocols for the research conducted in the building. It is expected that occupants will develop energy footprints for their research to establish targets and that the building measurement and monitoring system will allow for the tracking of performance against expectation on a lab-by-lab basis. While energy use will not be paramount in the design of
research protocols, the very process of determining research energy intensity, tracking actual performance and providing feedback to researchers is expected to influence research energy use.

b. Education and Training: Education and training will be provided for both the building operations staff as well as the building users and occupants. An on-going effort will be made to review occupant behavior as it relates to building energy use and to educate and train occupants in ways to reduce their energy needs. The training will include providing measurement and metering of specific building systems, both passive and mechanical, and office and laboratory equipment so users know what impact the equipment has on energy use, training on how to utilize fume hoods to reduce fume hood exhaust requirements over time, and training and assistance in designing research protocols to limit the energy intensity of the research where practical.

Building operations staff and building users will be trained on a continual basis to maintain and improve performance. The expectation of building operators and occupants is that given the right information and training, they can adjust operations and behavior over time to ultimately achieve an even higher performing building than initially projected.

c. Tracking User Behavior and System Performance: The intent of Measurement and Verification is to provide each occupant the necessary feedback on their energy utilization and environmental impact on a real time basis in order to influence their behavior. A state-of-the-art central energy management server will provide each user access to apportioned energy use down to 2000 sq. ft. via point of use energy monitoring of HVAC, lighting, and miscellaneous power (plugs). Shared resources (i.e. lobby conditioning) shall be apportioned on pro rata basis. Every monitoring point wired to the Building Automation System (BAS) shall be trended (in minutes) at all times and stored on the remote server for immediate access by students, investigators, professors, and building operators. It will also be made available in the lobby’s energy and water education display area. Energy source data will be available within the same data base as well as the variables affecting their cost/impact, i.e. weather conditions. Users having real time knowledge of their consumption through display meters has been shown to significantly reduce energy use. Having these systems in place will allow researchers to gather data and study the impacts first hand further supporting the notion of the building as a living laboratory. Provision of the real time data that is readily accessible also favorably influences occupant behavior.

d. Commissioning: Commissioning of energy using systems will be integral to the project. An independent commissioning agent will be part of the project team from the beginning to ensure that commissioning requirements are included in the project design and specifications. Commissioning will be very important due to the potential energy use of lab exhaust systems and complex air system controls. The building management system and energy monitoring and measurement systems will require commissioning to ensure proper operation. Commissioning will establish a base-line operation for the building with the intent that with continued monitoring of performance and properly designed feedback loops to operators and occupants, the building energy use can actually decrease over time rather than increase as is the norm. Commissioning activities will include review of system operations during the first year of operation to verify proper operation in all climate conditions. An important aspect of the commissioning initiative will be the development of a building operations manual to guide building operations staff in the most efficient and effective means of operations. In addition, a
re-commissioning manual will be developed to facilitate commissioning of building systems on an on-going basis.

Integral to the commissioning initiative will be the definition of on-going commissioning activities to be included with scheduled maintenance and normal building operations. By incorporating basic system operation checks into the routine maintenance activities, problems will be uncovered earlier and impact energy performance less. Trend logs will be set up as part of the building automation system and review of trend log information will be scheduled as part of the routine planned maintenance program for the building.

e. User Feedback Loops: Feedback loops will be provided to building occupants to enable them to optimize their energy use in the building. Using measurement and monitoring systems, feedback on energy use will be provided at a number of levels – on a building wide basis, on a tenant by tenant basis and on a lab by lab basis. Information will be provided on actual energy use in a number of different categories as well as compared to predicted or budgeted energy use. One outcome of the Behavior Charrette will be to identify those feedback loops that are most useful to building occupants and users.

Energy use will be broken down into meaningful categories for occupants to understand how their behavior impacts the building’s energy goals. Information will be provided on an aggregate level (total building/office/lab use) but also based on individual categories. Feedback will be provided to users for energy use they control in order to allow them to optimize their own behavior. For example, plug loads in an individual lab will be metered and the information will be provided back to the lab user as these are loads that are generally under direct control of the researcher.

**Partner Experience and Credentials**

PIDC, agent for PAID, is a non-profit economic development corporation formed in 1958 as a partnership between the City of Philadelphia and the Greater Philadelphia Chamber of Commerce. With an internal staff of 60 professionals specializing in land use planning, real estate development and construction project management, in addition to substantial project finance expertise, PIDC is well suited to effectively steward a collaborative renovation project of this scope.

Since 1958, PIDC has closed a total of 5350 individual transactions with combined project costs of $15 billion, which have contributed to retaining and creating over 442,000 jobs in Philadelphia.

In 10 years following the federal government’s transfer of the former Philadelphia Naval Shipyard to PIDC on behalf of the City of Philadelphia, PIDC has

- Recruited over 90 new private sector companies to establish tenancy. These companies employ over 7,500 people.
- Directly managed the renovation of 275,000 square feet of historic buildings in seven individual projects, putting them back into productive economic use as office space.
- Overseen over $100 million in public infrastructure expenditures, and leveraged this with $500 million in private real estate development investment.
• Overseen development of 3.3 million square feet of heavy manufacturing, warehousing, and distribution facilities, over 500,000 square feet of newly developed or renovated office space. Representative projects range from over 250,000 square feet of award-winning historical renovation by Urban Outfitters of five historic buildings to the 185,000 square feet of LEED Platinum and Gold certified multi-tenant office buildings newly constructed since 2007 by Liberty Property Trust and 100% leased today.

• The newly renovated Building 100 Innovation Center opened in November 2007. The building, a joint venture between Ben Franklin Technology Partners and DVIRC, brings together private industry, academic institutions and government research in a single location to spur innovation and commercialization, and forms the first major physical building that will house DOE HUB/GPIC activities.

• Managed over 60 commercial, industrial, and research buildings.

Finally, PIDC has completed the following projects to date using EDA money:

• Renovation Program – 1997
  o $1.69 million
  o Renovated Quarters A,K,L,M,N and Building 10
  o Leveraged $10 million in public and private investment
  o Support approximately 200 jobs

• League Island Boulevard - 1999
  o $2.5 million
  o Built new access road opening up development to the Research Park, Corporate Center, East End, and Historic Core
  o Matched with $2.5 million in local funding

• Demolition Program - 2001
  o $5 million
  o Demolition in Corporate Center and Historic Core
  o Created sites for more then $2 million square feet for office and R&D development
  o Approximately 350,000 square feet completed or in development

• Infrastructure Development - Multi
  o $13.85 million
  o Building stabilization program funded through defense appropriations
  o Matched by more than $25 million in non federal funding

• 26th street Express Feeder - 2009
  o $5.0 million
  o Provided new electrical service to Girard Point area
  o Helped retain and create more then 750 jobs
  o Helped leverage $121 million of private investment

Feasibility Analysis

This project will be built in a historic, vacated, brick building constructed in 1942. The existing building is a two-story, 30,000 square foot structure that formerly operated as a gymnasium facility with spaces including a basketball court, swimming pool, fitness center, and locker
rooms. Construction for this renovation will occur within the existing structure and in this regard the project faces physical size constraints. Aside from physical limitations, regulatory and agency requirements can affect project components; however, the identified regulatory processes for this particular project are not expected to unduly burden the projected timeline.

**Method of Construction**

The project will be completed using an integrated design-build project team consisting of the design and construction team, the occupants and PIDC as the building owner and operator. The integrated design process is addressed in The Design Methodology section earlier. The integrated team will be led through preconstruction and construction by the Construction Manager on the project. The project will be procured on a competitive bid basis. Each trade line item of the project will be competitively bid in accordance with EDA procurement requirements. The Construction Manager will work closely with the Design Team, PIDC, and key project stakeholders in the preconstruction phase to provide cost estimating, project scheduling, logistics planning, value engineering, constructability analyses, and purchasing. Throughout construction, the Construction Manager will implement the procedures developed during preconstruction and will include services such as effective reporting systems, trade coordination, cost and schedule controls, and safety and quality assurance programs, and will adhere to sustainable building practices. The construction method and team efforts will ensure the intended level of LEED® Certification.

**Useful Life of the Facility**

The existing facility was built in 1942 for an anticipated 100-plus year life. A site analysis has determined the building to be functionally sound for the renovations intended through this project. The structure is adequate to support the facility for the initial five year research program and well beyond. The facilities’ open spans lend themselves to creating a project that is adaptable over time. The ability to attract a variety of tenants without significant design intervention is key to keeping the space fully occupied over the long-term. When renovating the facility, special attention will be paid to maintaining a high degree of flexibility in how tenants can adapt and use the space. As the planned institutions may outgrow the space, PIDC’s long term plan is to continue to lease the spaces to private industry focused on innovative, commercially relevant business endeavors.

