eebHUB Energy Efficient Buildings Hub

Presentation at the
U.S. DOE Building Technologies Office
Peer Review Meeting

Henry C. Foley
April 3, 2013

Purpose and Objectives

- Problem Statement
  - Building energy efficiency has not increased in recent decades compared to other sectors especially transportation
  - Building component technologies have become more energy efficient but buildings as a whole have not
- Impact of Project
  - A 20% reduction in commercial building energy use could save the nation four quads of energy annually
- Project Focus
  - This is more than a technological challenge; the technology needed to achieve a 10% reduction in building energy use exists
  - The Hub approach is to comprehensively and systematically address market, government, workforce, and technical impediments
  - The EEB Hub focuses on integrated systems approaches addressing technology, people, and information.

Energy- Regional Innovation Cluster (E-RIC)

Dual E-RIC Mission

Reduce energy use in buildings
Regional economic development

Department of Energy

$122 million: Penn State

Small Business Administration

$1.3 million: Wharton SBDC

Economic Development Administration

$3 million: Penn State

$2 million: Ben Franklin Technology Partners

National Institute of Standards and Technology

$1.5 million: Delaware Valley Industrial Resource Center

Commonwealth of Pennsylvania

$30 million: Penn State

Start Date: February 1, 2011

Goal, Vision, and Mission

OVERALL GOAL:

Reduce energy use in commercial buildings in Greater Philadelphia by 20 percent by 2020.

VISION:

Design and demonstrate in Greater Philadelphia scalable market proven solutions to reduce energy use in commercial buildings and deploy these solutions throughout the nation.

MISSION:

Accomplish the goal through informed people, validated information, and proven technologies.

Objectives

1. Develop and deploy state-of-the-art modeling tools to support energy efficient design, construction, commissioning, and operation.

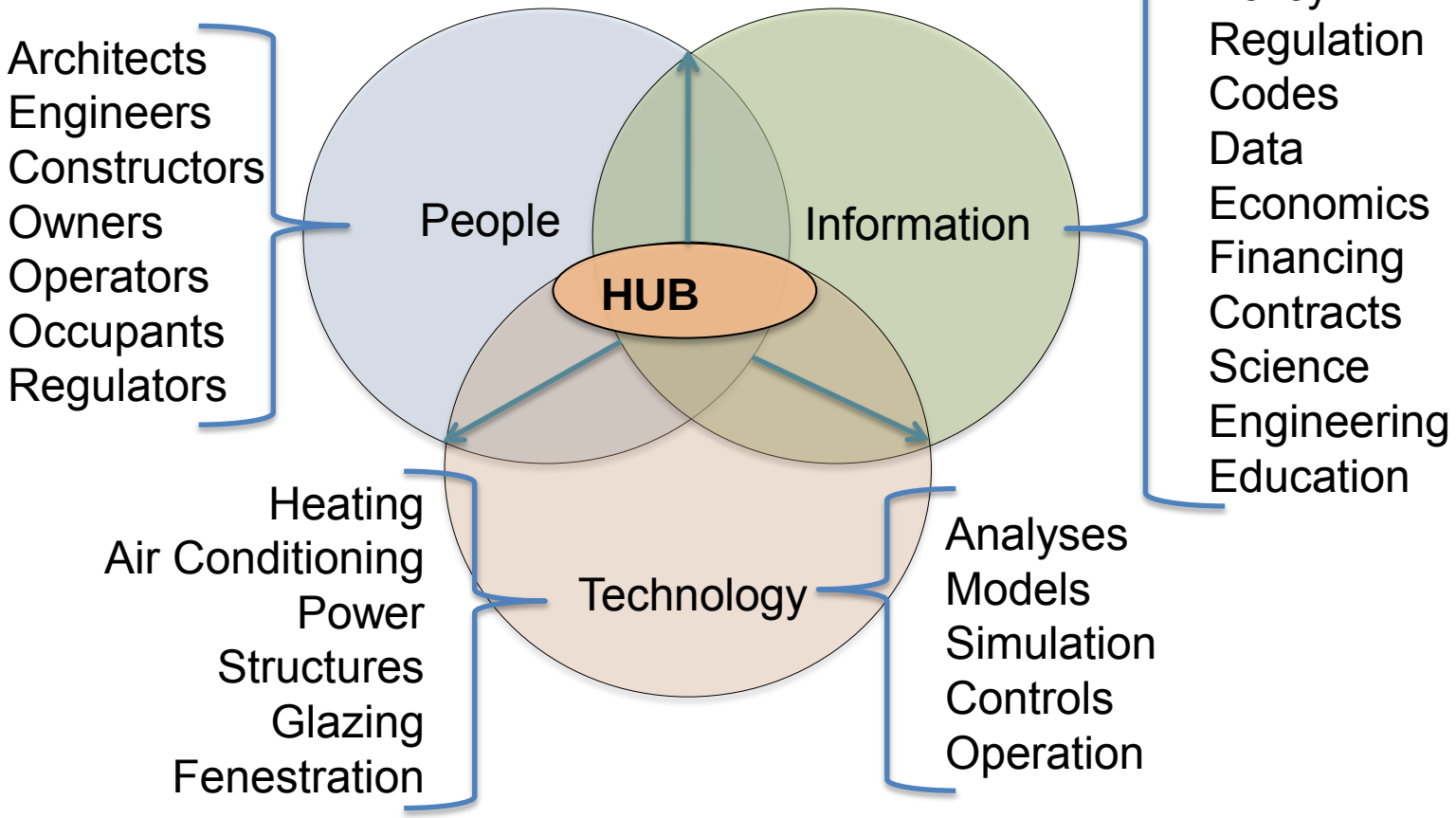
2. Demonstrate the market viability of integrating energy saving technologies for whole building system solutions

