



# Integrated Design

## Advanced Energy Retrofit

### ROADMAPS



Overview

Small to Medium-Sized Commercial Buildings

# WHAT IS AN INTEGRATED DESIGN ADVANCED ENERGY RETROFIT?

*Excessive energy use in buildings is a serious challenge—it may be yours!*

*"The annual cost to  
fuel and power the  
buildings of America is  
**\$400 Billion."***

\*RMI 1/26/12: Reinventing Fire: Buildings  
<http://www.youtube.com/watch?v=yli4aDCDrO8>  
&feature=youtu\_gdata\_player

## DOES YOUR BUILDING FACE THE FOLLOWING CHALLENGES?

- Increasing energy bills
- Cold and drafty offices, work spaces and warehouses
- Frequent heating and air-conditioning breakdowns
- Inadequate lighting
- Trouble retaining tenants
- Lower employee productivity
- Employees often sick or absent from work

## HIGH ENERGY BILLS?

*If yes, quite possibly, the building's...*

- Plug loads have increased with tenant changeover.
- Envelope has ruptures that allow air infiltration.
- Heating and air-conditioning systems are past their useful life.
- Lighting fixtures are inefficient and obsolete.
- System maintenance has been inconsistent and application of Measurement + Verification (M+V) has been limited.
- Passive heating and cooling benefits have not been maximized.

## What is an Advanced Energy Retrofit (AER)?

An Advanced Energy Retrofit is a building and systems based renovation of an existing structure focused on the energy savings potential of proposed retrofit activities. Modifications and improvements to building envelopes and mechanical systems can achieve 50% energy reductions, saving the owner significant operating costs throughout the life of the building.

*Your building may be ready for an Advanced Energy Retrofit!*

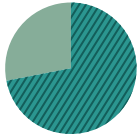


**Center for Building  
Energy Science and  
Engineering**

EEB Hub  
Advanced Energy Retrofit  
Philadelphia, PA  
Under Construction



"Buildings consume 42% of the nation's energy and 72% of its electricity."



\*RMI 2013: <http://www.rmi.org/About%20RMI>

"Commercial buildings account for 36% of all U.S. electricity consumption and have an annual energy cost of more than **\$190 Billion.**"

\*EERE 7/5/13: <http://www1.eere.energy.gov/buildings/commercial/about.html>

## How does one complete an Advanced Energy Retrofit (AER)?

Completing an Advanced Energy Retrofit (AER) is facilitated by a set of four **Integrated Design Roadmaps** developed by the Energy Efficient Buildings Hub (EEB Hub) with the goal of guiding building owners, their professionals and consultants in achieving high levels of energy efficiency. Each Roadmap discusses the recommended protocols and activities with the potential to achieve 50% energy savings.

## What scales of ID AER are available?

The **Lite Retrofit Roadmap** guides the market in the completion of retrofit projects whose scope includes the Purchase, Installation and Commissioning of a minimum of one new building system and the Existing Building Commissioning of at least one existing system.

The **Partial Retrofit Roadmap** guides the market in the completion of a retrofit project whose scope includes the Purchase, Installation and Commissioning of a minimum of two building systems and one building envelope component.

The **Substantial Retrofit Roadmap** guides the market in the completion of a retrofit project whose scope includes the Purchase, Installation and Commissioning of most building systems and building envelope components.

The **Comprehensive Retrofit Roadmap** guides the market in the completion of a retrofit project whose scope includes the Purchase, Installation and Commissioning of all building systems and building envelope elements through the use of customized process protocols.

## What is an Integrated Design Advanced Energy Retrofit (ID AER)?

Achieving the targeted 50% reduction in energy consumption requires the use of Integrated Design (ID) Protocols to coordinate the most effective energy conservation measures for attaining your high-performance goals. ID Protocols organize the various activities performed by all members of a retrofit team including building owners and their management teams; architects, engineers and constructors; as well as energy modeling and measuring professionals—all of whom are essential for an ID AER.