**Construction Estimate**

*See the attached breakdown for a summary of the detailed project cost estimate.*

**Required Permits**

A) Prerequisite Approvals (prior to permit applications)
   1. Zoning Application & Approval
   2. Building Permit Application (Expedited Review Process)
   3. Philadelphia Water Department - Water/Sewer/Storm Water Management Submission
   4. Streets Department - Encroachments on Public Way Submission
   5. City Planning Commission

B) Permit Submissions
   1. Soils Investigation Report
2. Structural Design Criteria Form
3. Special Inspection Forms
4. Energy Conservations Form
5. PE Stamped Building Drawings
6. PE Stamped Water Flow & Pressure Availability
7. PE Stamped Hydraulic Calculations for Fire Suppression System
8. PE Stamped Mechanical Drawings
9. PADEP Submission for E&S Controls
10. Phase 1 & 2 Site Survey

Schedule Estimate

The following is an estimate of the length of time required for each phase of the project:

1. Design Period 12 months
2. Solicitation of Bids and Awarding of Contracts 6 weeks
3. Construction Period 9 months
GPIC | Greater Philadelphia Innovation Cluster for Energy Efficient Buildings

Proposal to:  U.S. Department of Commerce – Economic Development Administration
             U.S. Department of Commerce – National Institute of Standards and Technology
             U.S. Department of Energy
             U.S. Small Business Administration

Date:       May 6, 2010

FOA:        Fiscal Year 2010 Energy Efficient Building Systems Regional Innovation Cluster Initiative

NIST MEP CO-APPLICATION
INTRODUCTION

The goals of the Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings are to improve energy efficiency and operability and reduce carbon emissions of new and existing buildings, focusing on full spectrum retrofit of existing average-size commercial and multi-family residential buildings, and to stimulate private investment and quality job creation in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond.

Greater Philadelphia is an interconnected, well-defined and historically recognized region comprising ten contiguous counties situated in Southeastern Pennsylvania and Southwestern New Jersey with the City of Philadelphia at its heart and occupying in excess of 3800 square miles. The location for the DOE HUB/GPIC is the Clean Energy Campus at the Navy Yard in Philadelphia. The Navy Yard, which was closed by the federal government in 1996, represents one of the nation’s largest and most dynamic redevelopment opportunities. The 1,200 acre site currently houses more than 90 companies with more than 7,000 employees and is poised for continued strategic investment and growth in the years ahead.

A cornerstone of the Navy Yard redevelopment effort is the Clean Energy Campus, aimed at making the Navy Yard a national center of excellence for energy research, education, and commercialization. The Clean Energy Campus currently houses the DOE Mid Atlantic Clean Energy Applications Center, the DOE Northern Mid Atlantic Solar Training Center, and the DOE Grid Smart Training Applications Resource (GridSTAR) Center.
The DOE HUB comprises a uniquely dynamic and diversified team of 11 prestigious academic institutions including a historically black university, two DOE laboratories, five high profile global industry partners, regional economic development agencies, and community colleges. DOE HUB activities are organized into five tasks, which are: 1) tools for integrated design, verification, and modeling; 2) components, diagnostics, sub-systems, and controls; 3) public policy, behavior, economics, and business; 4) education and workforce development; and 5) demonstration, deployment, and IP management.

DOE HUB headquarters facilities will include two buildings at the Navy Yard which will house HUB personnel. A historic building will undergo a major retrofit and a new advanced integrated building sciences laboratory will be constructed. These facilities will function as living laboratories from design, through construction, commissioning and operation for developing tools and methods to transform the industry’s current fragmented serial process into system performance driven, integrated, parallel, team processes. The Commonwealth of Pennsylvania has committed $30 million of new capital funding to support these facilities.

The GPIC is the culmination of many years of dedicated team building effort. More than 60 GPIC partners from government, industry, education and workforce development, banking and finance, labor, and philanthropic foundations have made commitments to the GPIC. The DOE HUB and the GPIC are tightly integrated. The EDA, NIST, and SBA co-applicants all are represented on the DOE HUB /GPIC Executive Board, and all serve as DOE HUB members.

The management of the DOE HUB /GPIC utilizes state-of-the-art communications and information technology and blends hierarchical control with decentralization, promoting day-to-day teamwork but also providing authoritative decision-making when needed. The heart of the enterprise is the collaborative Operating Committee comprising the five DOE HUB task leaders (two from industry, two from academia, one from a regional economic development agency), the Navy Yard test bed facilities manager, and the Deputy Director. Ultimate decision making authority, however, rests with the DOE HUB /GPIC Director and the Executive Board.

PROJECT SUMMARY

The GPIC comprises four Pennsylvania counties (Bucks, Chester, Delaware, and Montgomery), five New Jersey counties (Burlington, Camden, Gloucester, Mercer, and Salem) and the City of Philadelphia (also a Pennsylvania county). This initiative was undertaken to coalesce, develop, and leverage the region's substantial energy related assets in support of a robust strategy for economic growth through alternative energy development and commercialization. The Delaware Valley Industrial Resource Center (DVIRC) will collaborate and support the other co-applicants of the project: Penn State University, the Philadelphia Industrial Development Corporation, and the Wharton Small Business Development Center.

The partners in the Greater Philadelphia initiative have uniquely positioned the region to be a leader in energy efficient buildings research, education and training, and technology development, demonstration, and deployment. Central among
those founding partners is the DVIRC, a performance leader among the National Institute of Standards and Technology’s (NIST) Manufacturing Extension Partnership (MEP) Centers since 1995. The DVIRC is applying as the co-applicant for NIST funding to assist energy efficient building related small and medium size manufacturing enterprises (SMEs) in the Greater Philadelphia region improve their global competitiveness, develop new products and markets, and create high-quality jobs in the region. The DVIRC, in collaboration with its sister-center, the New Jersey Manufacturing Extension Partnership (NJMEP), will identify SMEs in the Greater Philadelphia region that are or can be integrated into the supply chains of original equipment manufacturers (OEMs) in the building energy efficiency sector, and will assist these firms to participate in all GPIC activities.

Efforts will target regional SMEs possessing manufacturing capacity and strategic objectives that can address and relate to the technology focus areas of the Energy Innovation Hub such as advanced lighting, HVAC systems, construction materials, power management, and others. The DVIRC will assist these firms in participating in Hub research, education and training, and technology development, demonstration, and deployment activities to position them as preferred suppliers to OEMs in key building energy efficiency sectors, as well as to benefit from every aspect of Hub activity. In partnership with the NJMEP, Wharton SBDC, and other project partners, DVIRC will encourage broad participation among all stakeholders, including business, academia, government, and economic development. In addition to being a co-applicant, DVIRC is also a funded DOE Hub member participating in the education and workforce development and, demonstration, deployment, and commercialization activities of the GPIC.

In alignment with the goals laid out in the NIST MEP report—*Innovation and Product Development in the 21st Century*—DVIRC and NJMEP will use this opportunity to promote the economic benefits of collaborating to create cultures of innovation that accelerate the adoption and implementation of advanced technologies, techniques and products: “Connecting firms into competitive cluster strategies is an important role played by government, industry associations, economic development agencies, and others within a state or region.”1 The GPIC project brings these strategic elements and partners together and supports this cluster approach to innovation.

DVIRC and NJMEP will seek to connect the project and the regional market of SMEs to the expertise at the NIST Laboratories, including but not limited to the Building and Fire Research Lab, the Chemical Science and Technology Lab, the Materials Science and Engineering Lab, the Information Technology Lab, and the Manufacturing Engineering Lab. Consistent with its organizational history and performance, DVIRC will document what it learns from discrete projects as a way to leverage knowledge in the marketplace. As a key partner in the overall project, and in collaboration with the NIST MEP program office, we will share and disseminate information and opportunities that emerge from the project to our broad set of regional and national stakeholders.

Ultimately, and consonant with the MEP mission, we will seek to maximize our work with individual companies and groups of companies to support our regional economy and to contribute to the business, environmental, and societal challenges facing the nation. For DVIRC and NJMEP, this translates into project activity within firms that produces a measurable company and community impact.

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1 Hollings Manufacturing Extension Partnership Advisory Board, February 2010.
According to Dun and Bradstreet Analytics (2Q, 2010), there are 8,717 firms that fall into the target NAICS/SIC Codes for the project in the 10-county Greater Philadelphia target marketplace:

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<tr>
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<td>Electrical industrial apparatus, nec</td>
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PROJECT NARRATIVE

This section describes the activities to be undertaken with NIST MEP support by the DVIRC, in partnership with its sister MEP, the NJMEP, as a GPIC co-applicant.

Encouraging Participation

DVIRC will encourage the participation of individuals from industry, universities, State governments, and Federal agencies in cooperative technology transfer activities, as well as efforts to make new manufacturing technology developed within the Energy Hub and E-RIC usable by United States companies.

