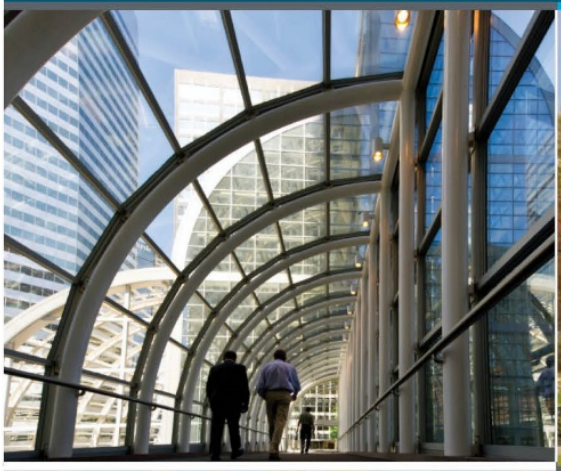
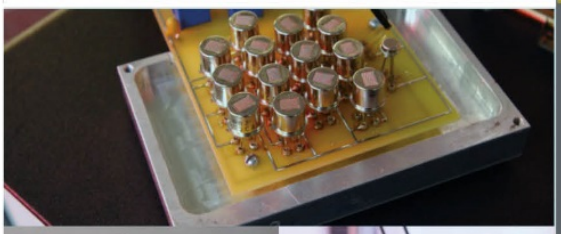
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BUILDING TECHNOLOGIES OFFICE





2015 Building Technologies Office Program Peer Review

November 2015

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U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy

2015 Building Technologies Office Program Peer Review

SUMMARY OF RESULTS

April 14–16, 2015
Vienna, Virginia

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Letter from the Director

Dear Reader:

Our nation continues to drive energy efficiency improvements in the buildings sector, reducing energy costs, lowering carbon dioxide emissions, and creating jobs. Over the last year, we passed a new energy efficiency bill (the Energy Efficiency Improvement Act of 2015), finalized a national plan to reduce carbon emissions from power plants (the Clean Power Plan), and made significant progress toward the President's Climate Action Plan goals. The U.S. Department of Energy (DOE) and the Building Technologies Office (BTO) have played a vital role in supporting these efforts. Along with our national laboratories and industry partners, we developed and helped commercialize low-global-warming-potential, energy-efficient refrigerants; we demonstrated new methods for rapidly moving technology to market at the first ever Industry Day; our Better Buildings program has expanded to over 250 partners committed to cutting their buildings' energy use by 20%; and we launched a new initiative to help states lock in energy savings from building codes.

The BTO Program Peer Review is a critical process in working toward DOE's goal to develop and demonstrate cost-effective technologies and solutions that enable a 50% reduction in building energy use intensity. At this important annual meeting, BTO partners describe their projects and progress toward developing high-impact, energy-efficient building technologies; accelerating movement of building technologies and solutions to the market; and supporting greater adoption of residential and commercial building energy codes. In 2015, 74 projects were evaluated at the peer review meeting, and more than 400 people participated. Fifty-nine independent experts assessed the progress and contributions of each project toward BTO's mission and goals. BTO will use those assessments to enhance the management and effectiveness of existing efforts and to inform the design of future programs and projects.

All presentations are located at www.energy.gov/eere/buildings/building-technologies-office-2015-program-peer-review. A summary of the Peer Review results for each project are included in this report, including a brief project description, the scoring results, and a summary of reviewer comments. The detailed reviewer comments are provided to the project performers and DOE project managers to consider as future plans are developed.

The 2015 BTO Program Peer Review would not have been possible without the dedicated efforts of our reviewers. Their careful, thoughtful, and in-depth observations and comments will continue to inform our efforts for years to come, and on behalf of the BTO staff, I thank them for their valuable support. I invite anyone interested in participating as a reviewer in future peer reviews to send a resume and contact information to btopeerreview@ee.doe.gov.

Sincerely,

Roland Risser
Director
Building Technologies Office
Office of Energy Efficiency and Renewable Energy

1. Introduction

The mission of the Building Technologies Office (BTO) is to develop, demonstrate, and accelerate the adoption of technologies, techniques, tools, and services that are affordable, as well as to enable high-performing, energy-efficient residential and commercial buildings in both the new and existing buildings markets. The mission requires a multi-pronged strategy to address diverse market, technology, and regulatory challenges. BTO's strategy, or ecosystem, shown in Figure 1 below, includes:

1. **Research and development** to reduce cost and improve performance of high-impact energy saving technologies.
2. **Market stimulation** activities to validate energy-efficient technologies and practices in new and existing buildings; reduce risk for builders, building owners and operators, and consumers to incorporate new energy-efficient solutions; and spur private sector investments in energy efficiency.
3. **Codes and standards** to remove market barriers, lock in lasting energy savings for all Americans, and drive further technology innovation.

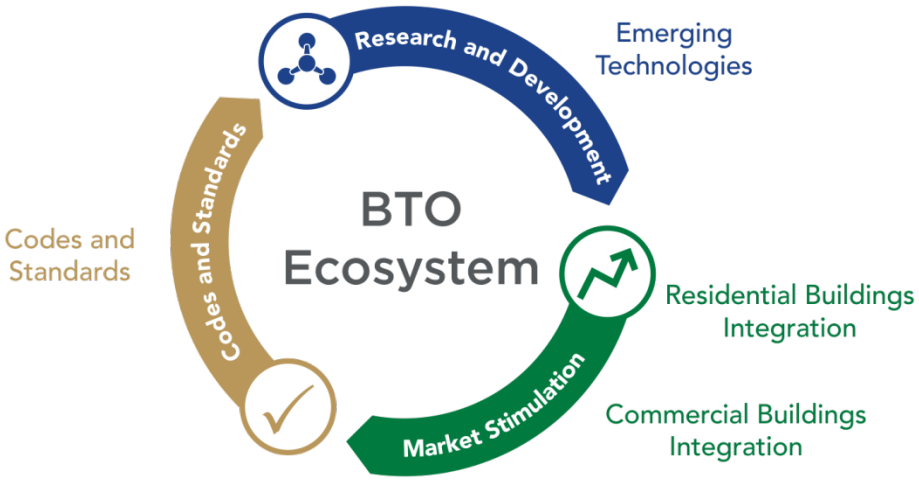


Figure 1. BTO Ecosystem

BTO's overarching long-term goal is to reduce the energy use per square foot of U.S. buildings by 50% compared to 2010 levels. Based on current analysis of the building sector and BTO program planning, BTO has established a goal of reducing building energy use intensity (EUI) 30% by 2030. BTO works toward this goal through five interdependent programs: (1) Emerging Technologies, (2) Commercial Buildings Integration, (3) Residential Buildings Integration, (4) Building Energy Codes, and (5) Appliance and Equipment Standards.

Independent evaluation of the quality and effectiveness of current projects is essential for enhancing existing efforts and designing future programs. Peer reviews are an important tool in providing independent, robust, and documented feedback for program evaluation and planning.

Program Peer Review

The 2015 BTO Peer Review was held April 14–16, 2015, at the Sheraton Tysons Hotel in Vienna, Virginia. The review was attended by more than 400 participants and included presentations on 74 projects: 30 from the Emerging Technologies Program, 37 from the Commercial Buildings Integration Program, 5 from the Residential Buildings Integration Program, and 2 from the Building Energy Codes

Program. This report summarizes the scores and comments provided by the independent reviewers for each project. The Appliance and Equipment Standards Program is excluded from the BTO Peer Review since it is not involved with typical research and development or market stimulation projects.[1]

The objectives of the peer review were to:

- Conduct an independent evaluation of current BTO projects and performers, their efforts over the past year toward BTO goals, and their future plans;
- Provide a forum to promote collaborations and partnerships among project performers and other stakeholders; and
- Communicate the value of BTO investments.

Reviewers were drawn from a variety of building-related backgrounds and included experts from industry, academia, government, and other stakeholder groups. The reviewers were screened for conflicts of interest and assigned to projects based on their area of expertise and interests. Appendix A provides a complete list of reviewers, and Table 1 indicates the average number of reviewers per project.