3. Identify strategies that will accelerate market adoption of energy efficient retrofits of commercial buildings in the Greater Philadelphia region.

4. Inform and educate people who design, own, construct, maintain, or occupy buildings about energy saving strategies and technologies.

5. Assist entrepreneurs to launch business ventures to exploit market opportunities for providing whole building energy saving solutions.

The Challenge: Adoption



An Emergent Organization

Twenty-two initial performers
- **Now twenty-five**

Not a closed consortium

Dynamic association

Driven by performance

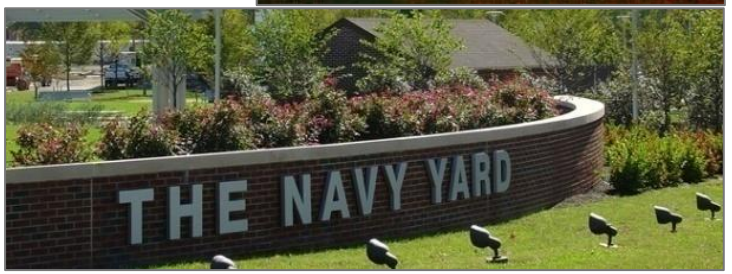
Capabilities spanning:
- **Research**
- **Development**
- **Demonstration**
- **Deployment**

Shared governance model

Penn State
Balfour Beatty
Bayer MaterialScience
Ben Franklin Technology Partners of SE PA
Carnegie Mellon University
Delaware Valley Industrial Resource Center
Drexel University
IBM Corporation
Lawrence Livermore National Laboratory
Massachusetts Institute of Technology
Morgan State University
New Jersey Institute of Technology
Pennsylvania College of Technology
Philadelphia Industrial Development Corporation
Princeton University
Project Based Learning, Inc.
PPG Industries
Princeton University
Purdue University
Rutgers University
United Technologies Corporation
University City Science Center
University of Pennsylvania
University of Pittsburgh
Virginia Tech

The Navy Yard

- Redevelopment project of regional and national significance
  - Redevelopment Master Plan updated January 2013
  - 10,000 jobs as of January 2013
  - Mix of industrial, commercial and government uses
- Test bed for energy research and demonstration
  - Independent unregulated micro-grid
  - Energy Master Plan completed January 2013
  - 270 buildings
    - Early 19th Century to new construction
    - Most occupied and some awaiting redevelopment,
- Multiple DOE Centers
  - Mid-Atlantic Clean Energy Applications Center
  - Northern Mid-Atlantic Solar Training Center
  - GridSTAR Smart Grid Center
  - Energy Efficient Buildings Hub