- The founding principle of the Navy Yard Energy Campus and the KIZ was “partnership.” Based on the presence of Navy power and energy research activity at the Yard, since 2004 and well in advance of the E-RIC opportunity, the group of organizations constituting this Regional Industrial Cluster has been collaborating and leveraging its collective assets, experience, expertise, and physical and capital resources to develop a regional center of excellence in power and energy.
- DVIRC has a tradition of convening standing organizations to capture, share, and shape the regional economic development dialogue. Two powerful examples include: (1) the Greater Philadelphia Engineering Deans Economic Development Council that is comprised of engineering deans from the tri-state region’s nine engineering schools, and (2) the Regional Compact for STEM Education, an initiative, formed in partnership with Pennsylvania’s academic, business and government leaders, which has become a national model for the advancement of Science, Technology, Engineering and Math (STEM) education, and which has 100 signatories.
- DVIRC has a tradition of working with State government as evidenced by its long standing partnership with the Pennsylvania’s Department of Community and Economic Development (DCED) and further leverages its progress and promotion through organizations such as the State Science and Technology Institute, an organization of state-supported members organization directed at technology-based economic development.
- DVIRC has both a tradition and proven track record of successful relationships with federal agencies. The many examples include NIST for its MEP efforts, the National Science Foundation for its efforts in STEM education, the Department of Labor for Applied Engineering Technology education, the Navy for the National Defense Education Program, and SBA for programs dealing with emerging manufacturers.
- Ongoing work at the Navy Yard Clean Energy Campus (following) offers additional evidence of DVIRC’s interest in and ability to engaging in productive collaboration.

The Philadelphia Navy Yard was closed in 1996 by the federal government, and its redevelopment represents one of the nation’s largest and most dynamic urban redevelopment successes and opportunities. In 2004, The Navy Yard was designated a Keystone Innovation Zone as part of a program of the Commonwealth of Pennsylvania designed to foster unique public-private partnerships and to support entrepreneurship in economically challenged geographic areas. Founding sponsors of this designation included the DVIRC, Pennsylvania State University, Ben Franklin Technology Partners of Southeastern Pennsylvania, the City of Philadelphia, the Philadelphia Industrial Development Corporation (PIDC), and the Navy’s NAVSEA Warfare Center – Carderock Division (NSWCCD). The NSWCCD is a $500 million per year, 1,700 employee Navy laboratory focused on propulsion, energy, acoustics, communications and materials engineering and is among the nation’s premier concentrations of scientific and technical expertise in power and energy within the federal laboratory network. As such, their presence has contributed significantly to KIZ focus on the power and energy-related sectors.

Leveraging the Navy’s core technical expertise at the Navy Yard, the KIZ designation provided the catalyst for a thorough assessment of the regional strengths in research and technology as drivers of economic development, and led to the formation of The Navy Yard Power Group, a growing group of public and private partners focused on creating economic opportunity by leveraging the complementary activities of education, research & development, and technology commercialization, specifically in the power and energy industry.

The KIZ also worked with the DVIRC and Ben Franklin Technology Partners of Southeastern Pennsylvania to convert a historic structure into the Building 100 Innovation Center, a 30,000 square-foot centerpiece for research and development and commercialization of physical and engineering science. In addition to DVIRC and Ben Franklin Technology Partners, Penn State,
Drexel, and a number of startup technology firms reside within the Building 100 Innovation Center.

A key aim of the redevelopment effort is to make the Navy Yard and Greater Philadelphia a national hub for clean energy research, education, and commercialization focused specifically on clean and efficient energy production, storage, and management.

The centerpieces of this strategy are the combined education, research and commercialization strengths of government, industry, and universities in the Greater Philadelphia region. Since its inception, the Navy Yard KIZ has helped more than 100 entrepreneurs, attracted seven start-up technology companies, and advanced major research programs, commercialization, and workforce development initiatives including:

- **DOE Mid-Atlantic Clean Energy Application Center**, a partnership among DOE and KIZ partners, including DVIRC, to promote the use of Combined Heat & Power (CHP) within the region by reducing the perceived risk of CHP to users, foster CHP as a viable technical and economic option for the region, and to capitalize on existing regional CHP resources.

- **DOE Northern Mid-Atlantic Solar Resource & Training Center**, a partnership between DOE and Penn State to transform the solar energy market by facilitating translational research, commercialization, and workforce development in state-of-the-art solar photovoltaic and solar thermal technologies.

- **DOE Grid Smart Training Applications Resource (GridSTAR) Center** to provide education and workforce training in smart grid technologies with a permanent site at the Navy Yard.

- **Innovations in STEM**, a DVIRC-led, Navy funded tri-state (PA, DE, & NJ) initiative to develop and deploy Science, Technology, Engineering, and Math (STEM) programs throughout the region (particularly those developed by the National Defense Education Program), as well as a Navy Yard STEM initiative focusing on renewable and intelligent distributed power and energy, and green technology.

**Encouraging Implementation of Advanced Technology and Techniques**

DVIRC will assure the successful implementation of advanced technology and techniques developed by the DOE co-applicant and/or E-RIC partners. DVIRC, in the MEP tradition, measures its success by its effect on the top- and bottom-lines of its client companies. DVIRC measures its success in terms of increased profitability and productivity improvement, as well as increased sales and entry into new markets. To succeed, DVIRC must positively affect the competitiveness of its client companies. To that end, research publications and prototypes offer no benefit to the SME marketplace unless those developments can be translated into usable, marketable products and services.

The Greater Philadelphia Regional Innovation Cluster will utilize DOE Energy Innovation Hub funding to develop technologies and policies to accelerate the retrofit of existing commercial and residential buildings of average size (approximately 10,000-20,000 square feet). The goals of the effort are to improve energy efficiency and operability and reduce carbon emissions of existing buildings, and to stimulate private investment and quality job creation in building energy efficiency retrofit markets in the Greater Philadelphia region, the larger Mid-Atlantic region, and beyond.
DVIRC will work with and support the GPIC Hub’s integrated Research, Design, Development and Deployment (RDD&D) test bed facilities and processes, actively support and help companies connect to the GPIC-Commercialization and Creativity Institute (GPIC-C2I), and work directly with the project partners to help SMEs develop new products and processes that lead to commercialization of new energy efficiency technologies for OEMs and for mid-sized commercial and multi-family residential buildings.

The NIST MEP effort will focus on and support the five task areas of the project: 1) Tools for Integrated Design, Verification, and Modeling; 2) Components, Sub-Systems, Controls, and Diagnostics Task; 3) Public Policy, Behavior, Economics, and Business; 4) Education and Workforce Development; and 5) Demonstration, Deployment, and IP Management. The HUB will be located at the Philadelphia Navy Yard Clean Energy Campus.

The DVIRC will function within the consortium to help energy efficiency-related small and medium size manufacturing enterprises (SMEs) in the Greater Philadelphia region improve their global competitiveness, develop new products and markets, and create high-quality jobs. The DVIRC, in collaboration with NJMEP and the Wharton SBDC, will identify SMEs in the Greater Philadelphia region that are or can be integrated into the supply chains of original equipment manufacturers (OEMs) in the building energy efficiency sector, and help these firms participate in activities of the Energy Innovation Hub.

Efforts will target regional SMEs possessing manufacturing capacity that can address technology focus areas of the Energy Innovation Hub such as advanced lighting, HVAC systems, construction materials, power management, and others. The DVIRC will assist these firms in participating in Hub research, education and training, and technology development, demonstration, and deployment activities to position them as preferred suppliers to OEMs in key building energy efficiency sectors.

Since its inception in 1988, the DVIRC has engaged in services directed at improving the productivity and technological performance of several hundred small to mid-sized manufacturing firms. As such, the DVIRC has developed an expertise, unique among like MEP centers, in the barriers that these firms face in the adoption and utilization of new and, in particular, leading edge technologies. Furthermore, DVIRC has a similarly unique appreciation for the elevated risk associated with new technology adoption as it relates to continuity of production and the absence of production scale and capacity found in larger firms necessary to mitigate that risk.

DVIRC and the NJMEP will serve as the primary advocates for the region’s small to mid-sized manufacturing sector’s participation in, contribution to, and benefit from the identification, development, and capture of new knowledge, product and process technologies, and market opportunities resulting from the Regional Innovation Cluster. Toward that end, the DVIRC will perform the following tasks in partnership with NJ MEP and other E-RIC partners:

- **SME Market Analysis**: Conduct a market analysis of the targeted 9 county region spanning the Greater Philadelphia region to determine the following:
  - The number of SMEs that participate, directly and indirectly, in the supply chain value stream for energy-related systems & technologies, building technologies, systems, and construction, and energy management systems consulting.
  - The number of SMEs, particularly in sectors which utilize high-energy consumptive industrial processes, for which energy costs are affecting their ability to compete.
The level and area(s) of interest in participation in knowledge sharing, university-industry partnerships for joint technology/product/process development.

The identification of any and all barriers that exist to inhibit penetration of new markets, competition in existing markets, and the development and distribution of new or existing products, services, or production processes.

- **Market Analysis of Service Delivery Tools & Systems:** Conduct a market analysis of existing delivery tools & systems commercially available for the assessment, analysis, and optimization or transformation of a company’s energy profile and/or specific product development or utilization energy profile. Explore, at a minimum:
  - Products, tools, and systems that have been or remain in use within the national MEP network for energy assessment or for the elimination of waste in the design, production, and distribution value stream.
  - Products, tools, and systems that have been or remain in use by public utilities and federal agencies for energy assessment of buildings and production processes.
  - Products, tools, systems, and services that are commercially available for energy assessment of buildings and production processes.

