CBEI - Packaged Masonry Wall Retrofit Solutions for Small and Medium sized Commercial Buildings

2015 Building Technologies Office Peer Review

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

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Project Summary

Timeline:

Start date & Planned end date:

Phase(PH) I June 1st, 2013 to Oct. 1st, 2014

Phase(PH) II May 1, 2014 to Apr 30, 2016

Key Milestones

1. Collect FRP baseline data (Oct 2014)
2. Demonstrate down-selected top-performing scenarios on the Flexible Research Platform (April 2015)
3. Collect post retrofit data & disseminate results (April 2016)

Budget:

Total DOE $ to date: $535,531

Total future DOE $: $266,000

Target Market/Audience:

Commercial buildings with masonry façade in climate zones 4 & 5

Key Partners:

CBEI (PH I & II)
CBEI - Bayer Material Science (PH I & II)
Oak Ridge National Laboratory (PHI & II)
Carlisle SynTec (PH II)
Air Barrier Assoc. of America (PHII)

Project Goal: Develop a package of integrated wall retrofit solution that exceeds ASHRAE 90.1 2010 requirement with a payback ranging 10-15 years, based on laboratory testing of three different package solutions. The package will be demonstrated on the Flexible Research Platform (FRP) at ORNL.

Project Summary

CBEI CONSORTIUM for BUILDING ENERGY INNOVATION

Vision:

By 2030, deep energy retro-fits 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; Ben Franklin Technology PArtners

Universities: Penn State; NJIT; Penn; Drexel University; Carnegie Mellon University; Virginia Tech; Invent the Future; Purdue University; Morgan State University; Rutgers

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Purpose and Objectives

Problem Statement: Identify best practice retrofit recommendation for existing commercial buildings with masonry construction.

Majority of old masonry construction buildings are uninsulated offering a good potential to achieve energy efficiency through improved envelope performance. This can support the BTO goal to achieve 50% reduction in energy use for existing buildings by 2030.

Challenges for retrofitting masonry buildings with interior insulation:

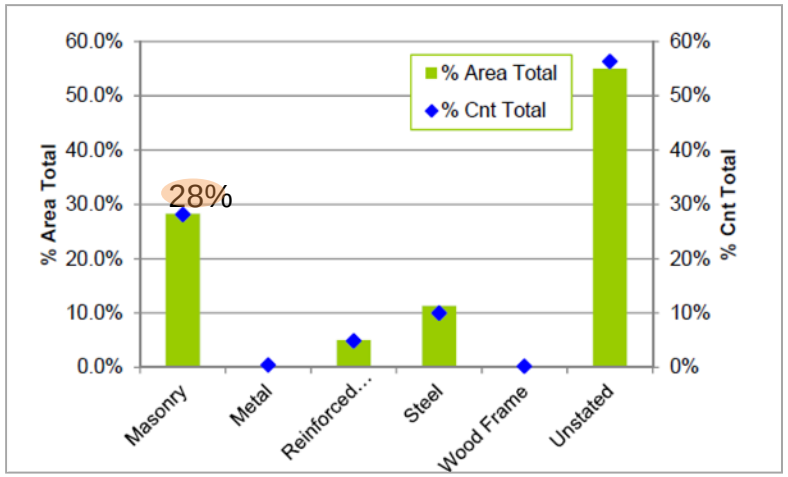
- Interstitial condensation
- Freezethaw damage

Issues to address when insulating a masonry wall on the interior:

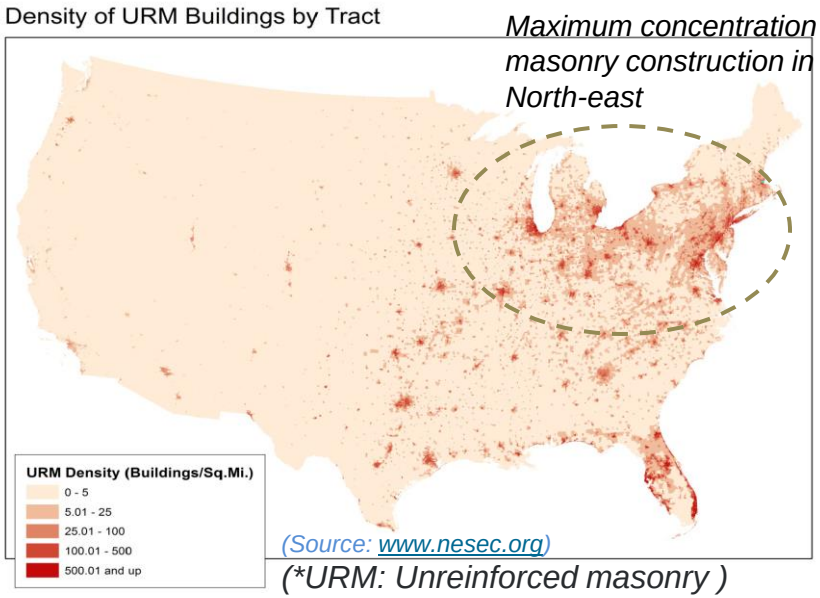
- Air-tightness
- Thermal performance
- Moisture performance

Purpose and Objectives

Target Market: Commercial buildings with masonry construction in climate zones 4 & 5 with potential to influence zone 6.



Masonry construction for existing office buildings in the ten county region around Philadelphia (Source: COSTAR, 2011)



(Source: www.nesec.org)

(*URM: Unreinforced masonry)

Commercial buildings with masonry construction(concrete mass walls) account for energy consumption of 974 trillion Btu (CBECS, 2003) which is 17% of the total energy consumption for the commercial sector *(*limitation: does not consider brick masonry buildings which is another target market for this project).*

Target Audience: Commercial building owners, commercial real estate service firms, utility companies.

Purpose and Objectives

Impact of Project:

- Identify best practice recommendation for internally insulating existing masonry construction in commercial buildings. This will support the BTO goal of 50% energy reduction by 2030 for existing commercial buildings.
- Deployment of the identified retrofit solution to the commercial retrofit market to achieve substantial energy and cost savings.
- Best practice retrofit solution identified through the project will achieve:
  - Reduced air leakage
  - Moisture management/improved durability
  - Good thermal performance in the buildings

Project Deliverables:

- Detailed case study highlighting the performance for the best practice recommendation.
- Best practice guidelines.
- Evaluation matrix comparing proposed retrofit scenarios againt critical parameters.

Purpose and Objectives

Metric for Success:

Near Term:	Analyze results for initial evaluation and lab tests to down-select top-performing retrofit scenarios. Share results with CBEI.
Intermediate Term:	Collect actual field data for demonstrated technologies and evaluate against lab test results. Present results at conferences, generate a detailed case study for the best practice recommendation, develop best practice guidelines.
Long Term:	Execute commercialization plan - share best practice guidelines and detailed case study with the industry, utilize marketing channels through market partners for deploying information about best practice recommendation, implement training plan if needed.

Approach

Approach: Demonstrate top-performing retrofit solutions and collect actual field data to identify best practice recommendation.

Phase I (BP*3):
Baseline data

Phase II (BP*4):
Research wall assemblies and demonstrate best practice strategy (on the FRP)

Phase II (BP*5):
Post-retrofit

- Collect baseline data for FRP
- Vet proposed list of scenarios through industry experts
- Evaluate list of proposed wall retrofit scenarios
- G/NG 1 — Down-select three top performing scenarios based on evaluation
- Construct mock-up walls for down-selected scenarios and perform lab tests
- G/NG 2 — Identify best practice recommendations based on lab tests performance
- Retrofit FRP with identified best practice recommendations
- Collect post-retrofit data
- Generate detailed case study and best practice recommendation guidelines

**BP or Budget Period is the financial year for CBEI which runs from May to April. (BP4 is May 2014 – April 2015; BP5 is May 2015- April 2016)*

Approach

Step 1: Evaluate 9 proposed retrofit scenarios against 6 critical parameters identified by industry experts. Generate evaluation matrix ranking scenarios based on performance.