Metrics Team: LLNL, Bayer, Penn State

One Goal: 20% by 2020
Five Objectives
Seven Deliverables
Ten Tasks, 38 Subtasks
Subtask Level Milestones
Task Level Metrics

Example of BP3 Deliverable, Milestone, & Metric

- **Deliverable**

  Ten market-based or behaviorally oriented strategies, tools, approaches, or programs delivered to public and private sector decision makers that could yield up to 30% annual energy savings in applicable commercial buildings

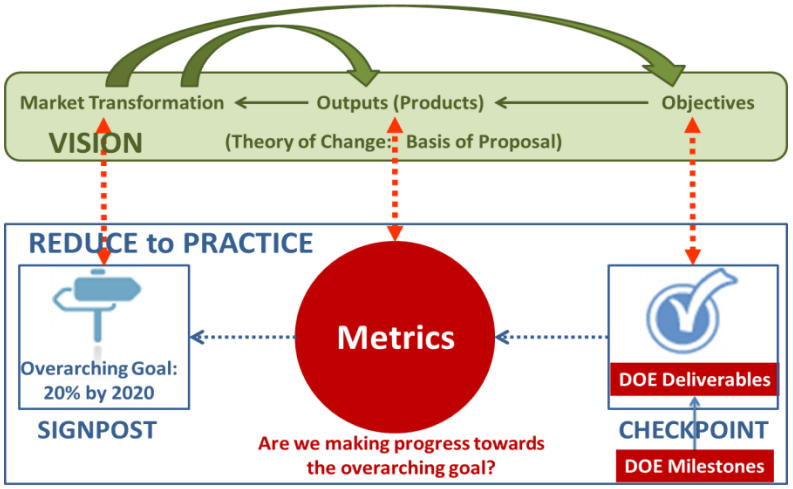
- **Metric**

  Track, by phase of development (conceptual, draft, review, or deliver) the number of subtask strategies, tools, studies, or other content that have at least a 50% likelihood of producing an output during the course of the budget period. Each of these efforts should be measured on the likelihood for achieving up to 30% energy reduction impact when delivered.