Table 1. Average Number of Reviewers per Project by Program at the 2015 BTO Program Peer Review

	Emerging Tech (30 projects)	Commercial Bldgs (37 projects)	Residential Bldgs (5 projects)	Building Codes (2 projects)
Average	4.77	4.65	3	2.5
Max	7	8	3	3
Min	2	3	3	2

Analysis Methodology

For the majority of the projects, reviewers were given five evaluation criteria and asked to score them on a 1–4 scale, with four being the highest. In addition to numeric scores, reviewers were asked to provide qualitative comments and feedback regarding the project's strengths and weaknesses, and any suggestions relating to the scope of the work. Reviewers were also asked to evaluate the value of the deliverables to the target audience/market and whether the key research areas/deployment activities relevant to the project scope are receiving sufficient emphasis. For the full evaluation criteria, please refer to Appendix B.[2] Scores were based on the following criteria and weights:

Score 1: **Relevance (standalone metric)** – Degree to which the project supports BTO goals and objectives. (*Note: this metric was not scored since it does not reflect on the performer of the work; this is an issue for BTO program and project managers.*)
Score 2: **Approach (30%)** – Degree to which the project is focused on the critical barriers (15%), and the degree to which the project's design addresses the barriers identified (15%).
Score 3: **Accomplishments/Progress/Impact (40%)** – Degree to which the project has made progress toward achieving the stated project goals (20%), and the degree to which the project will significantly contribute to the achievement of its BTO program's goals (20%).

[1] The Appliance and Equipment Standards Program also already works closely with a large range of stakeholders to ensure its energy conservation standards, test procedures, and certification and compliance regulations are based on technical merit. Decisions are also made based on economic analyses, and the consideration of impacts on consumers, manufacturers, and the environment.
[2] One initiative, the High Impact Technology (HIT) Catalyst, used a more extensive set of evaluation criteria (in lieu of scores) due to it being a larger initiative comprised of multiple, related projects, rather than an individual project. The full set of HIT Catalyst evaluation criteria can be found in Appendix B. The HIT Catalyst description and summary of reviewer comments can be found in the Commercial Buildings Integration Program chapter.

Score 4: **Project Integration and Collaborations (20%)** – Degree to which the presenter has demonstrated an understanding of the key stakeholders necessary to accelerate the movement of technologies or practices into the market (10%), and the degree to which the project staff collaborates or coordinates with industry or other relevant stakeholders (10%).

Score 5: **Proposed Future Work (10%)** – Degree to which the project has effectively planned its future in a logical manner by incorporating appropriate decision points, considering impediments to its goals, and, when sensible, mitigating risk by providing alternate pathways.

For each project, relevance was assessed as a standalone metric and the other four criteria were used to calculate a weighted average using the equation shown in Figure 2.

$$\left[\left(\frac{\sum_1^n Score\ 2}{n}\right)x(0.15)\right]+\left[\left(\frac{\sum_1^n Score\ 3}{n}\right)x(0.15)\right]+\left[\left(\frac{\sum_1^n Score\ 4}{n}\right)x(0.2)\right]+\left[\left(\frac{\sum_1^n Score\ 5}{n}\right)x(0.2)\right]+\left[\left(\frac{\sum_1^n Score\ 6}{n}\right)x(0.1)\right]+\left[\left(\frac{\sum_1^n Score\ 7}{n}\right)x(0.1)\right]+\left[\left(\frac{\sum_1^n Score\ 8}{n}\right)x(0.1)\right]$$

(n equals the number of reviewers per scoring metric)

Figure 2. Equation used to calculate each project's weighted average score

Organization of the Report

To align with BTO's organization, the peer review results are grouped by program (Emerging Technologies, Commercial Buildings Integration, Residential Buildings Integration, and Building Energy Codes). This report presents a summary of the results for each project, which includes a brief project description, a scoring chart, and a summary of the reviewer comments. (The detailed reviewer comments are provided to the project performers and U.S. Department of Energy project managers to consider as future plans are developed.) The scoring chart for each project shows the project's weighted average and how it compares with the other reviewed projects within its program area. A sample graph and explanation are provided in Figure 3.

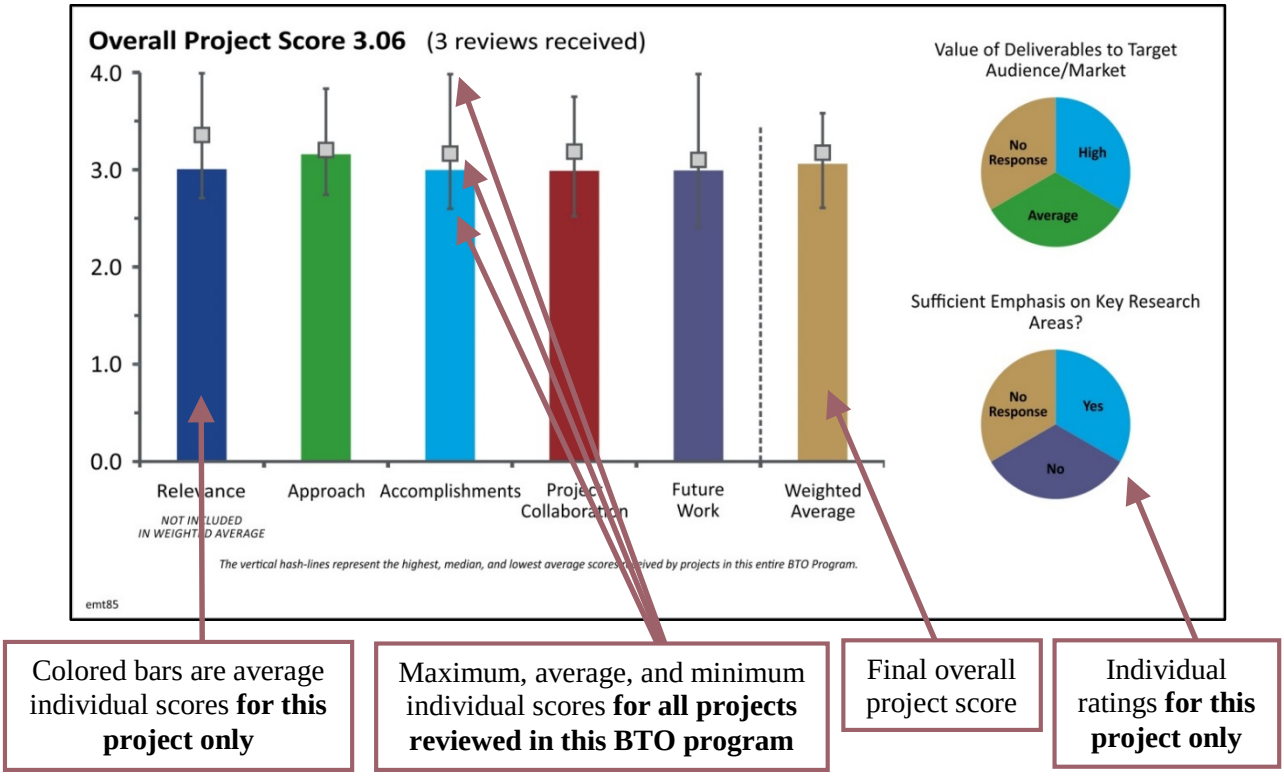


Figure 3. Sample project score graph with explanation

2. Emerging Technologies

2.1 Program Overview

The Emerging Technologies Program supports applied research to accelerate the development and initial commercialization of technologies and systems capable of substantially reducing primary energy use in buildings. The Program invests in the development of the following technologies and tools:

- Solid-state lighting
- Heating, ventilation, and air conditioning (HVAC)
- Water heating
- Appliances
- Building envelope
- Windows
- Sensors, controls, and the transactional network
- Building energy modeling

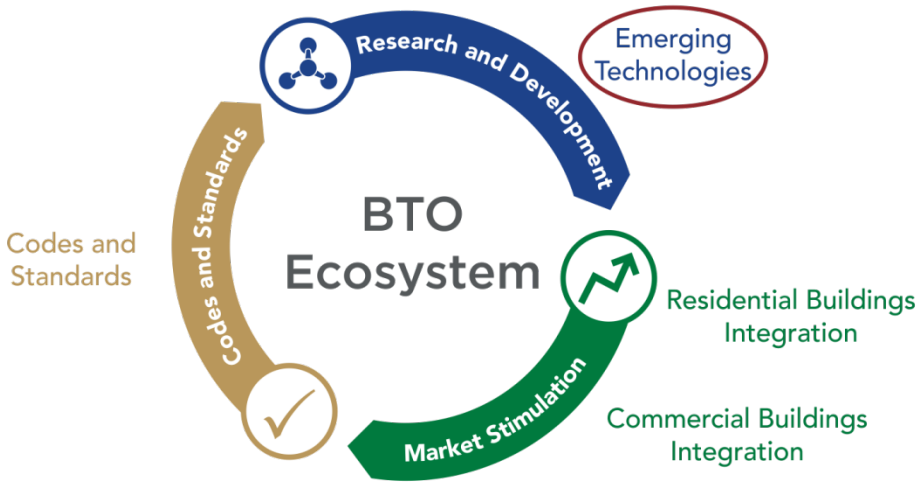


Figure 4. The role of the Emerging Technologies Program in the BTO Ecosystem

The Program develops technology-specific roadmaps that identify cost and performance metrics and targets. The Program's overall goal is to introduce technologies to the market that can achieve significant energy savings. Specifically, the Program's goal is to enable the development of cost-effective technologies that collectively will be capable of reducing a building's energy use per square foot by 30% by 2020 and 45% by 2030, relative to 2010 technologies. The Program tracks its progress by monitoring technology cost and performance improvements, and by evaluating how much it has influenced the overall change in energy efficiency trends. To achieve its goals, the Program partners with industry, universities, national laboratories, and small businesses to conduct merit-reviewed research and development projects.