Scenario No.	Proposed Retrofit Assemblies
A.	**Cost-Effective Solution - Retain Existing Wall (w/ existing insulation)**
1	Rigid board over existing insulation (2”)
B.	**Semi-cost Effective Solutions - Retain Existing Studs (w/o existing insulation)**
2	Open-cell spray foam within existing stud (6”)
3	Closed-cell spray foam within existing stud (5")
C.	**Energy-Efficient Solutions - Remove Existing Insulation and Studs**
4	Blown-cellulose (6”)
5	Closed-cell spray foam (3.5")
6	Hybrid Spray foam (2")
7	Hybrid Spray foam (1.5")
8	Rigid board w a/b (2.5")
9	Rigid board w/o a/b (2.5”)

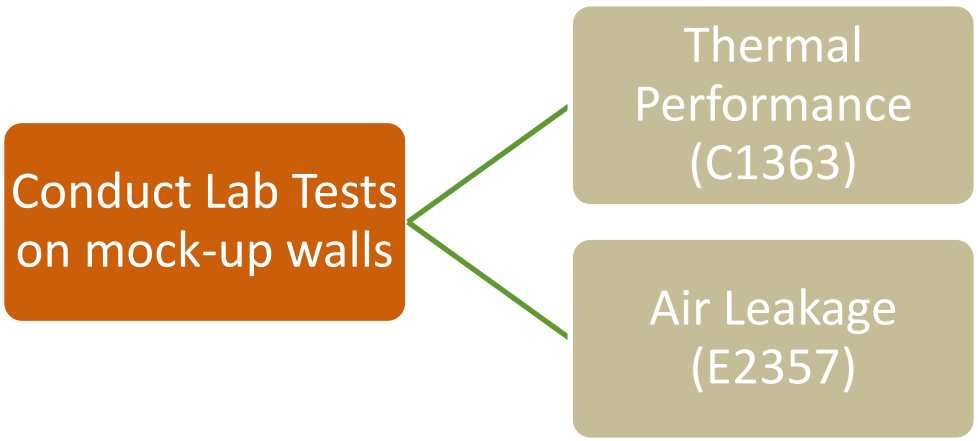
Critical Evaluation Parameters (with weighted percent) identified by industry experts:

- Cost-Effectiveness – 35%
- Thermal Performance – 18%
- Air leakage – 12%
- Moisture Management/Durability – 20%
- Disruptiveness/Consrtuctability – 9%
- Indoor Air Quality – 6%

Step 1 result: Down-select three top-performing retrofit scenarios based on evaluation matrix.

Approach

Step 2: Construct mock-up walls for the down-selected scenarios in step 1 and conduct lab tests.



Lab test results:
Down-selected two top-performing retrofit scenarios to demonstrate on FRP:

1. Most cost-effective solution: Retain existing wall; install polyiso rigid board with taped seams on existing wall

   **Good solution, but may not be applicable in all situations (dependant on condition of existing wall)*

2. Most energy-efficient solution: Install 3.5” closed cell SPF with 1.5” c.i. on the concrete block wall.

Step 2 result: Down-selected the most cost-effective and the most-energy efficient scenario for actual demonstration on the FRP

Approach

Key Issues:

- Challenges for retrofitting masonry buildings with interior insulation:
  - Interstitial condensation.
  - Freezethaw damage.
- Improper insulation and disregard for air and moisture transfer through a masonry wall system can lead to faster deterioration of brick and poor thermal performance.
- Building envelope retrofits are rarely undertaken due to high upfront costs and lengthy payback periods.