## WHICH BUILDING COMPONENTS ARE RETROFITTED DURING AN AER?

### BUILDING ENVELOPE SYSTEMS

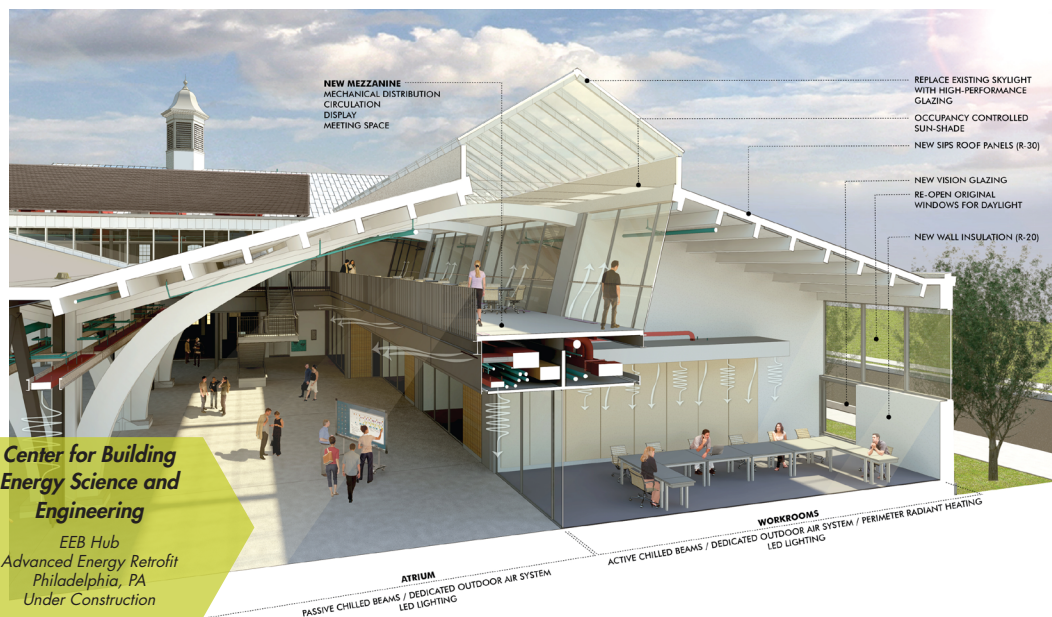
- Windows
- Wall Insulation
- Roof Insulation
- Air Infiltration

### MECHANICAL SYSTEMS

- Heating
- Ventilation
- Air Conditioning
- Controls + Sensors

### LIGHTING SYSTEMS

- Fixtures
- Controls + Sensors





# INTEGRATED DESIGN IN AN ADVANCED ENERGY RETROFIT

## What is an Integrated Design (ID) Process?

Integrated Design (ID) is a collaborative process-oriented set of activities for identifying shared priorities and goals in an effort to build consensus amongst all members on the retrofit team. Participants include the:

- Owner (building portfolio/financial/facility-managers)
- Architect
- Engineers
- General Contractor + Sub Contractors
  - Product and Service Suppliers
- Modeling and Measuring Professionals

To direct the ID Process, 7 Integrated Design Protocols are used in all Advanced Energy Retrofit projects, regardless of scale or scope. The EEB Hub Roadmaps organize all activities associated with each of the Integrated Design Protocols. These activities include collaborative project planning meetings, drafting of mission statements, and agreements on energy saving priorities, budgets, values, and goals.

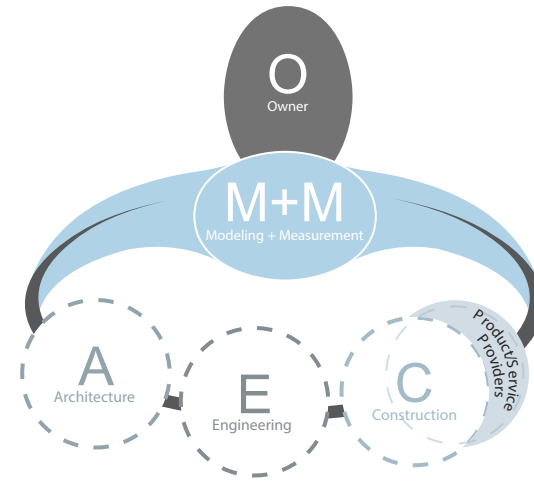
## How is an Integrated Design Process different from a typical renovation?

