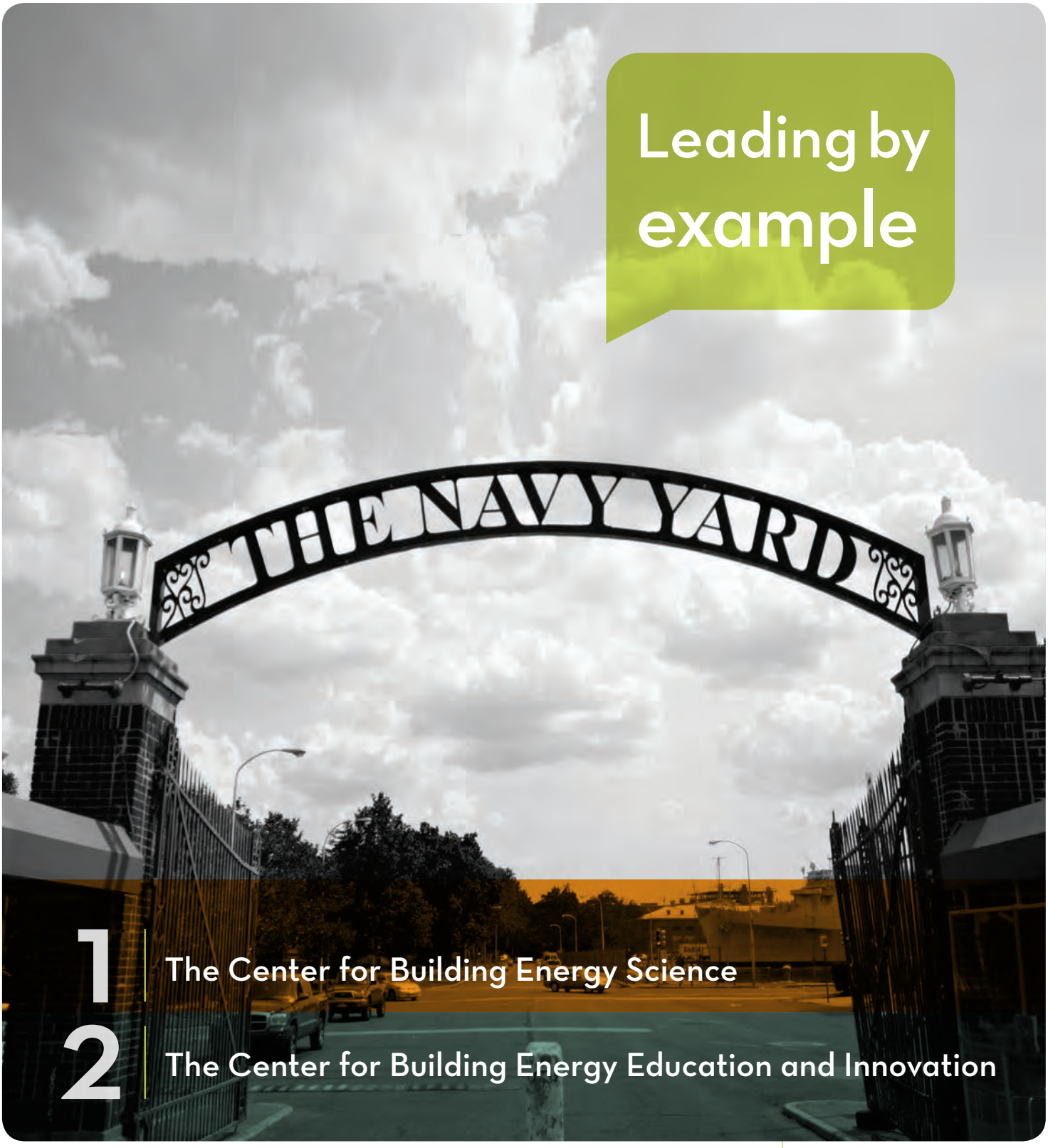

Leading by example

1 The Center for Building Energy Science

2 The Center for Building Energy Education and Innovation

eeb HUB Energy Efficient Buildings Hub

Re-energizing buildings for the future.™

Re-energizing buildings for the future

EEB Hub FACILITIES at The Navy Yard

With support from the Commonwealth of Pennsylvania and the U.S. Economic Development Administration, Penn State is developing two buildings at The Navy Yard in Philadelphia to advance the mission of the Energy Efficient Buildings Hub. One is a renovation of an existing building and the other is a new construction project. Each building supports and complements the objectives of the EEB Hub through its design methods, construction process, technologies incorporated, and mix of tenants and uses.

The building projects employ integrated design, construction, commissioning, and operational methods that optimize building systems and maximize energy efficiency. In addition, both buildings emphasize economical, state-of-the-shelf technologies that are easily transferable to the commercial building marketplace.

INTEGRATED ENERGY EFFICIENT DESIGN AND DELIVERY

The integrated design and delivery process serves as an example for industry to follow. This process includes establishing a new and different governance structure to guide the project, and a collaborative team that works together to make decisions for the design of the buildings.

The EEB Hub facilitated a meeting of building stakeholders – including owner, occupant, architect, construction management, and contractor representatives – to collectively identify project values in a pre-design workshop. The workshop concluded that the project values should include collaboration, learning, performance, predictability, and certainty, among others. Successive decisions were made using the filter of the accepted project values. This process increases quality and efficiency, decreases waste, and fosters greater collaboration among stakeholders.

1 Penn State Center for Building Energy Science

The Penn State Center for Building Energy Science is an innovative example of the type of advanced energy retrofits that are needed throughout the region and the country. The intent is to demonstrate how integrated design and construction methods can result in the cost-effective reduction of building energy use by at least 30 percent.