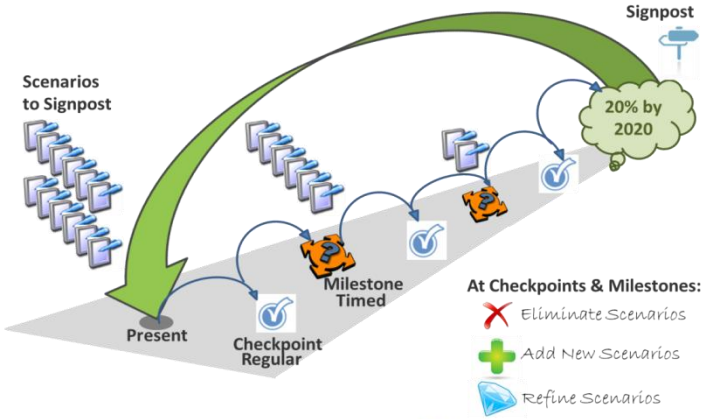
- **Milestone**

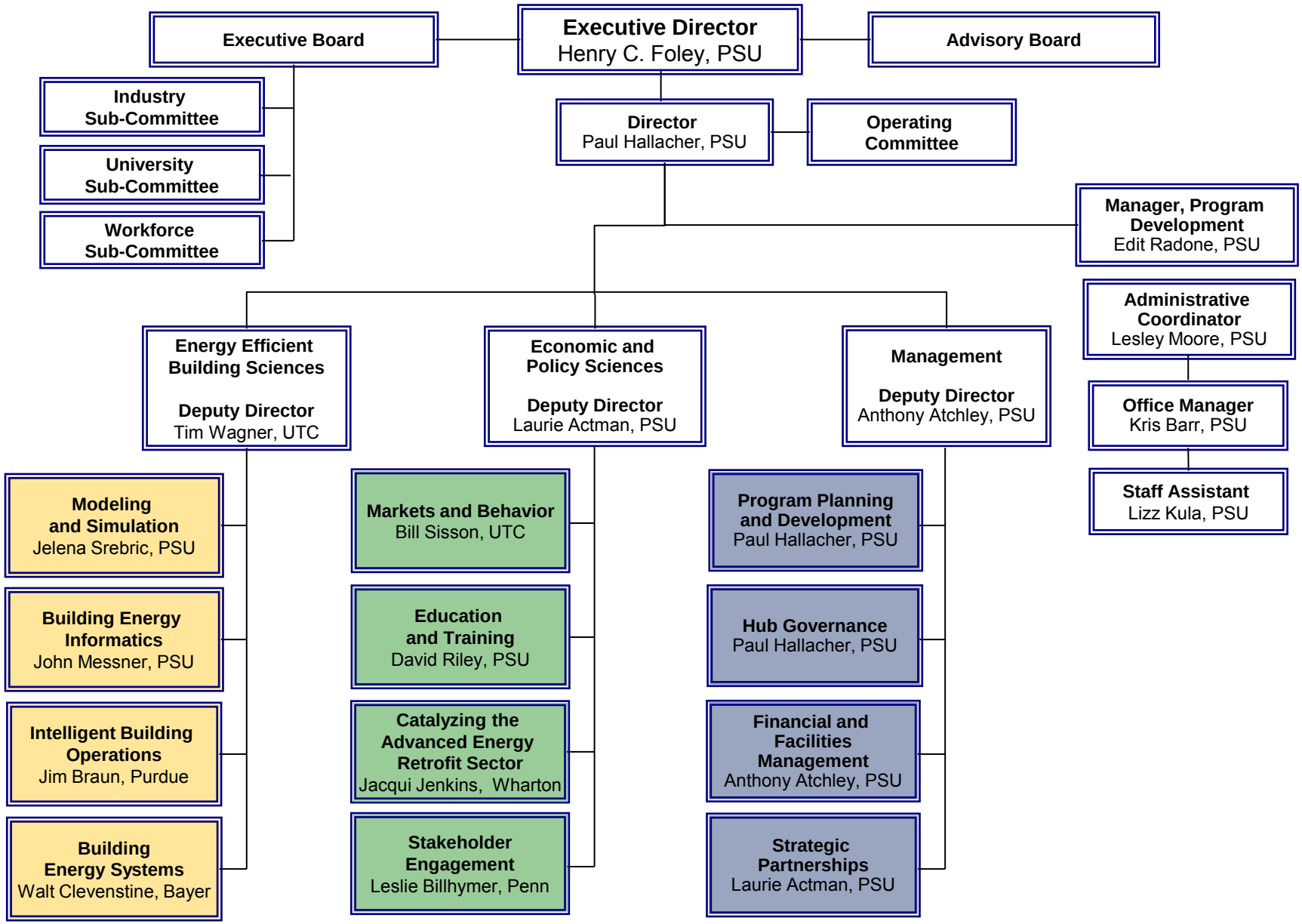
  By 9/30/2013, the assessment of the potential of Performance-Based Codes and Standards to achieve energy use goals for the Greater Philadelphia Region is reviewed by market actors.

Conceptual Framework



Measurement Framework




Executive Board
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Building Energy Informatics
John Messner, PSU
Intelligent Building Operations
Jim Braun, Purdue
Building Energy Systems
Walt Clevenstine, Bayer
Markets and Behavior
Bill Sisson, UTC
Education and Training
David Riley, PSU
Catalyzing the Advanced Energy Retrofit Sector
Jacqui Jenkins, Wharton
Stakeholder Engagement
Leslie Billhymer, Penn
Program Planning and Development
Paul Hallacher, PSU
Hub Governance
Paul Hallacher, PSU
Financial and Facilities Management
Anthony Atchley, PSU
Strategic Partnerships
Laurie Actman, PSU