2.2 Summary of Peer Review Feedback

Project # ET-37: Research Triangle Institute: Solid-State Lighting Luminaire Reliability Model

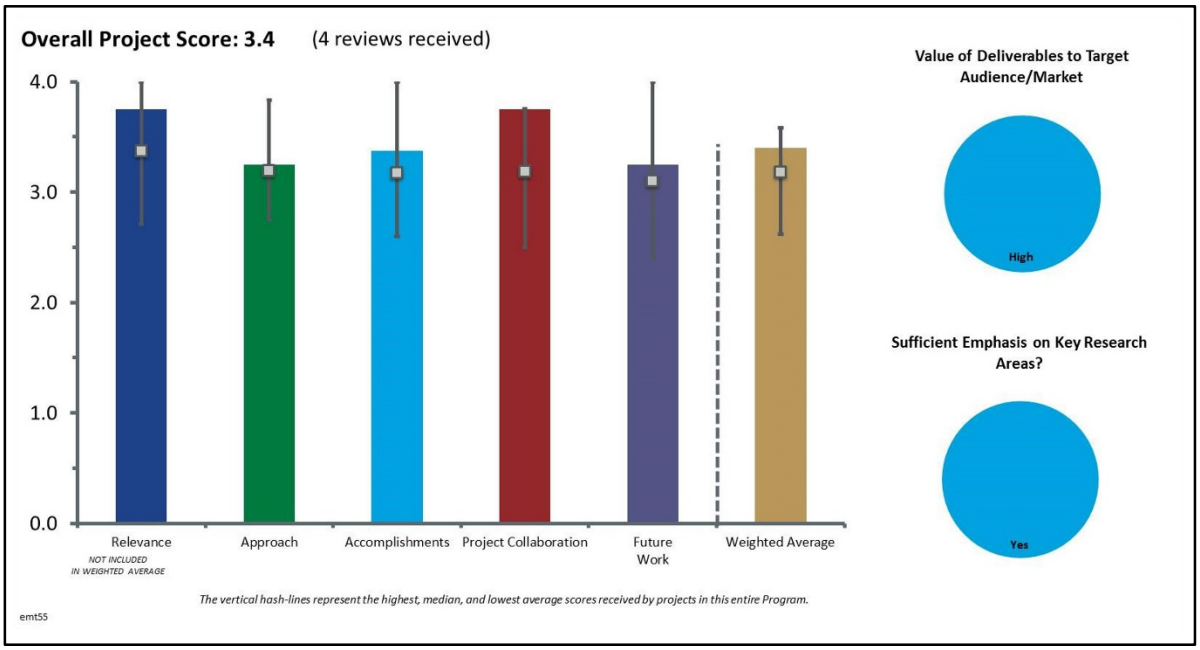
Presenter: Lynn Davis, RTI International, ldavis@rti.org
DOE Manager: James Brodrick, james.brodrick@ee.doe.gov, 202-586-1856

Project Description

This project is developing and validating a multivariable reliability prediction tool for solid-state lighting (SSL) luminaires and new accelerated life testing methodologies for evaluating the system performance of SSL luminaires in less than 3,000 hours of testing. The target audience consists of manufacturers, specifiers, and potential users of SSL products looking to justify higher upfront costs for SSL products. This group consumes about 650 terawatt hours of electricity annually; adopting SSL devices can reduce consumption by about 30%.

Summary of Review Comments

Reviewers found this project to be of high value, commending its efforts to improve consumer and industry confidence in SSL technology and therefore drive wider market acceptance of the technology. Cited strengths include the project's (1) sound accelerated testing methods, (2) robust collaboration and outreach activities, and (3) plans to further study color shifts. A reviewer also praised the project for addressing some of the problems seen in early energy-reducing lighting system technologies, such as compact fluorescent light reliability. Most reviewers felt the project is making good progress, but one thought it was difficult to gauge the full impact of the accomplishments from the presentation. One reviewer questioned the project's inability to confirm the testing standard's accuracy. Another reviewer reported that while the study lists thermal management, power management, and optical management as components for SSL reliability, the presentation did not cover those components. Reviewers did not offer any specific recommendations.



Project # ET-40: CBERD: Monitoring and Benchmarking

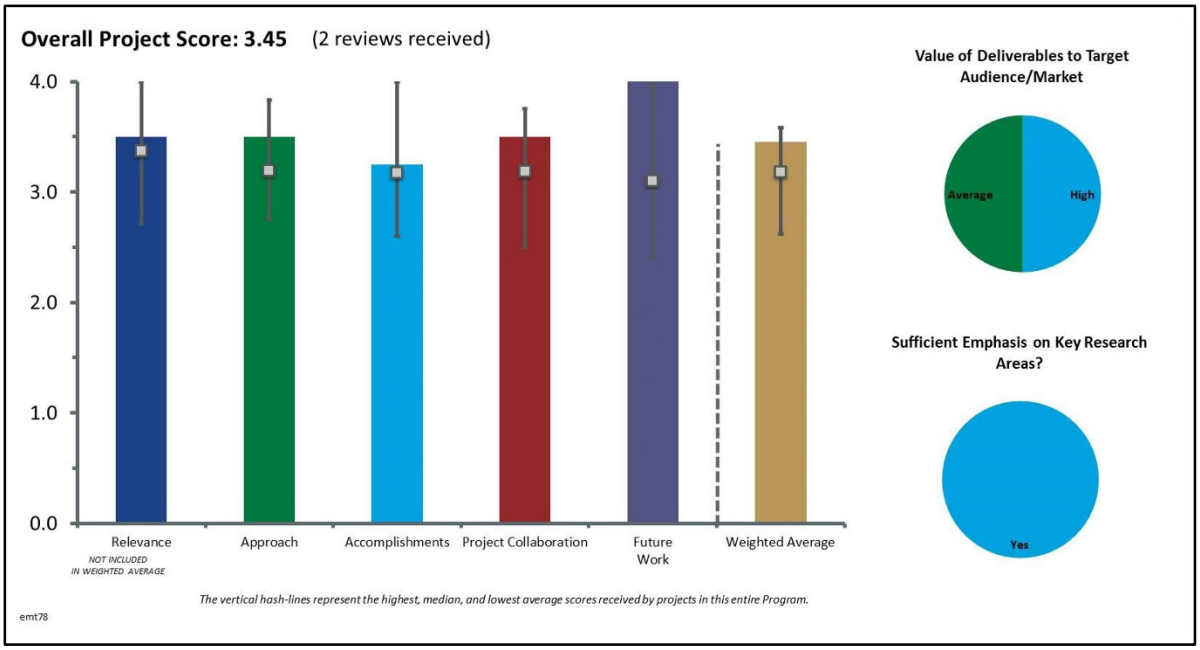
Presenter: Paul Mathew, Lawrence Berkeley National Laboratory, pamathew@lbl.gov
DOE Manager: Karma Sawyer, karma.sawyer@hq.doe.gov, 202-287-1713

Project Description

This U.S.–India Joint Center for Building Energy Research and Development (CBERD) project is facilitating broader use and applicability of advanced benchmarking and energy information systems (EIS). Advanced benchmarking and EIS can enable up to 20% energy savings; however, there is a lack of scalable, cost-effective building monitoring tools to inform building design and operation. To address this problem, the project is first developing new specifications for EIS solutions. The project is also creating an integrated suite of benchmarking methods, tools, and practices, along with a plan to embed them into market deployment programs and policies. The project also gives U.S. EIS vendors the opportunity to strengthen their foothold in emerging international markets, such as India.