Divided into three separate programmatic zones – with appropriate integrated mechanical systems applied in each – the building functions as a living laboratory to showcase multiple energy saving technologies, with built-in monitoring and verification strategies for testing and performing energy efficiency research. Monitoring is critical to demonstrate performance, validate energy models, and provide case studies for industry-wide adoption.

ENERGY EFFICIENCY MEASURES

The Center for Building Energy Science features exposed mechanical and lighting approaches, real time monitoring, and public education spaces. Energy efficiency measures include:

- Passive and active chilled beams serving large public spaces and workrooms
- Under floor air delivery with displacement diffusers serving the second floor high-occupancy spaces
- Variable refrigerant volume system serving the first floor offices
- Dedicated outdoor air (DOA) unit with exhaust air energy recovery (enthalpy wheels)
- Demand controlled ventilation
- High efficiency condensing hot water boiler
- Heat recovery chiller providing regenerative heating and reheat during cooling season
- Automatic lighting controls in all non-utility spaces, vacancy/occupancy control in enclosed spaces, and time of day controls in common areas
- High efficiency LED lighting

Benefits

- Optimal levels of spray foam insulation added to walls (R-value 24) and roof (R-value 30) to reduce heat loss
- New double glazed low-emissivity (low-e) argon-filled units with thermally broken frames to replace existing windows, with higher performance glazing on the south facing windows and skylights
- Manual interior shades below skylight
- Trees on east and south side of the building to prevent glare and to act as exterior shade
- Reduced overall lighting power by approximately 8.5% below ASHRAE 90.1-2007 baseline

1. The current energy model indicates that the proposed design performs 43% better in terms of annual energy consumption relative to the ASHRAE baseline. This amount exceeds Penn State's requirement for 30% energy savings relative to ASHRAE 90.1-2007 (the relevant baseline for LEED version 3).

2. The proposed design is expected to earn thirteen of nineteen possible LEED EAc1 points (points for Energy & Atmosphere in sustainable design). Sixteen additional LEED EAc1 points may be achieved by proposing an atypical calculation method for airtightness improvements, resulting in significant energy savings.