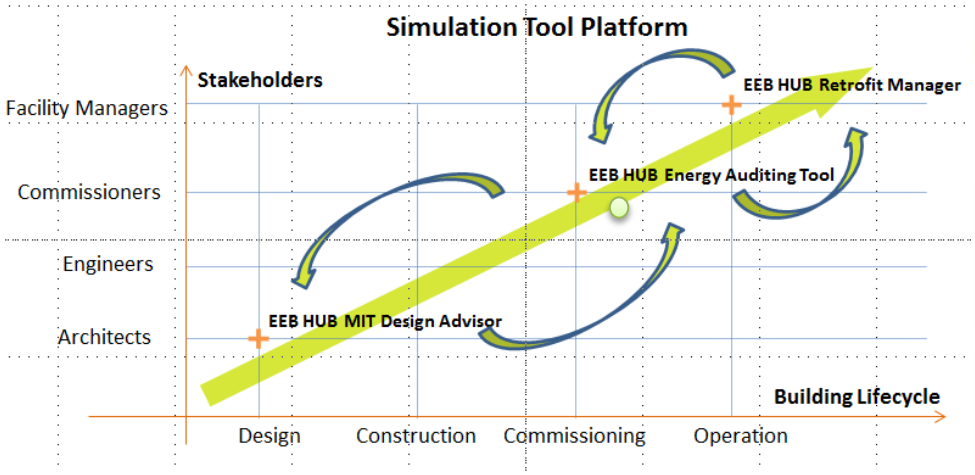
EEB Hub 2013 Task Leaders

- Modeling and Simulation, Jelena Srebric, Penn State
- Intelligent Building Operations, Jim Braun, Purdue
- Building Energy Informatics, John Messner, Penn State
- Building Energy Systems, Walt Clevenstine, Bayer MaterialScience
- Policy and Markets, Bill Sisson, United Technologies
- Education and Training, David Riley, Penn State
- Catalyzing the AER Sector, Jacqui Jenkins, Wharton School of Business
- Stakeholder Engagement, Leslie Billhymer, University of Pennsylvania

Integrated Design and Delivery

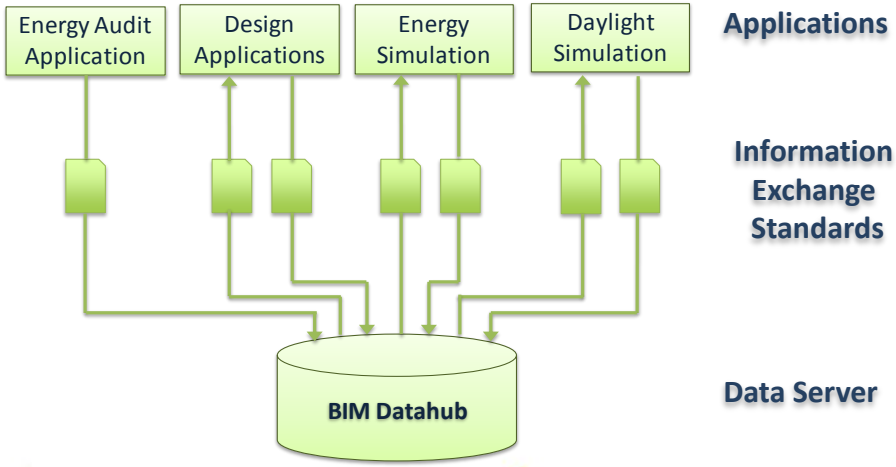
Cloud-based simulation platform supporting four retrofit types:

- Light
- Partial
- Substantial
- Comprehensive



Interoperability throughout building design and delivery:

- Building Information Modeling (BIM) Datahub using open information standards
- Coordinated with BTO Standard Energy Efficiency Data (SEED) Platform