Summary of Review Comments

According to reviewers, the project combines technology innovation with applicable energy-savings goals, helping both India and the United States better gauge their progress toward their building efficiency goals. The approach was described as holistic, with selection of different building types demonstrating an understanding of the complexity of building owners' concerns, and one reviewer stated that the project's holistic nature indicates that the project team prepared the timeline and layout of each aspect with care. One reviewer stated that the project is invested in discovering the barriers and that these barriers, as they are uncovered, are driving the project's evolution. Reviewers commented on the project's bilateral nature, noting both the benefits of sharing best practices and the challenges and delays involved in cross-continental coordination. One reviewer, concerned about project fatigue, recommended maintaining an even pace to ensure milestones are achieved with results. Collaborations were seen as appropriate for the current stage, with one reviewer noting that future phases will require additional stakeholders. One of the reviewers had concerns about (1) the EIS's effectiveness and reliability in capturing the data, (2) whether the technology has been sufficiently proven in the market, and (3) whether the project's goal is only to bring this technology to emerging international markets. It was suggested that the project team consider including behavior modification elements as baseline energy use consumptions are calculated, and consider how commissioning should be introduced into the project.



Project # ET-41: CBERD: Simulation and Modeling

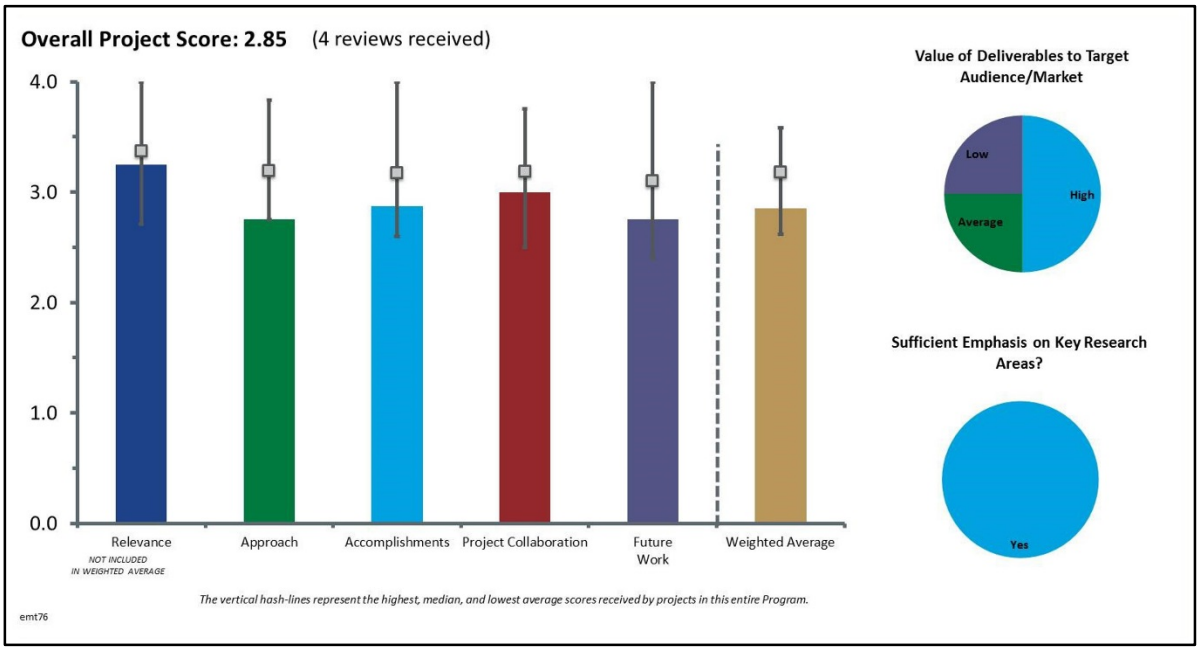
Presenter: Phil Haves, Lawrence Berkeley National Laboratory, PHaves@lbl.gov
DOE Manager: Amir Roth, amir.roth@ee.doe.gov, 202-287-1694

Project Description

In this project, the U.S.–India Joint Center for Building Energy Research and Development (CBERD) is developing improved design analysis tools and data, control strategies, and diagnostic tools for building design and operation to improve the energy efficiency of commercial and high-rise residential units. Current simulation tools fail to fully meet the needs of practitioners throughout the building life cycle. In particular, the project team has identified significant gaps in early stage design analysis, code compliance tools, and control of passive thermal storage. Thus far, the project has developed a beta version of a code compliance tool and implemented real-time model predictive control (MPC) strategies in a building and test bed equipped with a low-energy heating, ventilation, and air conditioning (HVAC) system.

Summary of Review Comments

According to reviewers, this project is well aligned with Building Technologies Office (BTO) goals, although a few reviewers expressed concern that the project's components did not clearly connect. Efforts to improve simulation—e.g., through developing MPC for early design tools, adding capabilities to state-of-the art modeling tools, and improving passive design modeling capabilities—were seen as very valuable and, in one case, called critical to the BTO mission. One reviewer noted the importance of incorporating low-energy design strategies in developing economies (such as India). Reviewers had mixed assessments on the project's collaborations; two reviewers commended the project team for establishing partnerships with key stakeholders, while two others were unclear about partners' roles. Reviewers also differed in their evaluation of the project's progress. Two remarked that the project is on target with developing projected tools to date, although it was noted that the substance of the results would only be seen in forthcoming testing and validation; one felt the presentation did not clearly articulate the accomplishments; and one found it disturbing that more concrete results were not conveyed. Next steps were generally seen as valid, although one reviewer found them overly ambitious. A reviewer also wondered whether this effort is coordinated with other ongoing efforts related to the development and use of EnergyPlus-based tools. One reviewer recommended that the project team continue the validation work and keep the tools open source.



Project # ET-42: CERC: Modeling and Simulation of Human Behavior in Buildings

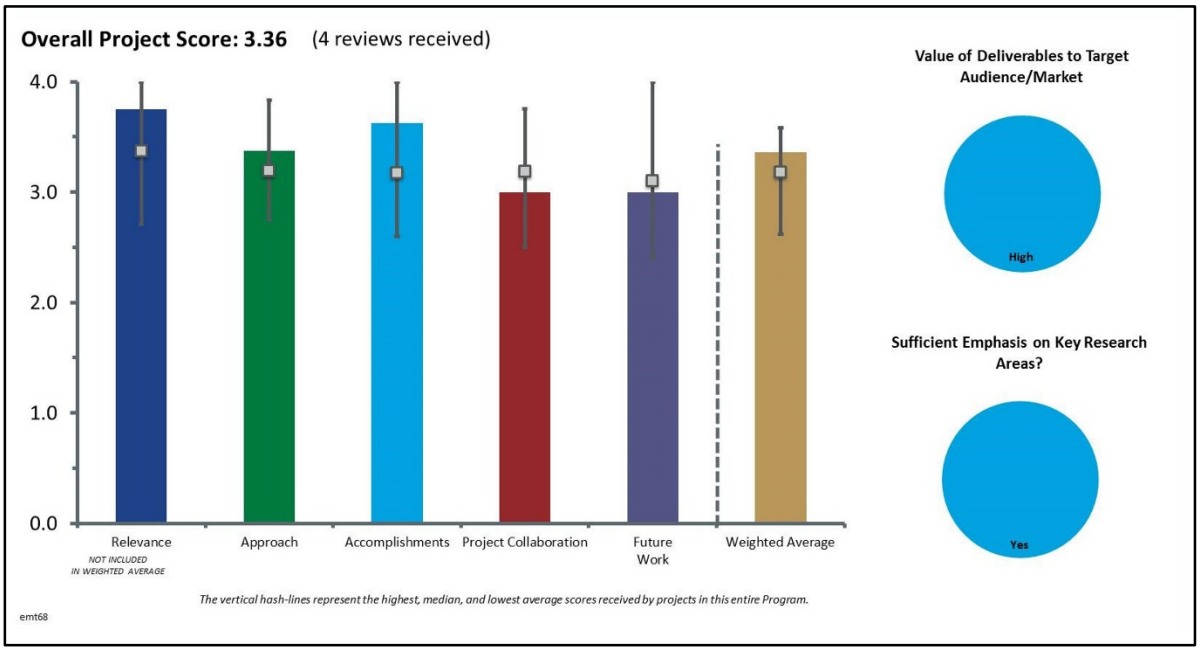
Presenter: Tianzhen Hong, Lawrence Berkeley National Laboratory, thong@lbl.gov
DOE Manager: Amir Roth, amir.roth@ee.doe.gov, 202-287-1694

Project Description

This project by the U.S.–China Clean Energy Research Center is developing case studies and data to gain an enhanced understanding of energy-related occupant behavior. Human behavior plays a crucial role in building design and operation, and thus energy use. However, data and case studies on occupant behavior are lacking. This project is collecting data to standardize the description of human energy-related behavior and integrating the behavior models into whole-building performance simulation tools. According to estimates by Lawrence Berkeley National Laboratory, understanding and optimizing occupant behavior or designing buildings to better align with occupant behavior can reduce building energy use by as much as 50%.