DVIRC will represent SME interests in GPIC RDD&D activities and will utilize its understanding of the marketplace of needs and opportunities to ensure appropriate consideration by SMEs in the research & development activities of the GPIC by:

- Ensuring that products, services, and technologies that are developed are scalable and financially accessible to the SME marketplace.
- Brokering opportunities for participation in joint research & development with participating university partners and larger enterprise partners.
- Providing expert knowledge and understanding of the SME marketplace needs and gaps to other consortium members as inputs to the research and development process.

DVIRC and NJMEP will link this activity with our emerging Tech Scouting activity in partnership with RTI.

**Documentation and Leverage**

DVIRC will assure the proper documentation and leveraging of a particular advanced technology or process. In addition, market analyses and tools developed will be broadly shared with GPIC partners, mindful of company confidentiality issues, as we work to help SMEs identify and engage in innovation opportunities that result from the project.

- DVIRC will apply its expertise in the small and mid-sized manufacturing marketplace to ascertain if a particular technology or process is scalable and affordable (and therefore usable!) by smaller firms. In an effort to ultimately transfer the technology to the broader marketplace appropriate documentation and intellectual property provision must enable ready access to the development. DVIRC will serve as the advocate for the SME interest in all relevant developments by the DOE co-applicant and/or E-RIC partners.
- DVIRC will contribute to the centralized database for all RIC activities, including existing but project-modified software for the planning, scheduling, tracking of all program activities, as well as income, expenditure, and evaluation.

**Sharing and Dissemination of Information**

DVIRC will share and disseminate information related to manufacturing technologies among industry, universities, non-profit economic development organizations and state governments.
• DVIRC will establish a web-based clearinghouse to disseminate lessons learned, best practices, and case studies of energy efficiency related practice areas with SMEs. The clearinghouse will employ “push” technologies to participants interested in keeping track of cluster developments, market opportunities, and opportunities for collaboration. Target audiences include cluster partners, regional and national SMEs, State governments, economic development entities, other MEP organizations, and the private sector.

• DVIRC will keep its existing networks – the Navy Yard KIZ, the national MEP network, the IRC network, the Dean’s Council, the Regional Compact for STEM, and the states through SSTI – apprised of new technologies, new processes, and service developments of the Regional Innovation Cluster.

As DVIRC, NJMEP, and Wharton SBDC work to inform the marketplace about the emerging technology development and commercialization opportunities, DVIRC and NJMEP will continue to offer training and consulting services to the SME marketplace directed at cost savings and/or growth opportunities that improve the firm’s overall competitiveness or develop and expand new and existing markets. Focus areas include:

• **Building retrofits**: Partnering with Penn State in the identification and transformation of existing buildings utilizing the tools, technologies, systems, and protocols developed by the research partners.

• **New product/market development**: Work with SMEs to identify new energy related products and markets. Assist companies in redesigning existing products/services and processes to reduce carbon footprint leading to “greener” products. Assist SMEs in capturing the “green” marketplace.

• **Workforce development**: Work with area community colleges and K-12 educators to develop certificate and degree-based educational programs and to deliver training modules directed at the development of the current and next generation of scientists, engineers, and technicians in energy-related fields. DVIRC has a track record of successful work with local educational institutions on Applied Engineering Technology certificate and degree programs. Leverage Navy/National Defense Education Program investments to complement Cluster workforce training and educational development efforts.

The partners will work to ensure the timely dissemination of best practices, tools, new technologies, and service methodologies developed by the research and economic development partners in the areas of energy efficiency and building retrofits. These will include the following:

• **Communication with regional SMEs**: DVIRC will leverage market research and analysis as an opportunity to create a community of interest in energy efficiency related research, developments, benchmarks, policies and protocols, and supply chain opportunities.

• **Communication with other service providers**: Leverage training and consulting tools and techniques to like entities beyond the regional marketplace. Such secondary markets include other MEP centers, other economic development organizations, State governments, training and workforce development entities, and private service providers. To the maximum extent possible, training, tools, and delivery techniques should be packaged in a manner to ensure the widest dissemination and maximum leverage and impact of the federal investment.
• **Clearinghouse**: DVIRC will work with the NIST MEP Program Office to establish a clearinghouse to disseminate lessons learned, best practices, and case studies of energy efficiency related practice areas with SMEs. The clearinghouse will employ “push” technologies to participants interested in keeping track of cluster developments, market opportunities, and opportunities for collaboration. Target audiences include cluster partners, regional and national SMEs, State governments, economic development entities, other MEP organizations, and the private sector. The National Innovation Marketplace is one tool that may support this clearinghouse function.

We will also coordinate and align, where appropriate, education and workforce development activities that seek to create educational programming and opportunities in the emerging market.

**Maximizing Impact**

DVIRC will encourage efforts to maximize economic, environmental, societal and innovation impacts in the context of regional, state, and national challenges.

- To the maximum extent possible, DVIRC will make available market intelligence as it relates to the needs of small and mid-sized manufacturing firms and their needs and abilities to readily adopt energy-related technologies that may decrease their carbon footprints, and, through adoption, the development of new products and markets.
- DVIRC will make available service delivery models, tools, and techniques for succeeding in this endeavor to like organization’s sharing a common interest. DVIRC sees this as the primary means for leveraging the impact of NIST’s investment in this proposal.

**Management, Governance, and Organizational Plan**

The two prime partners in this application—DVIRC and NJMEP—are fully committed to this project and will collaborate on the work described herein to support the individual project goals of this application and to support the larger goals of the Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings. As the prime contractor with NIST MEP, DVIRC will assume full project management responsibility and adhere to all federal standard operating procedures, fiscal requirements, and reporting guidelines.

DVIRC will serve on the GPIC Executive Board and, in addition to being a co-applicant, is also a funded DOE Hub member participating in the education and workforce development, and the demonstration, deployment, and commercialization activities of the GPIC.

The DVIRC is part of Pennsylvania’s Industrial Resource Network, a program funded by the Department of Community and Economic Development (DCED). The DVIRC is a private, not-for-profit economic development corporation supported by the Commonwealth and managed by private industry. The combination of DCED and NIST funding to the DVIRC represents about one-third of the DVIRC operating budget. DVIRC realizes the remainder of its operating budget through revenues generated by its consulting and training services. In 2006 alone, DVIRC customers documented over $170 million in cost savings or productivity improvements.

The NJMEP is the sole MEP center operating in New Jersey. Similar to DVIRC, NJMEP is a private, not-for-profit corporation managed by an industry-driven board of directors. NJMEP focus is to make New Jersey’s small to mid-sized manufacturers become more efficient, profitable, and globally competitive. Revenues generated through its consulting and training services and focuses on both cost savings and growth strategies similarly drive NJMEP.
has helped hundreds of companies save an average of 20% of the time, effort, or costs associated with the business and manufacturing processes.

As a Consortium member, DVIRC and by extension, NJMEP, will abide by the agreements itemized in the Memorandum of Understanding: Greater Philadelphia Regional Innovation Cluster for Energy Efficient Buildings.

- **Roles and responsibilities:** DVIRC and NJMEP will assume joint responsibility for outreach, communications, market analysis, and project work with the 10-county market of over 8,000 manufacturing and manufacturing-related SMEs in the targeted NAICs Codes.

- **Commitment of partners (timeframe, funding, role, contribution):** The partners understand that any initial commitment is for one year and that this application is part of a larger, multi-year project. Regardless, the partners are committed to participating in the longer-term effort as to support the larger goals of the Consortium and will work with Consortium members to identify and acquire the resources needed for continued participation.

- **Evidence-based decision making:** As organizations driven by the quantitative results of its work with clients, and as members of the national MEP system, the partners are committed to evidence- and data-based decision making. The MEPs’ broad experience in the discovery process that is used to help companies identify and articulate their needs, combined with independent, third-party verification of the results of work done with client companies has made the Centers data-driven with a keen eye toward return on investment.

- **Data sources and metrics:** As leaders of and voices for the advanced manufacturing sectors in their respective states, the partners consistently rely on and utilized primary and secondary source data to drive strategy and operations and to communicate with their clients. Among the data collection elements and performance metrics we seek to put in place are, including a two-tiered market stratification of 20-200+ employees and 1-19 employees:
  1. Number of Pre-qualifying questionnaires sent/completed
  2. Number of Full Disclosure questionnaires sent/completed
  3. Tele-marketing Pre-qualification results
  4. Tele-marketing Full Disclosure results
  5. Number of Direct Mail pieces sent/responded to
  6. Number of companies/individuals attending outreach/information seminars
  7. Number of one-on-one interface meetings held for final preferred supplier qualification
  8. Project work initiated as a result of one-on-one meetings

**Sustainability Plan (out years)**

Project work resulting from an innovative, collaborative approach to the market will create new opportunities for SMEs in the bi-state region to innovate for improved competitiveness. This project work will also help address sustainability issues and more clearly define the actual value that SMEs see and get for their efforts. In the MEP tradition, this is always the key to longer term sustainability.