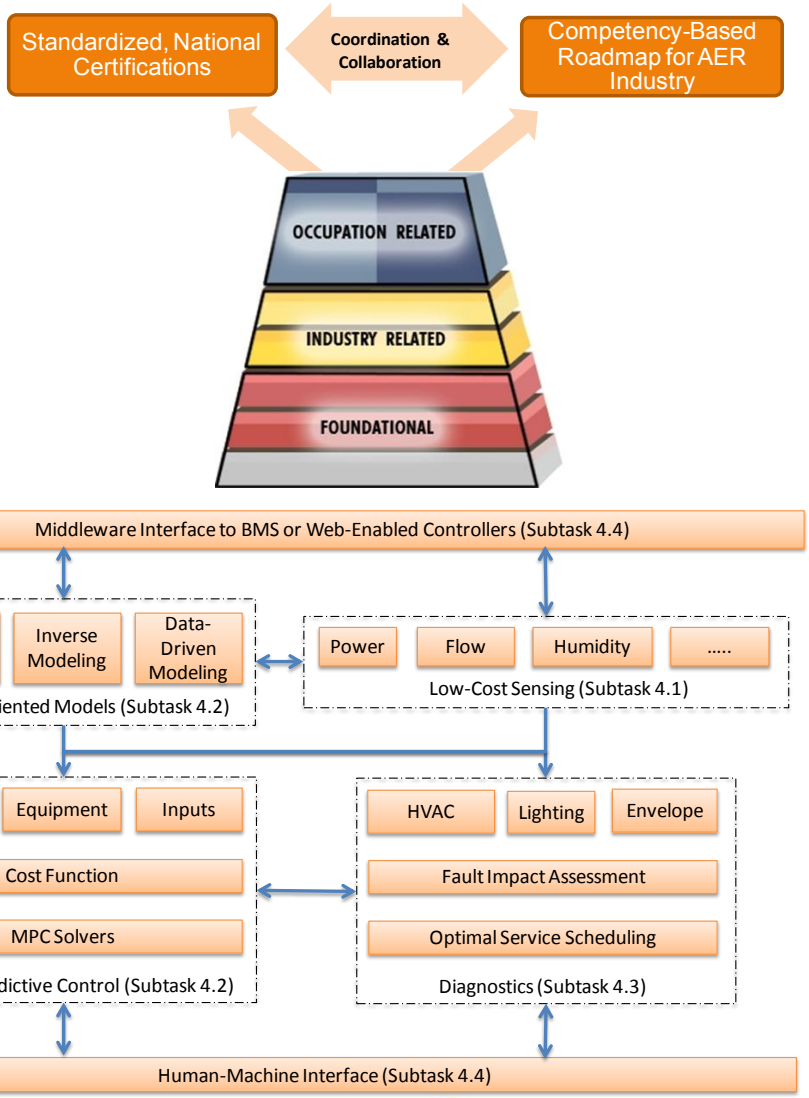
Optimizing Building Performance

Education and Training

- Delivering Building Operator Certificate program
- Delivering Building Retuning training with PNNL
- Building on BTO Job and Task Analysis Project

Intelligent Building Operations

- Prototype building operations platform that overlays on existing building control system
- Cost effective deployment of advanced sensor, control, diagnostic and decision-making
- Demonstrations underway in commercial buildings



Advanced Energy Retrofit Demonstration Projects

1 Montgomery Plaza,
Norristown, PA

Montgomery County

1973 mid-rise
Curtain wall office
215,000 sq. ft.

- Monitoring and verification (M&V) system installed
- AER includes integrated design process
- Demonstrating integrated window, walls distributed HVAC, lighting, and control technologies

Harvest Grille
Glen Mills, PA

Dave Macgrogan
Associates

2010 fit-out
6000 sq. ft.

- M&V, web-enabled thermostats installed
- AER demonstrating distributed HVAC controls & advanced control algorithms

Building 489,
Navy Yard

P&A Associates

1926 brick
32,000 sq.ft.

- M&V installed
- Contemporary core & shell renovation with tenant fit-out represents current practice
- After baseline defined, retro-commission building
- Hub recommended energy conservation measures (ECMs) based on analysis of M&V

Swope School of Music
West Chester, PA

West Chester University

2007 brick & concrete
90,000 sq.ft.

- EEB Hub installed M&V system
- Demonstrating advanced energy management system overlaying existing controls and integrating system diagnostics with optimal control algorithms

Advanced Energy Retrofit Demonstration Projects

Building 100,
Navy Yard

PNA 100 Associates

1901 brick barracks
Renovated to offices
32,000 sq. ft.