Renovations rarely capitalize on the value added benefits of having shared engagement between all project participants nor do they involve the degree of coordination typically undertaken during an Integrated Design Process. The ID Process ensures that building components are replaced, repaired or commissioned according to an agreed to list of priorities, maximizing the benefits of coordinated thinking.

## What's involved in completing an Integrated Design Advanced Energy Retrofit?

1. Commitment to a project mission statement that identifies shared protocols and outcomes.
2. Participation in collaborative planning meetings that align all team members around shared goals and outcomes.
3. The use of Integrated Design 'Requests for Proposals.'
4. Reviewing the added benefit of load reduction and energy free design solutions.
5. Adopting a whole building systems approach.
6. Using predictive modeling for identifying the most favorable energy conservation measures.
7. Committing to post-retrofit measurement and verification.

## TEAM ROLES + ORGANIZATION



## BENEFITS OF UNDERTAKING MODELING + MEASUREMENT IN AN ID AER:

By managing the energy consumption profile of your building both pre- and post-retrofit, benefits include:

- More efficient and comprehensive energy management.
- Increased energy savings both monthly, and throughout the building's life cycle.
- Comprehensive integration of engineering systems to meet energy targets.
- Facilitates participation in accreditation programs such as LEED and Energy Star.
- Encourages occupant behavior adjustment when post-occupancy results are shared.

# FIND OUT WHICH RETROFIT SCALE IS RIGHT FOR YOU

## TAKE THE QUIZ

### PART I: WHAT BUILDING TYPE ARE YOU RETROFITTING? (Circle One)

|                                   |                             |                            |                  |                           |                           |
|-----------------------------------|-----------------------------|----------------------------|------------------|---------------------------|---------------------------|
|                                   |                             |                            |                  |                           |                           |
| Single-Story Retail/Office (2 pt) | Multi-Family Housing (4 pt) | Three-Story Masonry (4 pt) | Warehouse (4 pt) | Multi-Story Retail (4 pt) | Multi-Story Office (6 pt) |

### PART II: HOW MANY ELEMENTS NEED TO BE REPLACED? (Circle All That Apply)

|                       |                |                         |                         |                                |
|-----------------------|----------------|-------------------------|-------------------------|--------------------------------|
|                       |                |                         |                         |                                |
| Roof (2 pt)           | Windows (2 pt) | Wall Insulation (2 pt)  | Air Infiltration (2 pt) | Lighting (2 pt)                |
|                       |                |                         |                         |                                |
| Light Controls (2 pt) | Heating (2 pt) | Air Conditioning (2 pt) | Ventilation (2 pt)      | HVAC Controls + Sensors (2 pt) |

### PART III: EXISTING BUILDING COMMISSIONING (EBCx) (Circle One)

Are you planning on completing some degree of Existing Building Commissioning?

YES (1 pt)      NO (0 pt)

### YOUR SCORE:

\_\_\_\_\_ + \_\_\_\_\_ + \_\_\_\_\_ = HOW MANY POINTS DO YOU HAVE?

PART I TOTAL      PART II TOTAL      PART III TOTAL

|       |
|-------|
| 5-7   |
| 8-12  |
| 13-18 |
| 19-26 |

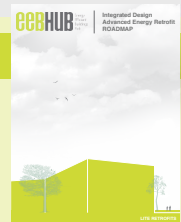
## INTEGRATED DESIGN PROTOCOLS

7 Integrated Design Protocols guide all Advanced Energy Retrofit Roadmaps, regardless of project size, scope and budget. The benefits for the project include:

