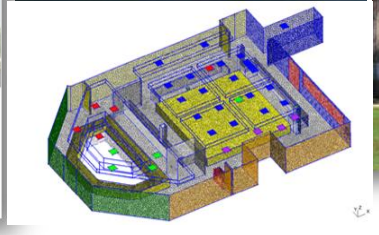
CBEI - Demonstrating & Deploying Integrated Retrofit Technologies & Solutions

2015 Building Technologies Office Peer Review



U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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Consortium for Building Energy Innovation

Project Summary

Timeline:

Start date: 1 February 2012 (BP2)

Planned end date: 30 April 2016 (BP5)

Key Milestones

1. Q1 2012 (BP2) initial testbed established
2. 2012-2013 (BP2 & BP3) additional test beds established
3. Q3 2014 occupy and begin documenting performance and IEQ in retrofit CBEI HQ

Budget:

Total DOE $ to date:	$1.467M
Total cost-share $ to date:	$0.077M
Total future DOE $:	$0.392M
Total future cost-share $:	$0.019M

Target Market/Audience:

Small- to medium-sized commercial building (SMSCB) owners, operators, service providers, solution vendors, building professionals, contractors, utilities & others in supply chain.

Key Partners:

CBEI-Penn State	CBEI-UTRC
CBEI-UPenn	CBEI-Purdue
CBEI-Carnegie Mellon	Owners of demo buildings
Regional energy retrofit contractors	Regional EMS & BAS contractors

Project Goal:

Provide robust capability, in real-world 'testbed' buildings, for 'pre-commercial' demonstration and documentation of performance of cost-effective, broadly applicable, 'deep' energy efficiency retrofit solutions designed for SMSCB retrofits.

CBEI CONSORTIUM for BUILDING ENERGY INNOVATION

Vision:

By 2030, deep energy retrofits that reduce energy use by 50% in existing SMSCB, which are less than 250,000 sq ft

Mission:

Develop, demonstrate and deploy technology systems and market pathways that permit early progress (20-30% energy use reductions) in Small and Medium Sized Commercial Buildings

Our Goals:

- **Enable deep energy retrofits** in small to medium sized commercial buildings
- **Demonstrate energy efficient systems** tailored for SMSCBs in occupied buildings – living labs
- **Develop effective market pathways** for energy efficiency with utilities and other commercial stakeholders: brokers, finance, service providers.
- **Provide analytical tools** to link state and local policies with utility efficiency programs

CBEI Partners

Industry

Bayer MaterialScience

United Technologies Research Center

Economic Development Organizations

DVIRC

PIDC

Driving growth to every corner of Philadelphia

Ben Franklin Technology PArtners

Universities

PENNSTATE 1855

NJIT

Penn University of Pennsylvania

Drexel University

Carnegie Mellon University

VirginiaTech Invent the Future

PURDUE UNIVERSITY

MORGAN STATE UNIVERSITY

RUTGERS

Purpose & Objectives

Problem Statement:

- Commercialization partners for new technologies require 'proof of performance' from real-world demonstrations as a precondition to substantive discussions about commercializing the technology.
- Decision-makers in SMSCBs lack confidence that commercially available energy efficiency solutions will work in their buildings; they lack expertise to select investments and oversee installation.
- This CBEI project develops and manages demonstration testbeds, in real occupied buildings, for solutions developed by CBEI Investigators, vetted and funded in prior and current BPs.
- These deployed solutions experience challenges and constraints of real-world building systems; overcome these challenges; develop performance data to attract commercial partners.

Purpose and Objectives: Market & Project Impact

Target Market and Audience:

- Service providers, installers, manufacturers and vendors of energy efficiency solutions, utilities.
- SMSCB owners & operators (O/Os); large and small portfolios.

Project Impact

- Focus is on the BTO CBI objective to provide cost-effective measures for Existing Buildings in the near-term (-20% by 2020).
- Near-term impact: Document reduction in energy use / increase in occupant comfort at demonstration sites from solution.
- Intermediate-term impact: Targeted commercialization of methods and solutions by 'energy efficiency leaders' and 'early adopters'.
- Long-term impact: Uptake of methods and solutions by service providers and supply chains on national scale.

Approach

- Identify CBEI technologies and solutions for field demonstration.
- Identify and engage building owners willing to host multi-year demonstrations in their occupied buildings.
- Employ evidence-based, data-driven methodology for retrofit project 'testbed' development:
  - Install M&V, establish baseline, program energy model, maintain retrofit installations, conduct data analysis.
  - Prepare and disseminate reports and 'Findings' that address information & economic barriers and promote market uptake.
- Assessment, validation, and continuous improvement through building performance monitoring (energy and IEQ) using objective (static and time-series data from BAS/M&V) and subjective data (Pre- and Post-Occupancy Evaluations).