- M&V system installed
- Demonstration of minimal sub-metering required to establish actual building performance.

Building 1,
Navy Yard

U.S. Navy

1875 brick building,
34,000 sq. ft.

- Performed energy audit & recommended ECMs.
- Installing M&V, benchmarking building and systems
- Researching window replacements that are energy efficient, cost-effective and that can meet “Minimum Antiterrorism Standards for Buildings”.

Building 661,
Navy Yard

Penn State

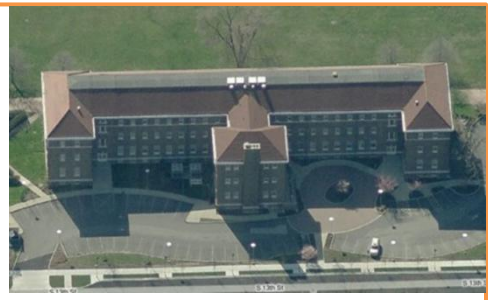
1942 brick building
36,500 sq. ft.

- Initial demonstration of integrated design process
- Incorporates three distinct energy retrofit approaches for different occupancy usages
- Broadly applicable to brick building archetype

Building 101,
Navy Yard

PIDC

1911 brick building
Renovated to offices
34,000 sq. ft.



- Extensive M&V installed and commissioned
- Multiple energy audits conducted
- Demonstrating advanced energy management system overlaying existing controls
- Investigating additional ECM

Deploying Energy Saving Systems

HVAC & Envelope Integration

- HVAC approaches and optimizations
- Vertical envelope alternatives

Window & Lighting Integration

- Day-lighting, glazing
- Artificial illumination

Integrated Roof Replacements

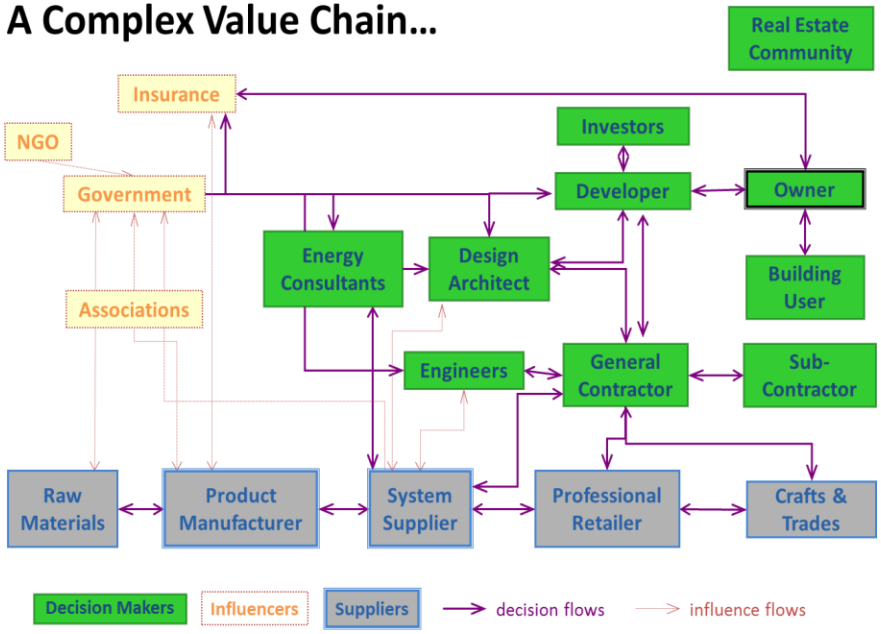
- Roof insulation optimization
- Skylights, white roofs, etc.