|   |  |   |  |
|---|--|---|--|
| <p><b>1 PROJECT MISSION STATEMENTS</b></p> <ul style="list-style-type: none"> <li>• Shared by all members of the team, they create alignment around project goals and expectations.</li> <li>• Establish values, cost priorities, people-based protocols and performance metrics.</li> <li>• Organize and guide most decisions and procedures for the entirety of the AER.</li> </ul> | <p><b>2 ID REQUESTS FOR PROPOSAL (RFPs)</b></p> <ul style="list-style-type: none"> <li>• Sets performance based standards and financial goals for all team members.</li> <li>• Ensures all team members, including AEC professionals, Modeling and Measuring Consultants, and Product and Service providers have the requisite knowledge and experience for achieving the Owner's energy savings goals.</li> </ul> | <p><b>3 COLLABORATIVE PROJECT MEETINGS</b></p> <ul style="list-style-type: none"> <li>• Participation in all team gatherings creates engagement among team members.</li> <li>• Fosters feelings of ownership by all on the team.</li> <li>• Facilitates goal setting and project updating, as well as periodic detailed project reviews.</li> </ul> | <p><b>4 ENERGY FREE DESIGN</b></p> <ul style="list-style-type: none"> <li>• Promotes and evaluates a range of passive energy solutions that encourage load reduction.</li> <li>• Contributes to minimizing the size and cost of any new HVAC and lighting systems.</li> <li>• Encourages the use of renewable energy.</li> </ul> |
|---|--|---|--|



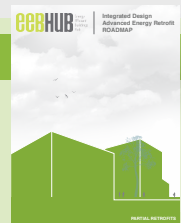
# SCALES OF RETROFIT: YOUR ROADMAP RESULTS



Please refer to the Lite Retrofit Roadmap

## LITE RETROFIT ROADMAP

A Lite Retrofit is a limited-scale project involving the participation of sub-contractors or building system suppliers in the Purchase, Installation and Commissioning of a minimum of one new building system and the Existing Building Commissioning of at least one existing system. Architects, engineers and construction management professionals are not required, with product suppliers and installers typically in charge of project delivery. In a Lite Retrofit, large-scale energy modeling and post-monitoring of the building and its systems will not occur.



Please refer to the Partial Retrofit Roadmap

## PARTIAL RETROFIT ROADMAP

A Partial Retrofit is a limited-scope retrofit of buildings involving the participation of one or no design and engineering professional(s) and completed with or without the participation of a general contractor. The project includes the Purchase, Installation and Commissioning of a minimum of two building systems and one building envelope component. Post-occupancy evaluation and minor energy modeling is recommended. Some form of Measurement and Verification (M+V) is recommended for post-project monitoring of the retrofit.



Please refer to the Substantial Retrofit Roadmap

## SUBSTANTIAL RETROFIT ROADMAP

A Substantial Retrofit is a large-scale project involving the participation of all architecture, engineering and construction professionals for the Purchase, Installation and Commissioning of most building systems and building envelope components. A significant amount of energy modeling is required as is post-construction monitoring of building systems. Significant resources are dedicated to M+V for post-project monitoring of the retrofit.



Please refer to the Comprehensive Retrofit Roadmap

## COMPREHENSIVE RETROFIT ROADMAP

A Comprehensive Retrofit is a maximum scope project involving the use of Integrated Design + Integrated Project Delivery protocols for the Purchase, Installation and Commissioning of all building systems and building envelope elements through the use of customized process protocols. Extensive energy modeling and post-occupancy monitoring is required to evaluate actual energy savings. The EEB Hub Roadmap would be significantly customized in a Comprehensive scope retrofit to meet the demands and goals of this AER.

## PROJECT TEAM GUIDE



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## PROJECT TEAM GUIDE



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# FINANCING ADVANCED ENERGY RETROFITS

## WORKFORCE SAVINGS

"When high performance, energy efficient buildings provide adequate daylighting, comfortable temperatures and better air quality to its inhabitants, savings accrued can reach:

**\$2,000/employee,**

leading to fewer absences and increased productivity."

(McGraw Hill Construction, "Business Case for Energy Efficient Retrofit and Renovation.")