In addition, going forward we will focus MEP project work and E-RIC project opportunities on SMEs in the urban center of Philadelphia, Camden, and Chester.
Greater Philadelphia’s design, engineering, and production capabilities remain formidable and will remain a key to the region’s ongoing economic viability. While the partners are hopeful that multi-year NIST funding will help to accelerate and take to scale the work described in this proposal, DVIRC and NJMEP will continue to bring this opportunity to the marketplace as one offering of an already robust suite of business growth and productivity improvement services.
GPIC
Greater Philadelphia Innovation Cluster for Energy Efficient Buildings

Proposal to:
U.S. Department of Commerce – Economic Development Administration
U.S. Department of Commerce – National Institute of Standards and Technology
U.S. Department of Energy
U.S. Small Business Administration

Date: May 6, 2010
FOA: Fiscal Year 2010 Energy Efficient Building Systems Regional Innovation Cluster Initiative

SBA CO-APPLICATION
GREATER PHILADELPHIA INNOVATION CLUSTER
SBA CO-APPLICATION

INTRODUCTION

The goals of the Greater Philadelphia Innovation Cluster (GPIC) for Energy Efficient Buildings are to improve energy efficiency and operability and reduce carbon emissions of new and existing buildings, focusing on full spectrum retrofit of existing average-size commercial and multi-family residential buildings, and to stimulate private investment and quality job creation in the Greater Philadelphia region and the larger Mid Atlantic region, and beyond.

Greater Philadelphia is an interconnected, well-defined and historically recognized region comprising ten contiguous counties situated in Southeastern Pennsylvania and Southwestern New Jersey with the City of Philadelphia at its heart and occupying in excess of 3800 square miles. The location for the DOE HUB/GPIC is the Clean Energy Campus at the Navy Yard in Philadelphia. The Navy Yard, which was closed by the federal government in 1996, represents one of the nation’s largest and most dynamic redevelopment opportunities. The 1,200 acre site currently houses more than 90 companies with more than 7,000 employees and is poised for continued strategic investment and growth in the years ahead.

A cornerstone of the Navy Yard redevelopment effort is the Clean Energy Campus, aimed at making the Navy Yard a national center of excellence for energy research, education, and commercialization. The Clean Energy Campus currently houses the DOE Mid Atlantic Clean Energy Applications Center, the DOE Northern Mid Atlantic Solar Training Center, and the DOE Grid Smart Training Applications Resource (GridSTAR) Center.
The DOE HUB comprises a uniquely dynamic and diversified team of 11 prestigious academic institutions including a historically black university, two DOE laboratories, five high profile global industry partners, regional economic development agencies, and community colleges. DOE HUB activities are organized into five tasks, which are: 1) tools for integrated design, verification, and modeling; 2) components, diagnostics, sub-systems, and controls; 3) public policy, behavior, economics, and business; 4) education and workforce development; and 5) demonstration, deployment, and IP management.

DOE HUB headquarters facilities will include two buildings at the Navy Yard which will house HUB personnel. A historic building will undergo a major retrofit and a new advanced integrated building sciences laboratory will be constructed. These facilities will function as living laboratories from design, through construction, commissioning and operation for developing tools and methods to transform the industry’s current fragmented serial process into system performance driven, integrated, parallel, team processes. The Commonwealth of Pennsylvania has committed $30 million of new capital funding to support these facilities.

The GPIC is the culmination of many years of dedicated team building effort. More than 60 GPIC partners from government, industry, education and workforce development, banking and finance, labor, and philanthropic foundations have made commitments to the GPIC. The DOE HUB and the GPIC are tightly integrated. The EDA, NIST, and SBA co-applicants all are represented on the DOE HUB /GPIC Executive Board, and all serve as DOE HUB members.

The management of the DOE HUB /GPIC utilizes state-of-the-art communications and information technology and blends hierarchical control with decentralization, promoting day-to-day teamwork but also providing authoritative decision-making when needed. The heart of the enterprise is the collaborative Operating Committee comprising the five DOE HUB task leaders (two from industry, two from academia, one from a regional economic development agency), the Navy Yard test bed facilities manager, and the Deputy Director. Ultimate decision making authority, however, rests with the DOE HUB /GPIC Director and the Executive Board.

PROPOSAL SUMMARY

The GPIC comprises four Pennsylvania counties (Bucks, Chester, Delaware, and Montgomery), five New Jersey counties (Burlington, Camden, Gloucester, Mercer, and Salem) and the City of Philadelphia (also a Pennsylvania county). This initiative was undertaken to coalesce, develop, and leverage the region's substantial energy related assets in support of a robust strategy for economic growth through alternative energy development and commercialization. The Wharton Small Business Development Center (SBDC) will collaborate and support the other co-applicants of the project: Penn State University, the Philadelphia Industrial Development Corporation, and the Delaware Valley Industrial Resource Center. All GPIC co-applicants are also funded members of the DOE HUB.
The GPIC for Energy Efficient Buildings offers an important opportunity for the Pennsylvania SBDC network – and the SBDCs at The Wharton School of the University of Pennsylvania, at Temple University and at Rutgers University in Camden -- to support the economic development of the Southeast Pennsylvania and Southwest New Jersey region by (1) helping small businesses understand, commercialize and deploy appropriate technologies to make buildings more energy efficient and to improve the environmental impact of small businesses in the region, thus creating jobs and business growth in the region, and (2) developing and implementing business models and tools that can be used to aid small businesses nationwide.

The SBDCs will support small businesses in the region to overcome many of the barriers that often prevent them from deploying energy efficient building technologies, including: lack of knowledge, a fragmented buildings community including many small businesses, financing challenges, misalignment of stakeholder incentives, different incentives for building owners and building users, and high up-front costs of energy and environmental technologies.

SBDC GOALS

The Pennsylvania and New Jersey SBDCs will support small businesses in the region and collaborate with HUB partners to develop the energy efficiency industry here as a foundation of economic growth, a national model and center of excellence through:

1. Promotion of awareness and understanding of new energy efficient building technologies and environmental responsibility to small business owners throughout the region through education, information and outreach.
2. Supporting small business owners throughout the Greater Philadelphia Region to evaluate, finance, and deploy technologies for clean technologies, energy efficient or green buildings, and environmental performance.
3. Accelerating the commercialization of clean and energy efficient building technologies within the region including those developed and demonstrated by the GPIC HUB.

Through these activities and through active participation in Task 5 and collaboration with Tasks 3 and 4, the Pennsylvania and New Jersey SBDCs will:

1. Accelerate and increase the effectiveness of commercialization of technologies developed by the GPIC by providing business inputs to the development, demonstration and deployment decisions of the GPIC members throughout the Stage Gate Process. The SBDC team will provide targeted market, competitive, and investment research to support commercialization decisions through active participation in the Commercialization and Creativity Institute (See Task 5).
2. Expand the partners participating in the GPIC and economy to include many more small and underrepresented (minority-, veteran- and women-owned) businesses.
3. Expand and accelerate the deployment of technologies and practices that increase performance of buildings in the region and technologies developed by the GPIC.

THE NEED AND THE OPPORTUNITY

Leading non-profits and local governments in Pennsylvania and New Jersey that are GPIC partners have been active in establishing policies to promote and to overcome barriers to implementing environmental and energy responsibility. According to the American Council for an Energy-Efficient Economy, New Jersey and Pennsylvania rank 13 and 14 out of the 50 states in 2009. EPA has identified their “National Top 50 Partner List (as of January 5, 2010) to
include the organizations which are the 50 largest purchasers of green energy in the nation. Among them are these partners in the GPIC: Commonwealth of Pennsylvania is number 8, University of Pennsylvania is the highest university on the list at number 20 rank, Carnegie-Mellon number 41, Penn State University number 43. In December 2009 Philadelphia offered tax breaks to businesses certified as sustainable.

As state and city governments, universities and large non-profits in the GPIC have instituted policies to promote environmental responsibility green jobs have been created in this region in substantial numbers. Global Insight indicates that Greater Philadelphia is one of the top ten regions where business and government have already created green jobs and are creating awareness of the challenges, and estimates that in 2006 there were 14,379 green jobs in the Philadelphia region. An October 2008 study by Global Insight for the National Council of Mayors predicts 183,000 green jobs to be created in the Greater Philadelphia region by 2038.

Much remains to be done toward the national and regional goals of reducing energy use and increasing environmental performance in buildings in the region. There are over 44,000 business establishments in the region that are involved in industries closely requiring buildings – real estate, construction, manufacturing and retail (US Bureau of Census, 2007 and 2009, County Business Patterns.) Most of these are small businesses, and most of these have not yet deployed green technologies significantly. Electricity prices in southwest Pennsylvania are scheduled to be deregulated in January 2010, with prices expected to rise by more than 10 percent.

The opportunities and challenges for these small businesses addressed in this program are substantial. Small business owners in the GPIC have a substantial need for business advice and knowledge about energy-efficient and environmental technologies, financing opportunities as they confront higher utility prices, new technologies, and the opportunities to grow their businesses and become local leaders. The region’s small businesses have been active in pursuing this knowledge and in increasing their environmental responsibility.