Summary of Review Comments

Reviewers were very positive about this project overall, noting that it addresses an important topic that receives too little attention—occupant behavior. The reviewers praised the project's approach for being comprehensive and for using analytics appropriately for a set of difficult-to-quantify variables. The investigators were commended for having a thorough understanding of occupant behavior and for including the relevant issues and stakeholders. Reviewers felt the project has delivered on its stated goals, including developing behavior models, a framework, and extensible markup language (XML) schemes, and integrating these schemes into EnergyPlus. There were mixed opinions about the data, with one reviewer stating the project has limited access to data from only one region (China), while another felt the project is using a large dataset that will provide confidence in the validity of the schema tool. One reviewer was unsure how the outcome will be released (e.g., as open source). A reviewer felt the project could be improved if it expanded its emphasis to exploring occupant behavior with respect to underlying demographic statistics and causal factors as a first step toward establishing a credible sense of how such behavior can be influenced to reduce energy consumption. Another reviewer suggested the project team study how the schema could be utilized to simulate integrated controls strategy in cases in which active and passive user-driven components interact, as well as conduct an actual occupancy study and make the outcomes publicly available.



Project # ET-43: Unico: Residential Cold Climate Heat Pump with Variable Speed Technology

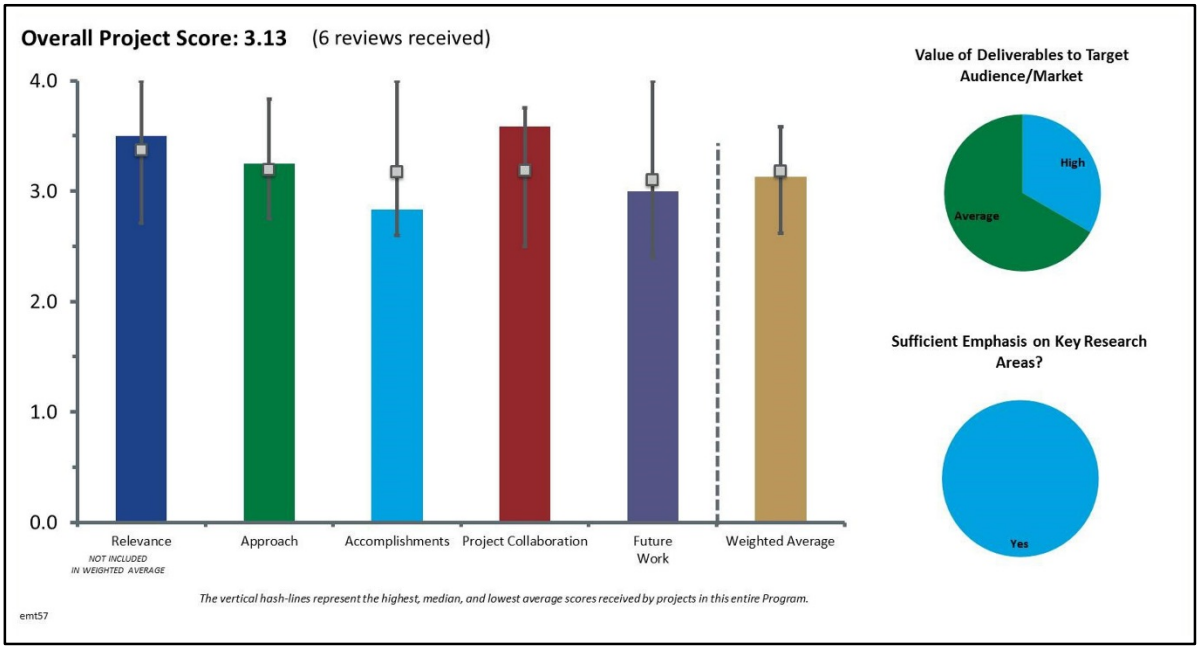
Presenter: Craig Messmer, Unico Systems, craig@unicosystem.com
DOE Manager: Antonio Bouza, antonio.bouza@ee.doe.gov, 202-586-4563

Project Description

The goal of this project is to develop a residential split-system 3-ton cold climate heat pump using boosted compression technology and variable speed motors. This next-generation technology represents a highly efficient and cost-effective heating, ventilation, and air conditioning (HVAC) system specifically geared toward colder U.S. climates. Unico seeks to meet efficiency goals of a coefficient of performance (COP) of 4.0 at the 47°F ambient temperature standard rating condition, and a cold ambient heating capacity (at -13°F ambient conditions) that is ≥75% of the nominal capacity. The project aims to achieve a simple payback of less than 5 years. The technology is poised to dramatically reduce heating costs and increase U.S. energy independence.

Summary of Review Comments

General consensus was that the project as originally conceived has potential for significant energy savings through more widespread use of heat pump technology in colder climates. However, reviewers explained that investigators have encountered difficulties with the initial approach (multiple compressors in series), and while they were credited with practicality in adjusting the project and moving to a single-compressor solution, the change presented reviewers with several concerns. One reviewer felt maintaining the project schedule would be very challenging; one noted new technical barriers and associated costs; and two stated that the new approach would not have the same energy efficiency and might not be any better than existing technologies. Reviewers recognized the excellence of the project team, including collaborators, noting relevant experience, clear focus, and good understanding of the issues. However, reviewers shared uncertainty about future plans, one specifically noting the presentation's lack of (1) experimental or testing results of the new design, and (2) a plan for moving from the present COP of 2.4 to the targeted 3.0 or higher. One reviewer suggested that the project team begin researching consumer demand and identifying state agencies and utilities that would be likely to promote this type of product, particularly through incentives, and another recommended testing to ensure the cooling performance is not compromised when the heating performance goal is reached.



Project # ET-45: UTRC: High Performance Commercial Cold Climate Heat Pump (CCCHP)

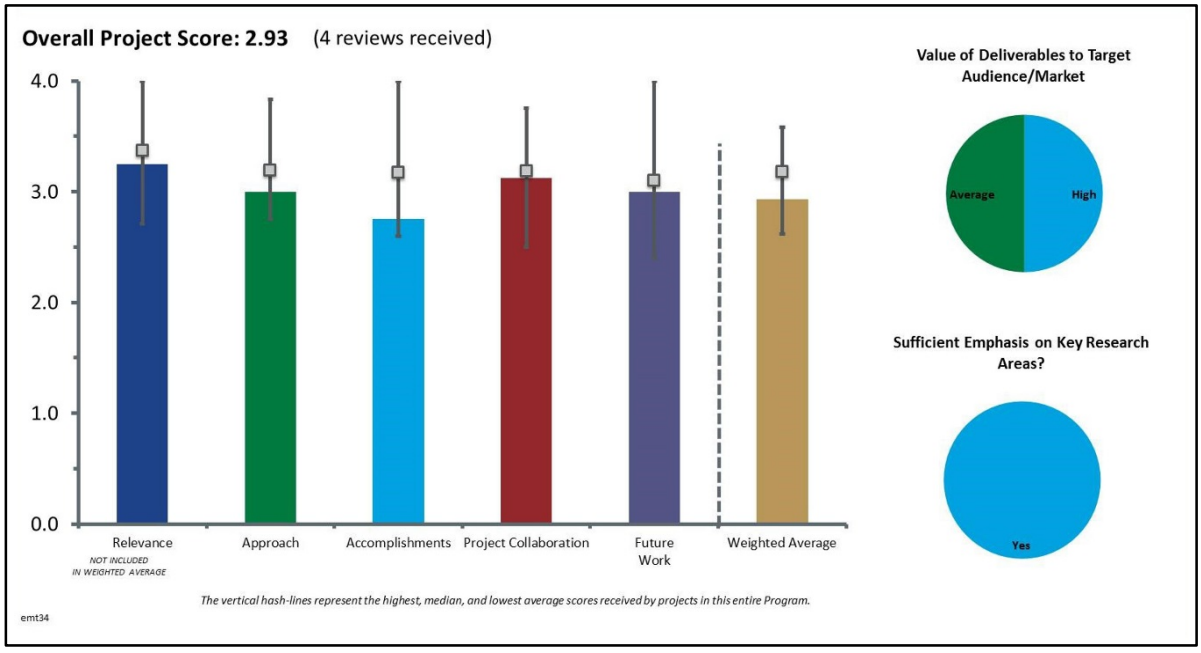
Presenter: Ahmad Mahmoud, United Technologies Research Center, mahmouam@utrc.utc.com
DOE Manager: Antonio Bouza, antonio.bouza@ee.doe.gov, 202-586-4563