## ENERGY EFFICIENT COMMERCIAL BUILDINGS TAX DEDUCTION

"Owners who reduce energy costs in a building at least 50% could potentially deduct up to:

**\$1.80/sq ft**

from their federal income taxes using the Energy Efficient Commercial Buildings Tax Deduction."

(Department of Energy 2012: 179D DOE Calculator, <http://www.iea.org/aboutus/faqs/energyefficiency/>)

## INCENTIVES

State based energy saving incentives are found in the Database of State Incentives for Renewables and Efficiency:

<http://www.dsireusa.org>

With this interactive map, property owners and their representatives have access to a full list of financial programs designed to facilitate the completion of advanced energy retrofits.

## Financing your Advanced Energy Retrofit

Completing an Advanced Energy Retrofit can result in significantly lower operating costs over the life cycle of the building. This results in savings for you and your business!

"Successfully retro-commissioning a building can result in a 10 to 20% savings in energy consumption with a payback of as little as four months, for an average cost of \$.30 per square foot. (Pike Research and LBNL)"

"Retrofitting a building's plug loads can be accomplished with minimal, if any, capital costs incurred, for a saving of 6 to 15 KBTU/SF/YR. ([www.Nilskok.com](http://www.Nilskok.com))"

## Observed Financial Benefits

Several certification programs exist to assist in the reduction of a building's energy consumption, such as Energy Star. Following through with a program such as this can help to secure added financial gains for a completed AER.

"According to the Rocky Mountain Institute, completing an Energy Star Certification can offer the following benefits:

- 5.8-26% increase in property value
- 1.3-11% increase in occupancy rate
- 3.0-15% increase in lease rates"

(AIA: <http://www.aia.org/aiaucmp/groups/aia/documents/pdf/aia099241.pdf>)

## EEB Hub Incentive Program Guide

Local utilities often provide incentives for commercial building energy efficiency and retrofit projects; it is worth determining if there are applicable incentives as part of the process of planning a building retrofit.

The Energy Efficient Building Hub's *Incentive Program Guide* is a tool for building owners to become familiar with current incentive programs for energy efficient retrofits offered by state agencies and utility companies in the ten-county Hub region. Those counties include: Bucks, Chester, Delaware, Montgomery, Philadelphia in Pennsylvania, and Burlington, Camden, Gloucester, Mercer, Salem in New Jersey.

For additional information on market incentives, consult our *Incentive Program Guide* on the Energy Efficient Buildings Hub website at:

[http://www.eebhub.org/media/files/EEB\\_Hub\\_Region\\_Incentive\\_Program\\_Guide.pdf](http://www.eebhub.org/media/files/EEB_Hub_Region_Incentive_Program_Guide.pdf)

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### WHOLE BUILDING SYSTEMS

- Promotes the accrual of savings when multiple systems are retrofitted at the same time.
- Ensures the operation of all systems (new or existing) are efficiently coordinated.
- Identifies the value of bundling retrofit measures.

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### PREDICTIVE MODELING

- Offers baseline model benchmarking for building energy consumption, pre- and post-retrofit.
- Forecasts where other energy savings or benefits may exist.
- Validates and tests potential design solutions for effectiveness in achieving energy target goals.

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### MEASUREMENT + VERIFICATION

- Enables the calibration of building systems post-retrofit to ensure they are operating as expected.
- Offers measurable data to substantiate energy savings claims.
- Demonstrates energy savings to tenants (existing and future) as well as to financing bodies.

"In 2010, energy utilities (gas + electric) in North America invested over **\$7 BILLION** to help their customers save energy."

\*IEA: FAQs: Energy Efficiency <http://www.iea.org/aboutus/faqs/energyefficiency/>

**30%**

Portion of energy in buildings used inefficiently or unnecessarily."

\*US EPA, Energy Star: Useful Facts and Figures [http://www.energystar.gov/ia/business/challenge/learn\\_more/FastFacts.pdf](http://www.energystar.gov/ia/business/challenge/learn_more/FastFacts.pdf)





COMPREHENSIVE RETROFITS

SUBSTANTIAL RETROFITS

PARTIAL RETROFITS

LITE RETROFITS

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