Approach: Key Issues & Distinctive Characteristics

Key Issues:

- CBEI does not control demo site staff, renovation budgets, decisions, or schedules.
- Real buildings have existing equipment that can fail without warning.
- Typical renovation projects take multiple years; CBEI budgets are determined annually.
- Renovation projects can change significantly before CBEI projects are completed.

Distinctive Characteristics:

- Use of 'real' commercial buildings with actual owners influenced by market conditions.
- Negotiated formal Agreements.

CBEI Demonstration Testbeds

	CBEI Testbed Elements					Demonstration Type		
Demonstration site	Agree-ment	M&V	IEQ & POE	PI Coresight visual-ization	E+ model	Advanced Supervisory Controls	Integrated Systems	Whole Bldg Retrofit
Building 101	x	x	x	x	x	x		x
Harvest Grille	x	x		x		x		
Swope School	x	x				x		
OMP	x	x	x		x		x	x
PBTC	x	x	x	x		x	x	
Ft. Belvoir #1	x	x	x		x		x	x
Ft. Belvoir #2	x	x	x		*		x	x
Ft. Belvoir #3	x	x	x				x	x
Building 661	x	x	x	*	x	*	x	x
Building 489	x	x						x
SEPTA 69th Stn.	x							x
MHCR	x							x
Phila. City HC#5					x			x

x = current site capability
** = future/planned capability*

Progress and Accomplishments: Lessons Learned

- Select real-world testbeds carefully!
  - Some selected sites featured ‘un-tuned’ and ‘at-end-of-life’ systems which inconveniently failed during investigation.
- Experiencing and overcoming challenges in real buildings provides opportunities to develop robust solutions more likely to reach commercialization.
  - Enables iterations of solution development cycles.
  - Revise approach and try again in current or new demonstration sites.
- Inability to overcome challenges supports decisions to stop or redirect efforts.

Progress and Accomplishments

- Developed data monitoring tool for 6 sites to oversee data collection status and notification of system faults for timely response.
- Developed advanced M&V data systems to support evaluation of testbed technologies by providing building data interfaces for visualizing and optimizing building operations.
- Developed data labeling software with machine learning capabilities for rapid classification of field BAS control point names into DOE/BEDES naming convention.
- Submitted datasets to BPD.
- Established “Open Data Access” credentials for researchers inside & outside CBEI seeking access to M&V datasets.
- Completed Post Occupancy Evaluation (POE) for two CBEI projects and one classroom project.
- Developed ‘lessons learned’ reports on 10 past and current research projects.

Progress and Accomplishments: Market Impact

- CBEI testbeds provide CBEI Solution developers (Investigators) with 'real-world' environments in which to install, test and iterate their solutions.
- CBEI testbeds enable documentation of technical and economic feasibility in real situations,
  - develop convincing field evidence, required to attract 'early adopter' service providers to CBEI solutions, move solutions towards commercialization.
- CBEI considers the capability to develop functioning testbeds as a valuable 'core competency', bridging the gap between the laboratory and 'early stage' commercialization by niche and small scale service providers.

Project Integration and Collaboration

Project Integration:

- For each demonstration, project staff works closely with CBEI investigators from academia and industry, building owners and operators, incumbent HVAC contractors, EEM installers, M&V installers.

Partners, Subcontractors, and Collaborators:

- Penn State, Carnegie Mellon, Purdue, UTRC, UPenn, PIDC
- SEPTA, City of Philadelphia, West Chester U., Methodist Home for Children, U.S. Army, Harvest Seasonal Grille
- Regional HVAC, EMS and BAS contractors, regional retrofit contractors.

RADIUS Systems

PIDC
PHILADELPHIA'S ECONOMIC DEVELOPMENT CORPORATION SINCE 1958

ECSI 360

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Project Communications

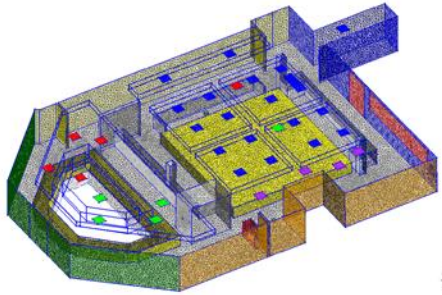
- ~30 publications or presentations generated related to M&V data collection, visualization IEQ, published in journals and national and international conferences including: ASHRAE,AIA, and sustainability-themed conferences.

- 10 ‘Findings’ (4 page summaries of results) prepared for distribution to non-technical markets through CBEI mailing list, trade and professional associations.

Next Steps and Future Plans

- Enable on-going CBEI project demonstrations of:
  - Wireless RTU Coordination
  - RTU Fault Detection & Diagnostics
  - AHU Fault Detection & Diagnostics
  - Virtual Sensors
  - Integrated Lighting and VAV AHU control retrofit
  - Whole Building retrofit solutions

- Document performance and IEQ of CBEI HQ building renovation and multi HVAC systems, conducted using an ID process.
- Prepare and disseminate additional 'Findings' of CBEI techniques, tools and solutions to the market place.