Indoor Environmental Quality

- IEQ & energy savings trade-offs
- Keeping user satisfaction in mind

West Windsor, NJ Deployment Pilot

- Codes, standards, and incentives that foster investment in energy efficiency
- Expanding to NJ, PA, and beyond



Benchmarking and Disclosure

Philadelphia Benchmarking and Disclosure

- Effects commercial buildings greater than 50,000 square feet
- EEB Hub will serve as:
  - Repository and analyst for the disclosed data
  - Education and outreach partner to commercial building owners
  - Advisor to leverage/recommend future energy efficiency programs

Utility Data Access Working Group

- Regional utility now implementing automatic Portfolio Manager data transfer

Retrofit Market Development

Hosting monthly outreach sessions for small businesses

- Inform them about opportunities in the AER marketplace
- Develop a working relationship with the EEB Hub - 74 businesses participated

Launched Satellite Quorum

- Networking program for high growth companies in the AER marketplace
- Entrepreneurs meet with angel investors, subject matter experts, and industry leaders in the AER marketplace
- 95 businesses participated to date

Launched the Hub Commercialization Center (HCC)

- Operating space and virtual services for companies in the AER marketplace.

Buildings Energy Science Center

- Prototypical integrated advanced energy retrofit project
- Building functions as a living laboratory to showcase multiple energy saving technologies
- Three separate programmatic zones each with appropriate integrated mechanical systems
- Built-in monitoring and verification strategies for testing and energy efficiency research

Buildings Energy Education and Innovation Center

- Newly constructed training facility for building operators, energy auditors, and others
- Prototypical commercial building with capability for hands-on training and problem solving
- Mix of energy technologies and systems currently found in many commercial buildings, and more innovative approaches

Planned BTO/EEB Hub Coordination Matrix

Task	Subtask	Lead TM from BTO
TASK 1: Management		Richard Karney
TASK 2: Modeling and Simulation	Subtask 2.1: EEB Hub Design Advisor	Amir Roth
	Subtask 2.2: EEB Hub Energy Audit Tool	Joan Glickman
	Subtask 2.3: EEB Hub Retrofit Manager	Amir Roth
	Subtask 2.4: EEB Hub Simulation Tool Platform	Amir Roth
TASK 3: Building Energy Informatics	Subtask 3.1: Process and Information Standards	Amir Roth
	Subtask 3.2 Building Information Modeling (BIM) Datahub	Amir Roth
	Subtask 3.3: Building Energy Information Management	Elena Alschuler
	Subtask 3.4: Energy Information Visualization	Kristen Taddonio / Shalon Brown
TASK 4: Intelligent Building Operations		George Hernandez
TASK 5: Building Energy Systems	Subtask 5.1: HVAC and Envelope Integration	Karma Sawyer
	Subtask 5.2: Window and Lighting Integration	Karma Sawyer
	Subtask 5.3: Integrated Roof Replacements	Karma Sawyer
	Subtask 5.4: Indoor Environmental Quality	Eric Werling
TASK 6: Markets and Behavior	Subtask 6.1: AER Market Analysis	Kristen Taddonio
	Subtask 6.2: Codes and Standards	Jeremy Williams/ Kym Carey
	Subtask 6.3: Energy Utility Regulatory Policy	Elena Alschuler
	Subtask 6.4: Occupant Behavior and Decision Making	Shalon Brown
TASK 7: Education and Training	Subtask 7.1: Training Programs and Credentials	Benjamin Goldstein
	Subtask 7.2: Building Operator Training	Benjamin Goldstein/Shalon Brown
	Subtask 7.3: Educational Outreach	Shalon Brown
	Subtask 7.4: Building Energy Education Center	Benjamin Goldstein/Shalon Brown
TASK 8: Catalyzing the AER Sector		Kristen Taddonio/ Arah Schuur
TASK 9: Stakeholder Engagement		Richard Karney
TASK 10: Reporting		Richard Karney

Penn State

- Largest and most comprehensive energy degree programs in U.S. according to 2013 National Council for Science and the Environment survey
- Top university worldwide in multidisciplinary alternative energy research according to 2009 Elsevier Alternative Energy Research Leadership Study
- Ranked first in U.S. for college graduates best suited for the world of work in a 2010 survey of corporate recruiters by the Wall Street Journal
- Innovative new IP policies for industry sponsored research
- $808 million sponsored research in FY 2012 ($507 federal, $110 industry)
  - $297 Science and Engineering
  - $183 Defense Units
  - $146 Medicine and Health
  - $103 Ag Sciences
  - $79 Other