- In January and February 2010, over 60 business owners attended Wharton SBDC educational programs, co-sponsored with B-Lab and the Greater Philadelphia Sustainable Business Network, to learn about the city tax break offered to businesses certified as sustainable.
- The Sustainable Business Network of Greater Philadelphia, a group of small business owners pursuing the “triple bottom line,” has grown to over 500 fee-paying members since its founding in 2002.
- Social Venture Institute of the Sustainable Business Network of Greater Philadelphia, in which the Wharton SBDC collaborates, had over 120 attendees in each of the last 2 years. Over 25% percent of the attendees were minorities.

“One problem that currently exists in the industry, however, is a knowledge gap across many contracting firms. Some firms are not fully aware of some green construction techniques or the wide variety of modern materials that can be used in a given renovation project. This makes them unable to effectively educate customers about the energy efficient building options that are available. ... Despite these current limitations, we should not expect to see a new industry populated by a new breed of "green construction workers." As green building technology becomes increasingly popular—due to advocacy programs like Energy Star® — traditional contractors will develop their skill sets and expand their knowledge bases in ways that will allow them to transform large numbers of ordinary buildings into some of the most energy efficient in
the world. The existing stock of energy inefficient buildings offers an opportunity to reduce total electricity demand and create jobs for these workers....” The National Conference of Mayors report prepared by Global Insight (p.13)

Wharton, Temple and Rutgers-Camden SBDCs together advise over 1,500 small businesses in the region each year. They are seeing increases in traditional contractors and small businesses in the region seeking to close these knowledge gaps and to apply clean energy and efficient building technologies to grow their businesses.

- Temple SBDC’s Construction Program – run annually over the academic year has been fully subscribed and has educated over 300 contractors to date– the program has experienced an increased interest in green and clean technologies among the contractors who participate.
- Example case: Griff Paper worked with the Wharton SBDC to investigate their CEO’s insight that investment in solar products would be a profitable area for the firm; now Griff is a leader in solar products.
- Example case: Russell Roofing first worked with the Wharton SBDC to investigate profitability and opportunities; the Wharton SBDC studied the solar technology market. By 2010 the company had established Russell Solar, a company with certified technicians installing solar systems and retaining over 50 jobs that were threatened during the economic slowdown.

Small businesses in the region have also evidenced a large interest in increasing the energy efficiency of buildings they own by contacting the PA SBDC EMAP program. Over 500 energy audits and recommendations performed by the PA SBDC EMAP program on small business commercial buildings have resulted in an average of 25% reduction in energy use through changing the lighting, improving insulation and the building envelope, and increasing the HVAC efficiency. (The estimates based in part on one year post-implementation audits and projections.) This 25% energy use and cost reduction is in line with EPA’s Energy Start FAQ: **How much can I save?** Depending on your facility’s operating hours, condition, equipment and energy costs, savings of 25% or higher are typical. We can help you decide on a strategy that optimizes savings and upgrade costs, and help design an upgrade that quickly pays for itself, and then yields monthly cost reductions. EMAP has also enabled small business owners to tap into grants and subsidies provided by the Commonwealth of Pennsylvania.

Wharton SBDC has also seen an increase in small businesses who are commercializing new green or clean technologies intended to provide clean energy and energy-efficient building technologies worldwide or regionally:

- A real estate development and architecture firm in Philadelphia has worked with Wharton SBDC to develop their business plan for a sustainable building production system that produces replicable, modular and sustainable building production system which re-conceptualizes buildings as a collection of finished, highly crafted, highly sustainable and affordable modular spaces manufactured in a factory and assembled rather than built on-site. The objective is to deliver cutting edge, LEED- Certified buildings with twice the energy efficiency, in half the time, for costs similar to, or the same as non-sustainable, traditional construction.
- In 2010, a biofuels company with proprietary technology came to Wharton SBDC for aid to sales by quantifying the savings and value to municipalities from applying their
technology. They are using the analysis as a framework for sales and value description to potential customers.

- In 2010, a US based start-up came to the Wharton SBDC for aid in assessing the US market and developing marketing/sales approaches for applications of an energy-saving and award winning technology they had licensed from China.

ABOUT THE SBDCs

For the GPIC, the Pennsylvania SBDC network will leverage the capabilities and resources of SBDCs at The Wharton School of the University of Pennsylvania, Temple University and Rutgers University at Camden. The Pennsylvania SBDC network – comprised of SBDCs at 18 universities throughout the state has an outstanding track record of supporting small businesses to start, grow and prosper. In a typical recent year:

- Entrepreneurs and businesses served 7,000
- Educational Programs 216
- Financing obtained $79,027,994
- Businesses Started 860 489
- Jobs Saved and Created 3,755
- Sales Increased $105,240,304
- Tax Revenues Generated $25,000,000

Independent research has confirmed for many years that businesses that have consulted with the Pennsylvania SBDC network have higher business success and survival rates than typical small businesses in the nation: 80% of PA SBDC-assisted clients are still in business 8 years after receiving assistance from the Pennsylvania SBDCs. SBDC clients survive at a rate approximately 35% higher than the average new business in the United States.

The Wharton SBDC will lead the GPIC-SBDC program. The Wharton SBDC was founded in 1980 and is now part of the Sol C. Snider Entrepreneurial Research Center of the Wharton Entrepreneurial Programs - the first and widely acknowledged as one of the most influential entrepreneurial centers in a business school. Our mission is to aid small businesses in the Greater Philadelphia region to start, grow and prosper and to enhance the education of Wharton students.

The Wharton SBDC serves over 600 businesses with consulting and 1500 with workshops annually - over 25,000 since its founding in 1980. The Wharton SBDC has developed a unique and highly effective “teaching hospital” model for service delivery to leverage the students, faculty and staff of the Wharton School and partner with professionals and leading organizations including private equity funds and several leading strategic consulting firms, including McKinsey and BCG.

The Temple SBDC is known locally for its Construction Management Program. Over 300 people have been educated in the program since its inception. The program educates approximately 15 people on average each year. Most of the participants who attend the training program use the skills they have learned to develop their construction business or expand operations. For example, a contractor based in Chester County who attended the program was able to expand his operations, hire additional sub-contractors and bid on projects that he could not otherwise undertake prior to attending the program. A private developer who attended the program was able to understand the construction process better and deal with contractors more
effectively to his advantage. To date, he is still in business and continues to rehab and renovate buildings in the Philadelphia area.

Together the Wharton, Temple and Rutgers-Camden SBDCs serve over 1,500 small business clients annually. The Wharton, Temple and Rutgers-Camden SBDCs have delivered on their commitment to serve minority and women-owned businesses: over 30% of the Wharton SBDC’s small business clients self-identify as minority – a much greater percent than the percent of minority-owned businesses in the region. The percentages are even higher at Temple and Rutgers-Camden. The Wharton SBDC will model its SBA sponsored GPIC activities on three established programs:

- **CAP (Commercialization Acceleration Program)- Life Sciences** works with the Center for Technology Transfer at the University of Pennsylvania and other research centers in the region to provide business guidance for technology transfer officers as they prepare to license or develop start-up businesses based on discoveries from their institutions. CAP provides research to guide early commercialization decisions such as clinical trials, investing and indications to target. Research topics are focused to support decision-making and include market size in various applications, contributions to current medical practice, challenges to technology adoption and buying decisions through the value chain, evaluation of options for first applications of the technology and others.
  - Based on the 3-year program, 11 start-ups from the University of Pennsylvania have attracted entrepreneurs and funding options in part based on the contributions of the CAP program.

- **Clean Tech High Growth Consulting** was begun in 2009-2010. The clients in these projects have CEOs, often intellectual property, and usually sales. The projects aid the CEOs in making decisions about sales strategies and market expansion. Examples of projects include:
  - A biofuels company for which the project team conducted interviews and secondary research to develop a value proposition the company could use in their effort to sell projects to municipalities.
  - A funded start-up with US rights to a prize-winning Chinese energy efficiency technology. The project team in this case studied competitive technologies to aid the CEO in his go-to-market strategy.

- **The CIBER (Center for International Business Education and Research)** at the University of Pennsylvania has collaborated with the Wharton SBDC High Growth Consulting program for 2 years and provided funding for the program during 2010 to support the SBDC’s project consulting for small businesses which are enhancing their international competitiveness and undertaking exports. CIBER support has been for Wharton SBDC programs and consulting which increase the international competitiveness and exports of small businesses. The Wharton SBDC will be able to address export opportunities as they arise by drawing on its experience in high growth consulting projects.

**THE PROPOSED GPIC PROGRAM**

Led by the SBDC at The Wharton School at the University Pennsylvania, the Pennsylvania and New Jersey SBDCs at Temple and Rutgers-Camden will use SBA funds to support small businesses in the region by:
• Promotion of awareness and understanding of new energy-efficient building technologies and environmental responsibility to small business owners throughout the region through education, information and outreach.

• Supporting small business owners throughout the Greater Philadelphia region to evaluate, finance, and deploy technologies for clean technologies, energy-efficient or green buildings, and environmental performance

• Accelerating the commercialization of clean and energy-efficient building technologies within the region including those developed and demonstrated by the GPIC.