REFERENCE SLIDES

Project Budget

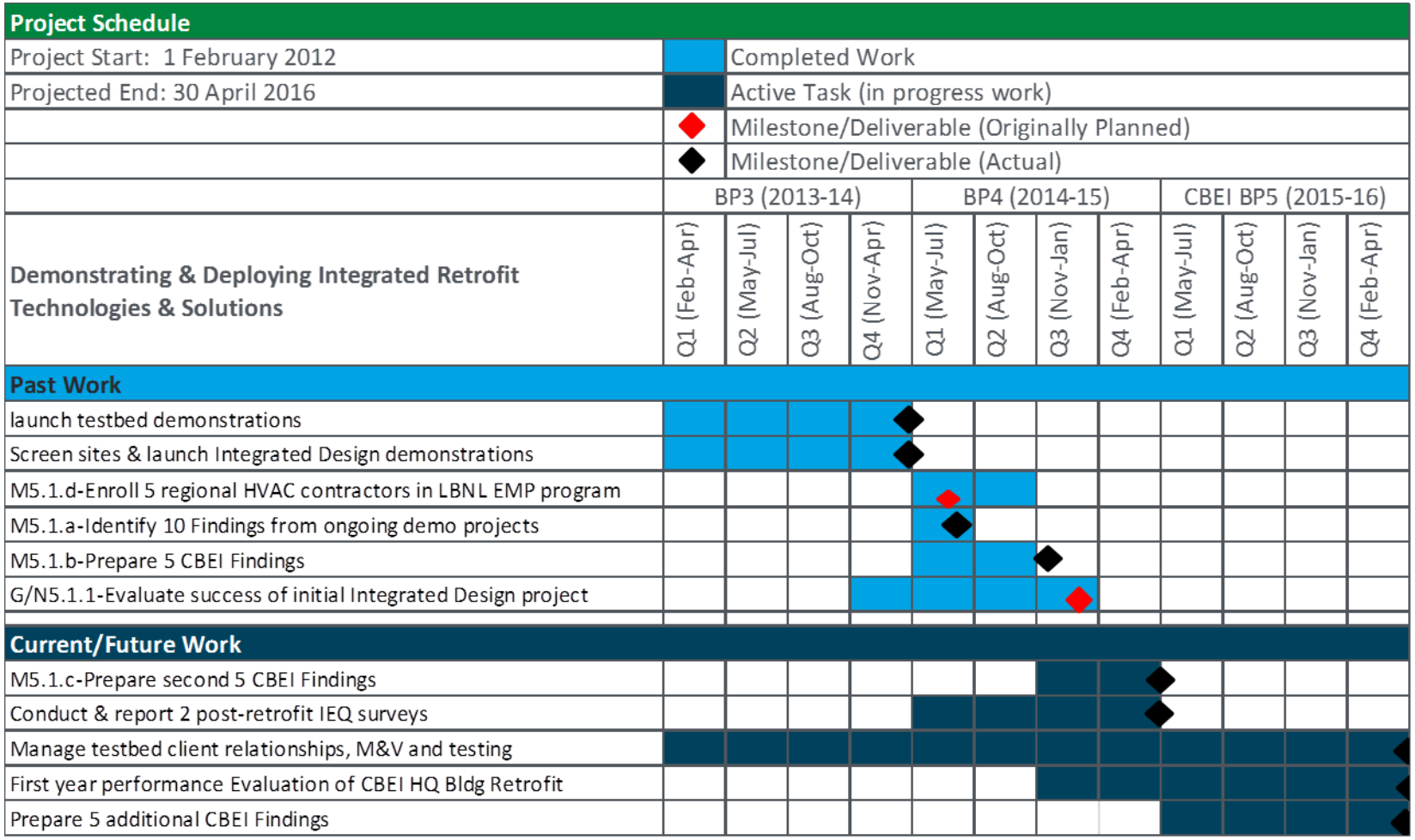
Project Budget: BP4: $787K
Variances: None
Cost to Date: BP3-4: $1,467K multiyear effort
Additional Funding: BP5: $392K

Budget History					
CBEI BP3 (past) 2/1/2013 – 4/30/2014		CBEI BP4 (current) 5/1/2014 – 4/30/2015		CBEI BP5 (planned) 5/1/2015 – 4/30/2016	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$680K	$40K	$787K	$37K	$392K	$19K

CBEI – Consortium for Building Energy Innovation (formerly EEB Hub)
BP – Budget Period

Project Plan and Schedule

- Demonstration projects began in earnest in FY2012.
- Planned completion date 30 April 2016.



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BP – Budget Period