Distinctive Characteristics:

- Diverse team to develop an integrated package addressing thermal performance, moisture performance and air leakage.
- Utilizing Flexible Research Platform at ORNL provides a risk adverse environment to demonstrate best practice retrofit solution and collect actual field data.

Progress and Accomplishments

Lessons Learned:

- An expert panel review helped identify 2 major factors contributing to retrofit decision along with energy savings:
  - Cost savings/Payback
  - Constructability/practicality of construction for the retrofit scenario
- Increased energy savings and reduced paybacks observed for regions with colder climate (increased heating degree days).

Accomplishments:

- 6 critical evaluation parameters with weighted percent for each parameter identified through industry experts to evaluate proposed retrofit scenarios.
- An extensive evaluation matrix generated which compares performance of 9 retrofit scenarios against the 6 critical evaluation parameters.
- Two top-performing retrofit scenarios identified based on evaluation matrix and laboratory test results. These comprise:
  - Most cost-effective solution
  - Most energy efficient solution.

Progress and Accomplishments

Market Impact:

- The proposed retrofit solutions offer energy savings ranging between 30% to 40% in climate zone 4 for buildings with masonry construction.

- The proposed solutions will impact commercial buildings with mass walls as the predominant exterior wall material (concrete blocks) which represents ~15% of the total commercial sector floorspace in US (CBECS, 2003) *(*limitation: this data does not include buildings with brick masonry which is also an applicable market for proposed solutions).*

Efforts to accelerate market impact:

- Disseminate project results to the construction industry through conference events and journal articles.

- Conduct education sessions with industry associations to promote best practice recommendation.

- Work with market partners to accelerate adoption of proposed solutions into the industry through their customer channels.

Project Integration and Collaboration

Project Integration & Partners: Teaming with ORNL, Bayer Material Science, Carlisle SynTec and the Air Barrier Association of America provides a direct route to material suppliers as well as applicators of these technologies and will accelerate findings into market practice.

Lead Institution (Raw materials and project management)	3rd Party Analysis (Simulations and Lab evaluations)	In-kind support (Systems supplier)	In-kind support (Installers)

Communications: ***Selected to present project at CSI CONSTRUCT 2015***

Next Steps and Future Plans

Next Steps:

- Collect field data for the retrofit solutions demonstrated on the FRP.
- Evaluate field data against initial evaluation results and lab test results.
- Generate a detailed case study highlighting performance for the identified best practice recommendation.
- Put together best practice guidelines and disseminate to the industry.
- Evaluate and compare constructability for the two down-selected scenarios demonstrated on FRP
- Execute commercialization plan.

Next Steps and Future Plans

Dissemination/Commercialization Plan:

- Utilize regional and annual conferences through associations (e.g. RCI, AIA, CSI, etc.) to disseminate findings to the construction industry.
- Utilize deployment channels (such as marketing and technical bulletins or regional and national trainings) available through market partners Carlisle Construction Materials and Air Barrier Association of America (ABAA).
- Publish project findings through journal articles.
- Organize education webinars through industry association programs to disseminate project results.

REFERENCE SLIDES

Forward-Looking Statements

This presentation may contain forward-looking statements based on current assumptions and forecasts made by Bayer Group or subgroup management. Various known and unknown risks, uncertainties and other factors could lead to material differences between the actual financial position, development or performance of the company and the estimates given here. These factors include those discussed in Bayer's public reports which are available on the Bayer website at www.bayer.com. The company assumes no liability whatsoever to update these forward-looking statements or to conform them to future events or developments.

Project Budget

Project Budget: Phase I budget ($140,000) Phase II budget ($661,531).
Variances: NA.
Cost to Date: Phase I budget expended. $395,531 of phase II expended for BP4
Additional Funding: NA.