These activities will be carried out in close collaboration with the DVIRC, the Commercialization and Creativity Institute (TASK 5), and with advice from the large business members of the E-RIC. The Wharton, Temple and Rutgers-Camden SBDCs will also be funded by DOE for outreach and to deploy the HUB-developed and demonstrated technologies. The Wharton SBDC will participate directly in the HUB Commercialization throughout the Stage Gate process through the Commercialization and Creativity Institute Task 5 – described in the Task 5 of the Joint Proposal – and collaborate with Tasks 3 and 4.

The GPIC SBDC program will draw on the expertise, programs and experience of the Wharton, Temple and Rutgers-Camden SBDCs and PA SBDCs E-MAP (Environmental Management Assistance Program). These SBDC programs will be carried out in close collaboration with technology licensing officers within the GPIC member institutions and will use GPIC facilities – showcasing GPIC facilities and technologies to small business owners in the region. This effort will be closely coordinated with the intellectual property management and technology validation, prototyping, demonstration, and deployment activities of the GPIC. The SBDC programs will be delivered throughout the GPIC, relying on webinars, conference calls, websites, as well as in-person demonstrations at the facilities at the Navy Yard.

PROGRAM ACTIVITIES AND DELIVERABLES

This section describes the activities to be carried out by the Wharton SBDC and its sister SBDCs in the Greater Philadelphia region with SBA support resulting from participation in the GPIC. Note, however, that the Wharton SBDC will also carry out additional activities as a funded member of the DOE HUB.

Activity 1: Promote Building Energy Efficiency Awareness

Efforts will be undertaken to promote awareness and understanding of new energy-efficient building technologies to small business owners throughout the region through education, information and outreach. The SBDCs at the Wharton School, Temple University and Rutgers-Camden will plan and promote awareness and understanding to small business owners throughout the region. Deliverables include at least 7 educational programs to a total of at least 200 participants in year 1 and 9 programs to a total of at least 250 participants in later years. Web-based information resource developed in first year and enhanced in subsequent years. At least 2 cases developed in years 3 and 4 to teach small business owners about energy efficiency and environmental responsibility in buildings.

At least 7 educational programs will be presented each year to at least 200 participants. Educational workshops, programs, and resources on Energy Efficient Building technologies and environmental performance will increase awareness of business owners of the technology options for energy efficient and clean technologies and will aid business owners to make good
business decisions about adapting and implementing the technologies in their own businesses and in offering these technologies to their customers.

- These programs will be presented at the SBDCs at Wharton, Temple and Rutgers-Camden during the first year. Presenters will draw on the expertise of professionals from GPIC. As the demonstration facilities and technologies are developed at the Navy Yard, programs will be offered there. Programs will also be offered via Webinar. Outreach and marketing will be done by all 3 SBDCs to small businesses throughout the entire GPIC: e-newsletters have subscriber lists which reach over 18,000 entrepreneurs in the region.

- Temple SBDC will develop and deliver twice in each year one educational program especially for contractors and construction entrepreneurs who provide service and have the opportunity to incorporate energy efficient technologies in the services they provide their customers. It will leverage the experience, expertise and contacts of the established and respected Construction Management Program SBDC at Temple University. The program will have no more than 4 sessions, be offered twice a year, to an expected 30 total participants a year, and the curriculum will be available to other SBDCs by request and via conferences.

- In year one the Wharton SBDC will adapt their core business planning and educational programs for all small business owners to include environmental responsibility and energy efficiency in buildings (technology, operations and financing opportunities). This will include at least 4 workshop programs presented to at least 100 participants during the first year and more thereafter.

- Once the facility at the Navy Yard is completed, in year two some educational and workshop programs will be based at the HUB and will use the demonstration facilities provided there.

- Participate in the annual Pennsylvania SBDCs E-MAP Resource Fair for small businesses in the region to promote awareness of new energy efficient building technologies developed by and demonstrated by GPIC, their potential impacts on the businesses, how to assess and evaluate their appropriateness for their business or facility and how/where to access construction and building services companies that can help them implement the technologies.

During the first year a web-based information resource will be developed and made available on the web to aid small business owners in the region to identify energy-efficient building technologies and environmental technologies appropriate for their business and in getting companies to work with them effectively to implement them. This will be enhanced each year and will be valuable to other SBDCs and small business support agencies throughout the country as they provide advice on energy efficiency technologies for small business.

By year three, the SBDCs will develop and use in educational and conference programs 2 cases each year based on GPIC experiences and small businesses receiving services. These will be an important basis for promoting understanding of energy efficiency and environmental performance in buildings among small businesses in the GPIC and can be used nationally. (These will relate to HUB learnings from Task 3 and 5 as well as the SBA-funded SBDC work.)

**Activity 2: Assist Regional Small Business Owners**

Small business owners throughout the region will receive assistance to evaluate and implement technologies for energy-efficient buildings and for environmental performance including use of hazardous materials, clean technology and alternative technologies. Deliverables include
advising over 20 small business owners each year on technology, business strategy, and financing, related to energy efficiency and environmental performance options. The program will leverage the established clean energy and business building consulting practices at The Wharton School which advises over 600 small business owners annually and will assist the consultants at Temple and Rutgers-Camden when clients present with this need. Advising over 20 small business owners annually on technology, business strategy and financing related to energy efficiency and environmental performance options. This includes the following:

- Helping small business owners to evaluate their business challenges, opportunities and options and make good business decisions. This will include sharing information about incentives, grants, tax provisions, and technology options with small business owners as well as developing financing strategies, sharing analysis and best practices and generating options for the small business owners. Including:
  - Small business owners who own buildings and must make upgrade/retrofit decisions
  - Small business owners in the construction, architecture, design or related service or manufacturing industries where they have the opportunities to recommend and implement new energy efficient building technologies. Some of these businesses will have the opportunity to export, and our services will – in collaboration with DVIRC – aid them to develop strategies for beginning expanding and financing exports.
- Leveraging the tools of the Pennsylvania E-MAP program to evaluate from an energy and environmental responsibility standpoint the buildings owned and used by small business owners. The program will provide technology, business and financing advice, and energy evaluations.

**Activity 3: Commercialization Acceleration Program (CAP)**

A Commercialization Acceleration Program (CAP) for energy-efficient building technologies will be developed by and with GPIC throughout the region. Deliverables include at least 15 commercialization projects a year for the first year, over 20 annually in later years. A program based at the Wharton SBDC to aid universities, and small businesses related to GPIC technology and companies as they bring new technologies to market. The program will be modeled on the Wharton SBDC’s successful CAP for the Life Sciences. This includes helping the universities and research institutes in the Hub as well as helping companies related to the Hub to commercialize new technologies.

Projects will address early and pro-actively some of the critical barriers to the deployment of technology. CAP research will begin early enough to impact demonstration decisions about the decisionmaking throughout the value chain. Projects will support Commercialization and Creativity Institute and PI decision-making by addressing issues such as – what are the barriers likely to impact adoption of a particular technology by builders, building owners, architects? How can the barriers be overcome by anticipating changes in technology, businesses involved, policy and/or in financing and/or in education and promotion?

- Wharton SBDC’s CAP for life sciences has found, for example, that early market research through the value chain can redirect the clinical trials from cardiology (where the technology has value but doctors are unlikely to use an experimental treatment which might undermine their billings for alternative gold standard procedures) to oncology (where doctors are looking for and will use new procedures more quickly).
• CAP projects based on GPIC technology – especially those that involve manufacturing -- are likely to have export potential. As needed by small business clients, the Wharton SBDC will be able to address export opportunities as they arise by drawing on its experience in CIBER high growth consulting projects for small businesses to enhance their international competitiveness and exports.

The CAP-Energy team will participate in the Commercialization and Creativity Institute – GPIC Task 5 (Commercialization). In this aspect of the Wharton SBDC program, the Program Director will participate early and often with BFTP and DVIRC in Task 5 reviews of new technologies throughout the Stage-Gate process. In addition, this part of the SBDC program will help the universities and research institutes in GPIC and additional GPIC partners to commercialize new technologies. The program, led by the SBDC at The Wharton School of the University of Pennsylvania, will include market opportunity and competitive assessments, technology assessments, planning for attracting financing (including advice on SBIR grants as appropriate), advice on developing new business models, and information needed for investors as well as potential customers. In each case, the project will be led by experienced professionals and staffed by University of Pennsylvania graduate and undergraduate students who are selected for their expertise and education. Many of the students participating are dual degree candidates at The Wharton School (business) and Engineering. Penn students are also evidencing very high interest in and commitment to energy, environmental performance and responsibility.

Activity 4: Extend Services Throughout and Beyond Greater Philadelphia

Programs and material resources will be made available to SBDCs, economic development agencies, and to small business owners located at a distance from Philadelphia.