Project Description

The United Technologies Research Center (UTRC) is developing a prototype 10-tons-of-refrigeration high-performance commercial cold climate heat pump system. The system improves on state-of-the-art heat pumps, which can degrade by up to 60% in capacity and 50% in system coefficient of performance at the -13°F ambient conditions targeted by the U.S. Department of Energy. The system's improved performance is achieved by utilizing compression with high efficiency over an unusually wide range of speed and pressure ratios and with system-level design optimization for cold climates. The system is expected to be scalable beyond 40 tons of refrigeration, be cost effective with a simple payback of less than 3 years, and enable a 25% (or more) reduction in annual electricity use for building space heating in cold climates.

Summary of Review Comments

Reviewers found this project's efforts to develop a high-efficiency commercial cold climate heat pump system to be very relevant to Building Technologies Office (BTO) goals for energy reduction. Reviewers praised the project for (1) designing technology that can be applied seamlessly into an existing system, and (2) addressing demand for cold climate heat pumps from the system point of view. Opinions on the project's collaboration varied—one reviewer critiqued the project for being a single-performer project, another reviewer felt the UTRC team has sufficient breadth and depth to provide all necessary project support functions, and a third reviewer stated that UTRC's standing relationship with Carrier Corporation should result in the smooth implementation of the conceived technical concepts. Reviewers also presented mixed views on the project's progress—one reviewer praised the project team for developing a working proof-of-concept that has already produced results close to the target, while another felt the project seems to have missed on the major benchmarks set by BTO. Individual reviewers expressed concern that (1) the hardware specifications and performance data are insufficient to validate the energy-saving claims, and (2) there has been insufficient analysis on how this system would be economically competitive with traditional cold climate heating, ventilation, and air conditioning (HVAC) systems. One reviewer recommended the project team describe and explain in detail the technological innovations incorporated in the system design that would ensure significant energy savings.



Project # ET-46: Thermolift: Natural Gas Fired AC and Heat Pump

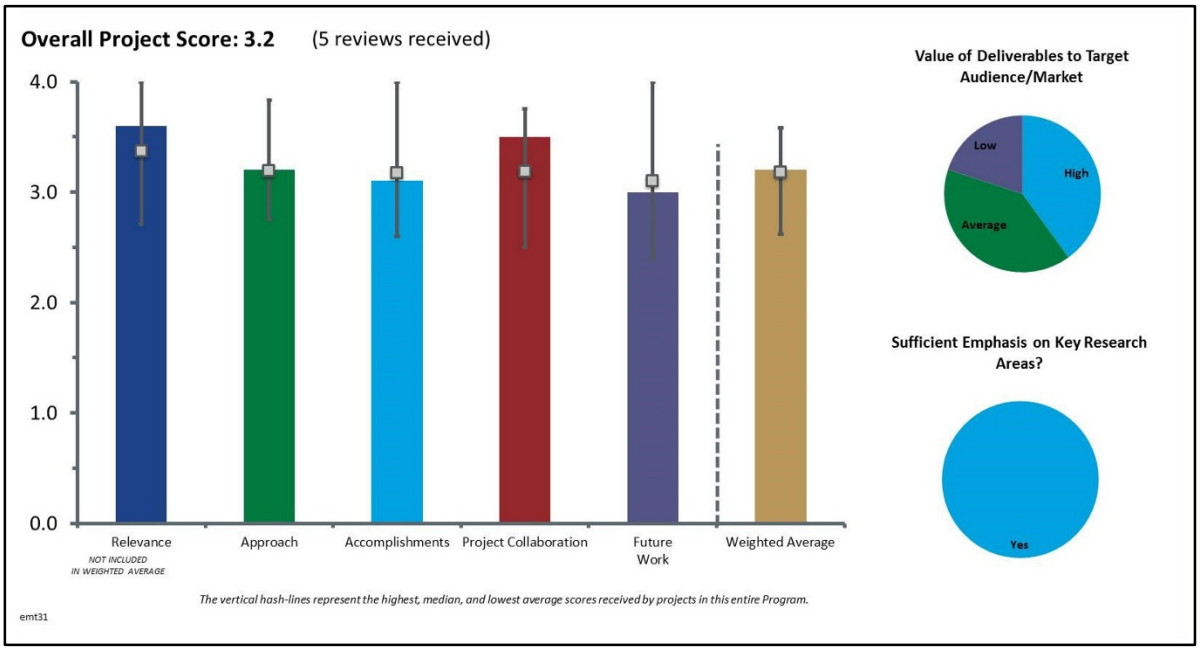
Presenter: Paul Schwartz, Thermolift, pschwartz@tm-lift.com
DOE Manager: Antonio Bouza, antonio.bouza@ee.doe.gov, 202-586-4563

Project Description

This project is developing a novel natural-gas-driven heat pump/air conditioner with the potential to replace residential and commercial heating, cooling, and hot water systems. This single-unit device provides significantly improved efficiency, with a lower carbon footprint, at a competitive price compared to current systems. As a heating unit, the device operates as a heat pump that can also reclaim combustion waste heat for improved efficiency. As an air conditioner, the device uses gas (or oil) rather than electricity, reducing the burden on the electrical grid. The device is expected to improve heating and cooling efficiency by 30%–50% relative to current standard-efficiency heat pumps.

Summary of Review Comments

Most reviewers agreed the project is exploring an innovative means of achieving high energy savings, but there were concerns about technology and market barriers. Some praised a high-risk, high-reward concept that could revolutionize the building energy market, and some saw the fast cycle of prototype iterations supported by modeling and simulation as a solid design approach. Others, however, thought that the project faces technical barriers that are not fully addressed. In addition, one reviewer remarked that simulation might not be appropriate for the design tasks at hand. Specific technical difficulties cited for the technology include (1) the low achieved run time to date, (2) its high cost (especially for retrofit applications), and (3) that high reliability (or redundancy) is required in a device that provides three critical services (space cooling, space heating, and water heating). Reviewers agreed the project team has maintained its schedule and budget and has met its goals to date, noting that it has developed and tested several prototypes. Consensus was that the project has excellent team members and multiple advocates. Future plans, which reviewers mentioned include testing at Oak Ridge National Laboratory, were seen as clear and well thought-out, although there was some concern the team might not have time for sufficient field validation. Recommendations include (1) using experimental data to validate numerical simulations, (2) using smaller connected prototypes to alleviate the flow resistance problem, and (3) hiring a pressure vessel designer who has experience with the endurance limits of materials with high cyclic duty.