3. The proposed design has an Energy Star rating in the range of 94-97, meeting the project goals of 75 or higher.

4. The energy use intensity (EUI) for the proposed design is 40 kBtu/sf-year, nearly half of the baseline design energy use intensity (EUI) of 71 kBtu/sf-year.

2 Penn State Center for Building Energy Education & Innovation

The Penn State Center for Building Energy Education and Innovation is a newly constructed training facility for building operators, building energy auditors, and other practitioners of building energy efficiency, and for the development of new business ventures in building energy efficiency. It represents a prototypical commercial building with capability for hands-on training, assessment, and problem solving associated with energy efficient building operations.

ENERGY EFFICIENCY MEASURES

The Center for Building Energy Education and Innovation features a mix of energy efficiency technologies and systems including many currently found in state-of-the-art commercial buildings as well as more innovative approaches that may have longer payback periods, but have the potential for greater market acceptance. Based on the integrated design process, the following energy efficiency and sustainability measures were included:

- High Efficiency ground source heat pumps for heating and cooling
- Displacement ventilation in auditorium
- Demand controlled ventilation
- Energy recovery ventilators
- Decentralized mechanical equipment that minimizes fan energy and length of duct runs
- Automatic lighting controls in all non-utility spaces, vacancy/occupancy control in enclosed spaces, and time of day controls in common areas
- High efficiency LED lighting
- 10 kW rooftop photovoltaic array that supplies a DC power grid ceiling in the technology classroom, an electric car charging station, and visible battery storage for demonstration
- Vegetated roof for stormwater management
- Innovative brick screen shading on the south facade that reduces heat gain and mitigates glare in the classroom and training spaces

Benefits

- Greywater system that filters rainwater for re-use in irrigation and toilet flushing
- Innovative translucent panel assemblies on the north and west facades which allow for higher interior daylight levels and reduced heat gain and loss due to higher insulation rates (R-9) than traditional glazing
- Reduced lighting loads through passive daylighting strategies in the classrooms, such as borrowed light from north-facing corridors, controlled shading on the south-facing windows, and overhead clerestory glazing
- Double glazed, low-e, argon-filled windows with thermally broken frames
- High performance insulation at the exterior walls (R-20) and roof (R-40)
- Reduced overall lighting power density by approximately 38% below ASHRAE 90.1-2007 baseline

1. The proposed design performs 32% better in terms of annual energy consumption relative to the ASHRAE 90.1-2007 (the relevant baseline building for LEED version 3).
2. The 32% reduction in energy consumption exceeds Penn State's requirement for 30% energy consumption savings relative to the ASHRAE 90.1-2007 baseline.
3. The energy use intensity (EUI) for the proposed design is 38 kBtu/sf-year, compared to the baseline design model energy use intensity (EUI) of 53 kBtu/sf-year.

SPECIAL THANKS TO OUR INTEGRATED PROJECT TEAM (IPT)

Kieran Timberlake (Architect)
- CVM (Structural Engineer)
- Bruce E. Brooks Associates (MEPFP Engineer)
- EMS/RADO (Integrated Design Mechanical/ Plumbing)
- MC Dean (Integrated Design Electrical)
- Hunt Engineering (Civil Engineer)
- Atelier Ten (Lighting Design/Environmental Consulting)
- Metropolitan Acoustics (Acoustical Consultant)
- Bryan Hanes Studio (Landscape Architect)
- Wilson Consulting (Specifications Consultant)

Balfour Beatty (Construction Manager)
- Associated Specialty Contractors, Inc. (Abatement and Demolition)
- Ernest Bock and Sons, Inc. (General Construction)
- Devine Brothers, Inc. (HVAC)
- Dolan Mechanical, Inc. (Plumbing)
- E.J. Electric, Inc. (Electrical)

Aramark Facilities Services (Commissioning Agent)
- Pennoni Associates (Geotechnical/Hazmat)

THE GOAL FOR COMMERCIAL BUILDINGS:
20% reduction in regional energy use by **2020**

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