• Outreach for all programs will leverage the SBDCs in Pennsylvania and New Jersey as well as the HUB.
• The material in courses and workshops and information resources of the Temple and Wharton SBDCs on the subjects of environmental responsibility and energy-efficient buildings will be made available to other SBDCs and those who aid small businesses through the Wharton SBDC and Temple SBDC websites as well as through GPIC conferences.
• Informational resources will be available on the website
• The programs will be offered to small business owners throughout the region in New Jersey as well as in Pennsylvania and will be made available to business owners farther away via webinar.

OPERATING PLAN

The Wharton SBDC Director will be a full member of the Executive Board of the GPIC. The Wharton SBDC Director will report regularly on SBDC program and deliverables to the Executive Board of the GPIC. The SBDC-DVIRC-GPIC Advisory Committee will be created and will provide coordination and guidance to the SBDC GPIC programs. The Committee will meet quarterly, be chaired by the Wharton SBDC Director, include Directors of Temple SBDC and Rutgers-Camden SBDC; Associate Director Pennsylvania SBDC, Director Pennsylvania SBDC E-MAP, and representatives from large business partners in GPIC, DVIRC, regional SBA, GPIC Commercialization and Creativity Institute.
SBDC GPIC Program

- The Wharton SBDC Director will be responsible and accountable for deliverables of the program.
- The SBDC Program will be evaluated and its plans adapted annually in consultation with the Advisory Committee.
- The Program Director will report and work closely with the Wharton SBDC Director.
- The SBDC GPIC Program Director will supervise and be responsible to the director for deliverables, and the organization will be part of the Wharton SBDC, modeled on and leveraging established Wharton SBDC operations.
- The GPIC Program Director will work with and be assisted by Wharton SBDC staff: Associate Director for developing and marketing educational workshops and programs and for working with administrative students, Managing Practice Leader for managing and guiding consulting projects and working with consulting students, Business Administrator for budget, IT specialist for developing web-based information projects.
- For specific deliverables such as the Construction Management Programs for Energy and Environmental Responsibility, the Wharton SBDC will subcontract to the Temple SBDC.
- For EMAP programs, the Program Director will work closely with the Director of the PA SBDC EMAP program.
- The SBDC GPIC Program Director will coordinate with Temple and Rutgers-Camden SBDCs to provide outreach for GPIC SBDC programs.
- The Wharton SBDC staff will provide administrative, financial and other support to the Program Manager.
- In Year 2 and beyond, DOE Task 5 will support the hiring of an Associate Director and additional consulting project resources for the SBDC program.
- The Program Director will be located at the Navy Yard for their primary office, traveling to Wharton and other locations as needed.

Year One Deliverables:

- 7 educational programs delivered to at least 200 total participants
- Web-based information resource for small business owners on energy efficiency for buildings developed and implemented
- Program Director participates in Commercialization and Creativity Institute
- At least 20 projects to advise small business owners to evaluate and implement technologies for energy efficiency and environmental performance
- At least 15 commercialization projects

Additional Option Year Deliverables:

- 2 additional educational programs to at least to additional participants
- Web-based information resource for small business owners on energy efficiency for buildings enhanced
- At least 5 additional commercialization projects
- At least 2 cases developed to teach small business owners about best practices in energy efficiency and environmental performance for buildings

Quality Assurance

The SBDC program will assure quality by hiring excellent, qualified, and committed staff and integrating them well into our team, maintaining a culture and values that uphold integrity,
learning, continuous improvement, viewing problems as opportunities for learning, and building quality into every program and consulting project from the beginning, per the policies of the Wharton SBDC.

- For instance, every new educational program and instructor is reviewed and approved by the Wharton SBDC’s Academic Director (currently the head of the Wharton Executive MBA Program and an Adjunct Professor of Finance)
- Written feedback is requested from every attendee at every educational program or workshop and reviewed by the Wharton SBDC Associate Director and Director.
- Consulting clients are all personally interviewed by the Director or the Managing Practice Leader; clients all complete needs assessments and indicate their business goals. Once the client’s needs are determined by these experienced professionals, a personalized action plan for services and collaboration is developed.
- When questions or problems arise, everyone brings the challenge to the group.
- Processes in place with reporting, regular checks and balances among staff and students.

PERSONNEL AND ORGANIZATION

The Wharton SBDC “teaching hospital” model of service delivery and experiential education has a proven track record of results, excellence, and efficiency. The Wharton SBDC has an excellent track record in attracting expert professionals as Program Manager and Consultants.

Wharton SBDC Director
The Wharton SBDC Director sits on the Executive Board of GPIC. The Wharton SBDC Director is responsible for the program deliverables, the education of Wharton students and small business owners, external relations, the development and financing of the organization, and the organization’s contribution to regional economic development. The current Director has taught marketing and operations management in The Wharton School’s MBA program since 1993 after a career of research and teaching at the Harvard Business School and Stanford University. She was the Director of the Global Consulting Practicum in the Wharton MBA program. She earned her PhD from Carnegie-Mellon University and her BS from Tufts University. She is the author of *Global Operations Management* (McGraw-Hill). She serves on the Advisory Board of the Roy and Diana Vagelos Program in Life Sciences and Management at the University of Pennsylvania.

GPIC Program Director (new position)
A Wharton SBDC employee, the Program Manager will hold an MBA from a leading business school or equivalent, will have experience and expertise in educating and advising entrepreneurs and small business owners, energy, environmental responsibility and buildings/real estate development, will have experience in achieving results through multi-organizational collaboration, guiding subordinates in consultation and business analysis. The individual will also have experience in and commitment to economic development and developing early stage technologies. The Program Director position is parallel to the managing practice leader position that has been filled for 7 years with professionals who hold MBAs from top programs and have significant post-MBA experience.

Example bio of the Current Managing Practice Leader: The Current Managing Practice Leader has 20 years of experience after her Wharton MBA. That experience includes: mergers and acquisitions for a large telecom firm, leading and founding her own tech-oriented consulting
firm, co-founding a venture capital firm. She holds an MBA from Wharton, a BA from Bryn Mawr, and is a candidate for PhD in cultural anthropology at the University of Pennsylvania.

Professional Consultants and Instructors
The Program Director will select and guide professionals for consulting and instructors with subject matter and skill expertise to supplement their own expertise. It is expected that they will leverage their own expertise with professionals with expertise in the design and construction of high performance green buildings, the use of renewable energy sources, the development and commercialization of clean technology, and/or energy efficient practices and with expertise in market research methodologies in early stage technologies, and/or with expertise in financing.

Example Bio of Consultant in CAP-Life Sciences: This consultant is an expert in advising big pharmaceutical companies on the market opportunities for early stage therapeutics. He founded and led his own market research firm which served big pharmaceuticals for 20 years before he sold the firm. He currently consults, invests, and teaches at Wharton and another local university. He holds a masters degree in Market Research from the University of Texas at Austin and a BA from the University of Pennsylvania.

MBA and Undergrad Consultants
Our MBA students have over 7 years of business experience before they apply and generally work for some of the world’s top consulting, financial and entrepreneurial organizations. They are supported and augmented with business analysis and research by Wharton Undergrads. Students in CAP-Engineering will – as needed – include students who have engineering, real estate and environmental experience, education, and interests.

Professional Advisors and Volunteers
The Wharton SBDC has enlisted experienced business professionals as volunteers and advisors to our student teams. In addition, top strategic consulting firms participate in educating and advising our teams. In 2009-2010, McKinsey, Bain, BCG, Deloitte, AT Kearney, LEK and Health Advances participated pro bono in the program. As the GPIC program proceeds, we expect to engage consulting firms that have specific energy and environmental and green building expertise.

Financing and Funding Expertise and Opportunities
The Program Director will call upon the established partners of the Wharton SBDC to educate and provide analysis of financing options for small businesses considering investments in energy efficient buildings and environmental performance technologies. Among these are:

- The PA SBDC EMAP program which has an excellent track record at aiding small businesses in the region to get grants and obtain incentives.
- SBIR advice from SBDC consultants; SBDC clients in CAP Life Sciences have an excellent record in obtaining SBIRs.
- Obtaining investment support from the Ben Franklin Technology Partners of Southeastern Pennsylvania
- Small Business Administration
- Local banks
TRACKING RESULTS AND DELIVERABLES

The SBDC GPIC program will leverage the MIS system of the PA SBDC (WebCats) of the SBDCs to track educational program and consulting activities and results. Educational program deliverables will be tracked according to the policies of the Pennsylvania and Wharton SBDCs policies. These have been established and are easily followed and reported. Consulting activity deliverables – hours and clients and consultants – will be tracked per PA and Wharton SBDC policy and practice on the WebCats MIS system. The outcomes of the programs, the milestones and progress among the individual business provided services through the program will be tracked by the program manager and staff and recorded in Webcats.

- The challenge in tracking the longterm results of consulting and advice in early stage commercialization programs and often in small business consulting will be met by the Program Director.
- The Director will ensure that each client provided advice will be contacted each year for an update – through email surveys and, if necessary, telephone outreach.
- Cases will be written to provide promotional and educational functions within deployment. They will also provide rich reporting on the impact and practices of the program and its clients.
- Results and deliverables will be reported on quarterly to the Advisory Committee.