Project # ET-50: LBNL: High R Smart Window Pella

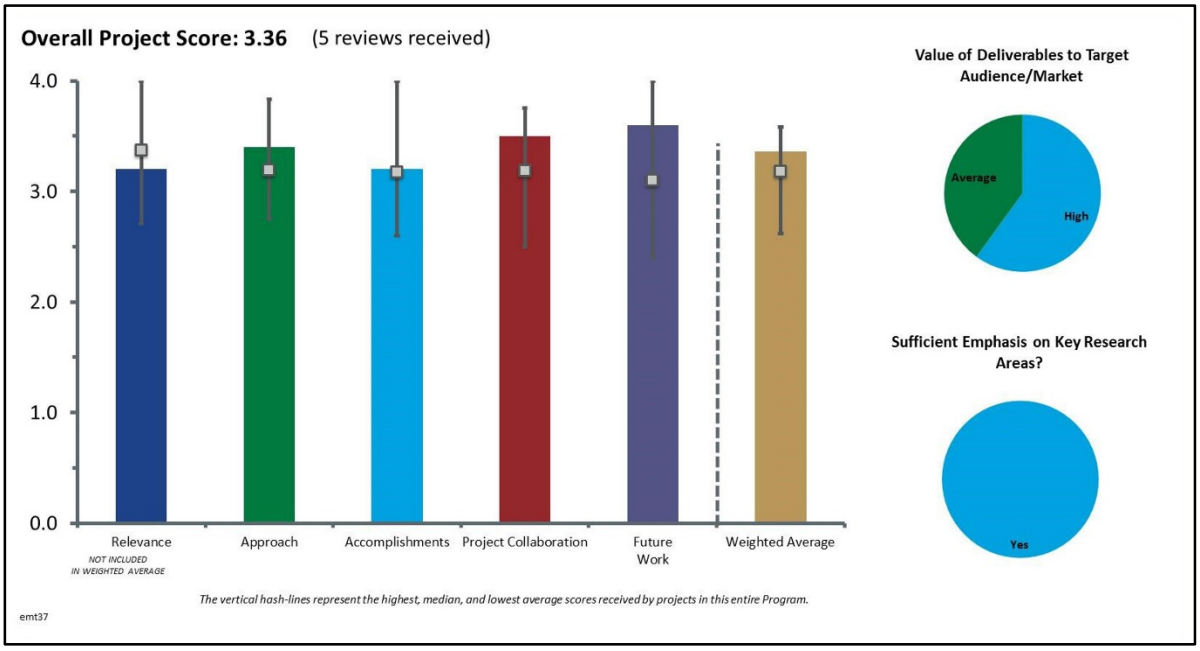
Presenter: Robert Hart, Lawrence Berkeley National Laboratory, rghart@lbl.gov
DOE Manager: Bahman Habibzadeh, bahman.habibzadeh@ee.doe.gov, 202-287-1657

Project Description

This project is creating a flexible technology platform for cost-effective, high-performance residential windows that maximizes net useful solar gain in heating mode and minimizes solar gain in cooling mode. Fully automated operation that optimizes energy savings is provided by an intelligent, networkable sensor/microprocessor package that is easily installed and calibrated. The technology proposed in this project will result in windows with a dramatically lower U-factor (U <0.21), while allowing a wide range of solar heat gain coefficients (0.15–0.42). The U-factor is a measure of the rate of heat loss in a window assembly – the lower the U-factor, the better its insulating properties. The windows will function autonomously and in a network configuration. The project team will pursue these technical accomplishments while focusing on a mature market cost increment of $12 per square foot of window.

Summary of Review Comments

According to reviewers, the project has an excellent technical approach that builds on the strength of its industry partner (Pella), and the focus on shading automation has great potential for improving energy efficiency in residential and small-scale buildings. However, one reviewer suggested that the biggest benefit of the technology may be improving occupant comfort. While most reviewers praised the project for its strong collaboration with Pella and for developing and successfully demonstrating a prototype window, two reviewers questioned the value of the deliverables until more is known about the actual energy savings and user satisfaction, and one called for greater collaboration with other manufacturers of home automation products. Reviewers recommended (1) extending the shade control beyond the basic on/off states to include intermediate states; (2) integrating this technology with other heating, cooling, and lighting systems; and (3) continuing to explore the balance between energy efficiency and cost.



Project # ET-54: PNNL: Dynamically Responsive IR Window Coatings

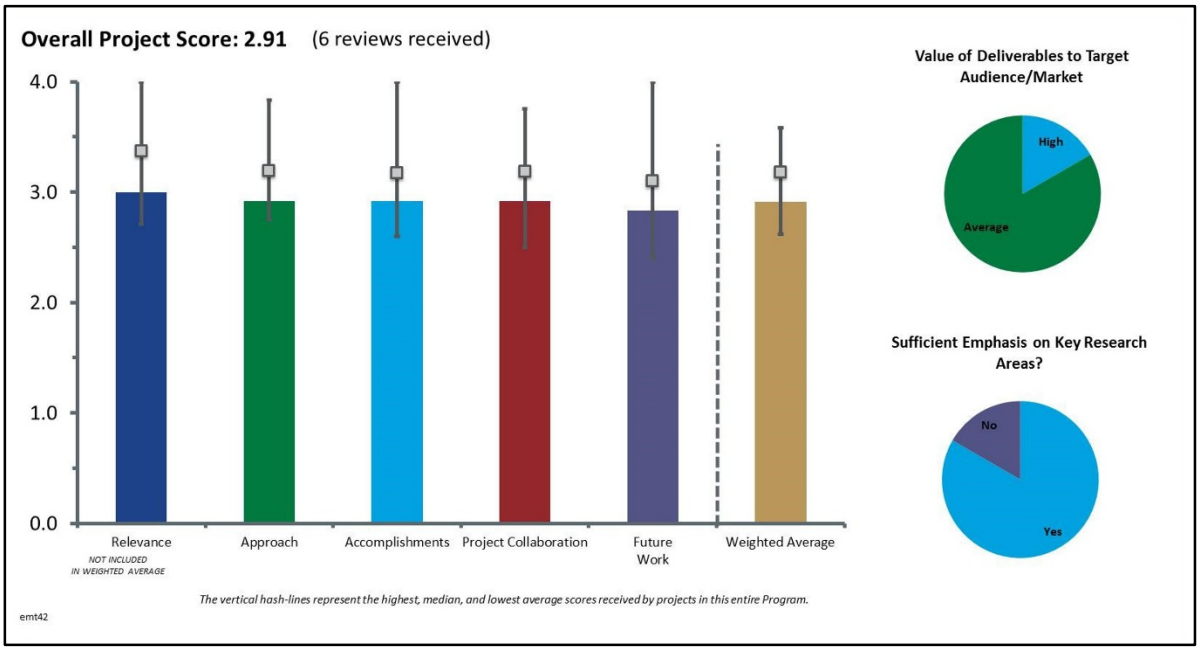
Presenter: Kyle Alvine, Pacific Northwest National Laboratory, kyle.alvine@pnnl.gov
DOE Manager: Bahman Habibzadeh, bahman.habibzadeh@ee.doe.gov, 202-287-1657

Project Description

This project seeks to develop and demonstrate scale-up feasibility of a low-cost, passively switchable dynamic infrared (IR) coating that integrates IR-reflective sub-wavelength nanostructures in a buckling layer. Two prototype films will be created: (1) a laboratory-scale (1-inch) dynamic IR-responsive coating with a near-infrared (NIR) transmission delta of 20% and a visible transmission of greater than 50%, as well as a temperature-switching window in the 30°–90°C range; and (2) a bench-scale (6-inch) integrated buckling and sub-wavelength film with an average NIR transmission delta of 10%–15% (over 750–900 nanometers), an average visible transmission of at least 20%, and a temperature-switching window in the 30°–90°C range. This technology has the potential to save up to 1.7 quads of building primary heating and cooling energy per year over low-e coating technology.

Summary of Review Comments

Reviewers commented favorably on the project's novel concept—a passively switchable dynamic IR window coating—and its efforts to find low-cost solutions that increase market penetration. The excellent collaboration with PPG Industries also received praise, although one reviewer suggested that a downstream fenestration partner should already be on board. Reviewers generally agreed that the coating is a promising technology and has demonstrated significant energy savings potential; however, reviewers also indicated that the research is in an early phase and the project has not yet created high-value deliverables. It was also noted that the coating fabrication process involves significant technical challenges. One reviewer called the approach to addressing these challenges—i.e., modeling, laboratory-scale testing of proof of concept, and intermediate scale-up testing—sound and effective. However, others indicated that the approach fails to address several critical aspects, such as the risk of performance failure over time and the relationship between window temperature and the temperature at which pre-buckled coating expands. One reviewer suggested that the project should better describe the problem statement, and how the technology's cost and performance compare/improve upon competing products. Reviewers recommended lowering the 90°C switching temperature to a more typically encountered temperature, conducting further work to assess the technology's service life, and reexamining the pricing model to ensure it accounts for the current cost of materials.