Budget History

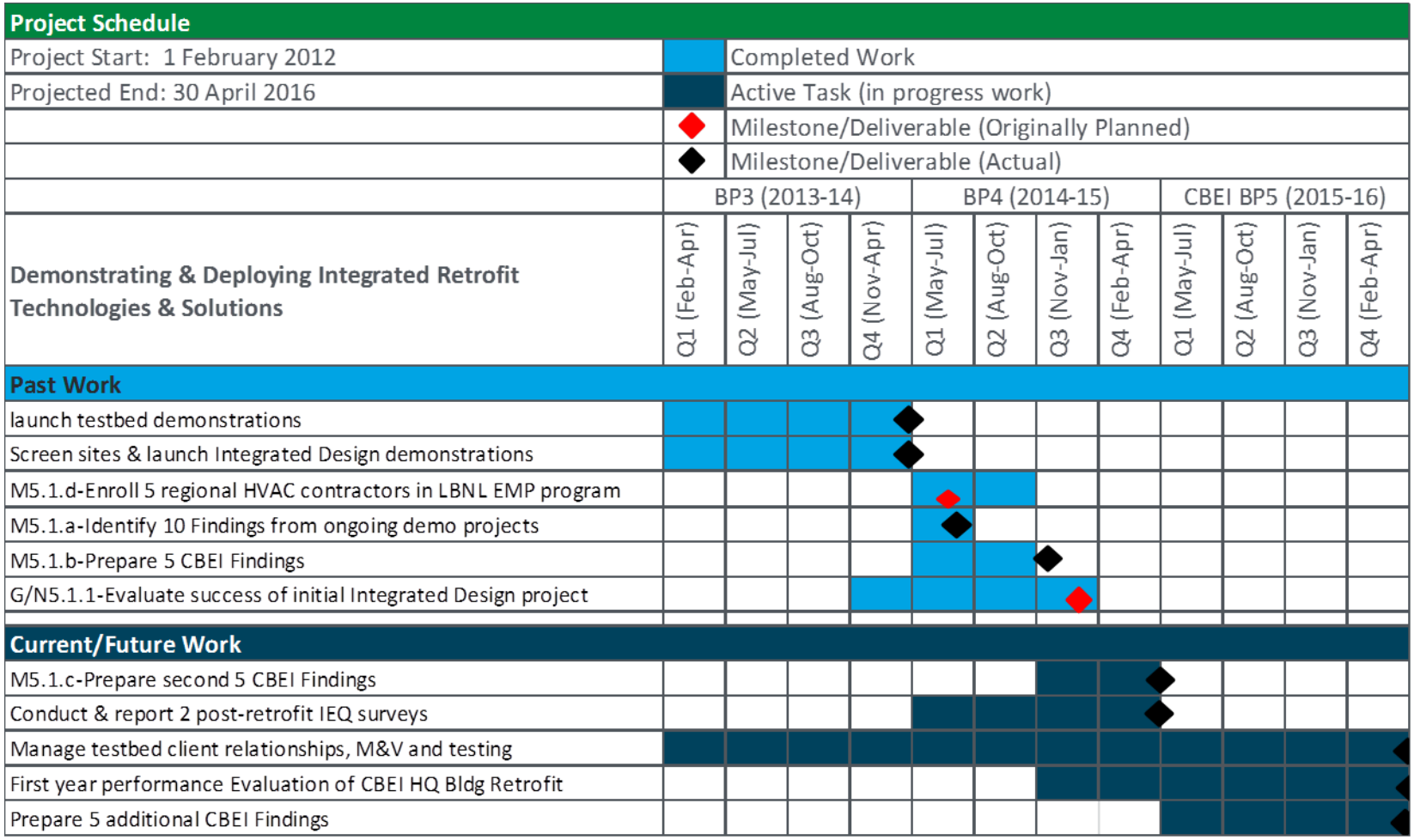
CBEI BP3 (past) 2/1/2013 – 4/30/2014		CBEI BP4 (current) 5/1/2014 – 4/30/2015		CBEI BP5 (planned) 5/1/2015 – 4/30/2016	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$140,000		$395,531	$501,787	$266,000	$276,289

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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