Project # ET-61: CBERD: Controls and Communication Integration

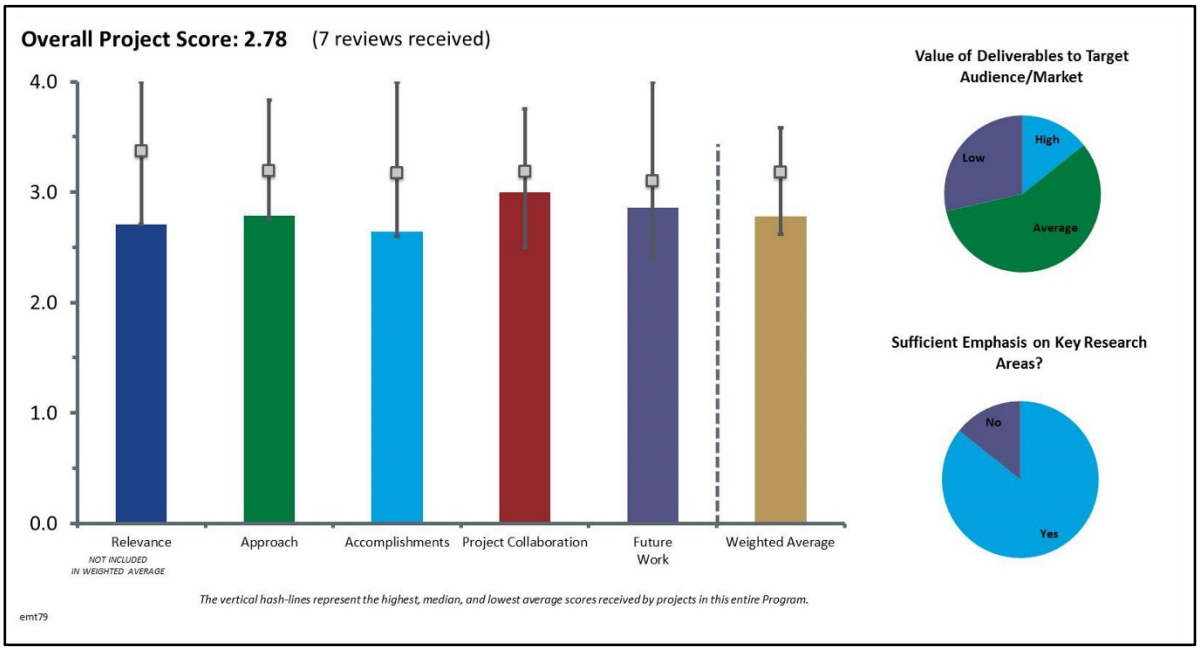
Presenter: Rich Brown, Lawrence Berkeley National Laboratory, rebrown@lbl.gov
DOE Manager: Karma Sawyer, karma.sawyer@ee.doe.gov, 202-287-1713

Project Description

This project is integrating open-source tools with next-generation building systems to enable increased interactions between systems. When there is no interaction between the various systems within a building, optimizing the entire building's energy performance is impossible. To demonstrate the benefits of open software architecture to industry, the project is developing proof of concept of a unified heating, ventilation, and air conditioning (HVAC); lighting; and plug-load control interface. The open-source, user-friendly platform will also integrate advanced plug-load management capabilities. The project is part of the U.S.–India Joint Centre for Building Energy Research and Development (CBERD), a bilateral consortium that promotes innovation in energy efficiency through collaborative research, contributing to significant reduction in energy use in both nations.

Summary of Review Comments

Reviewers expressed a variety of views on most aspects of this project, including its ability to contribute to national Building Technologies Office (BTO) objectives, the strength of the approach, and the degree of collaboration. Some reviewers praised the approach and the future work plan as being reasonable and appropriately tailored to overcoming market barriers, noting that open-source software tools that enable transactive energy control could provide significant benefits. However, others felt that the approach, critical barriers, and future plans are not well described. One reviewer wanted more details on how the existing software (VOLTTRON) would be extended or improved, and another noted that the barriers focus on integrated controls but that the actual project activities do not. While the U.S.–India partnership was frequently noted to be a strength that could provide unique benefits to the project, other reviewers felt the international collaboration was inadequately justified, limits the project's relevance to BTO goals, and could serve as a barrier because of inherent differences between the partners' in-country situations (e.g., resource limitations). One reviewer questioned whether the project is providing any unique contribution, noting that it is unclear that products will provide better performance than tools already available in the market. Reviewers generally agreed that there is a need for quantifiable evaluations (e.g., field trials) of the proposed system to demonstrate energy-saving potential.



Project # ET-63: CERC: Microgrid Equipment Selection and Control

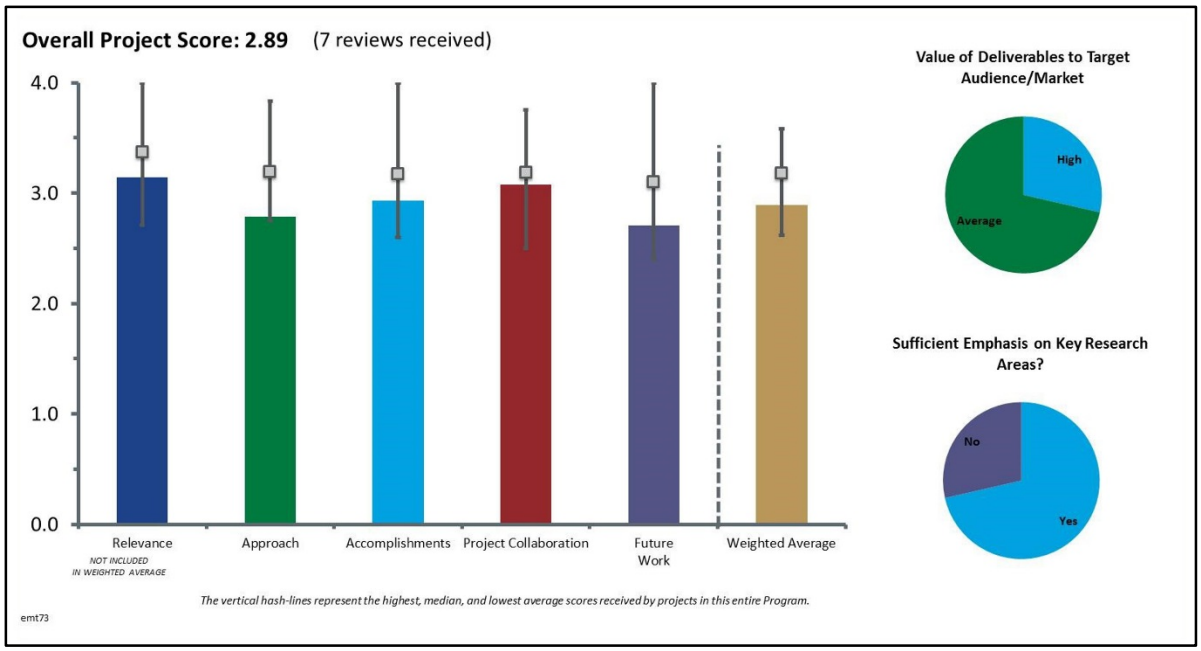
Presenter: Wei Feng, Lawrence Berkeley National Laboratory, weifeng@lbl.gov
DOE Manager: Karma Sawyer, karma.sawyer@hq.doe.gov, 202-287-1713

Project Description

This U.S.–China Clean Energy Research Center (CERC) project is developing software that optimizes distributed energy resource (DER) technology selection and operation. Optimization for both operations and equipment selection, which can be complex, is crucial for creating ultra-efficient buildings and microgrids. Three specific software tools are being developed: the first finds optimal on-site generation, storage, and control equipment combinations that minimize cost and carbon footprint; the second is a 1–7 day-ahead optimal control strategy generator; and the third analyzes multiple buildings to build bottom-up estimates of market trends. The project provides benefits for developers of complex commercial buildings and microgrids in both the United States and China. For example, implementation of DER technologies could reduce the carbon footprint of China's commercial buildings by as much as 40%.

Summary of Review Comments

Reviewers found little consensus about this project, which is developing software that optimizes DER technology selection and operation. All agreed that resource optimization is important, especially with the increased focus on microgrids, and that the project did achieve some energy savings in trial buildings. However, some reviewers did not see how this particular software provides a benefit beyond what is already market available or how the project increases DER adoption. One reviewer saw the partnership with China as one of the strongest features, as it provides different perspectives; another felt the nature of an international collaboration (e.g., language and distance barriers) limits project scope and slows progress; a third saw the collaboration as somewhat weak and not synergetic; and a fourth was unclear about any of the collaborators' roles. Opinions on barriers ranged from believing that difficult challenges relating to building and integrating data are clearly identified and addressed to thinking that market and technological barriers are neither clearly identified nor understood; one reviewer noted that specific barriers are identified (e.g., extending WebOpt to other technologies and working with nonlinear characteristics) but felt the project focus is not related to those barriers. One reviewer suggested that the project develop a generalized software deployment plan to make a more significant impact and one suggested setting more specific goals will help the project reach a higher level.



Project # ET-65: University of Maryland: Miniaturized Air to Refrigerant Heat Exchangers

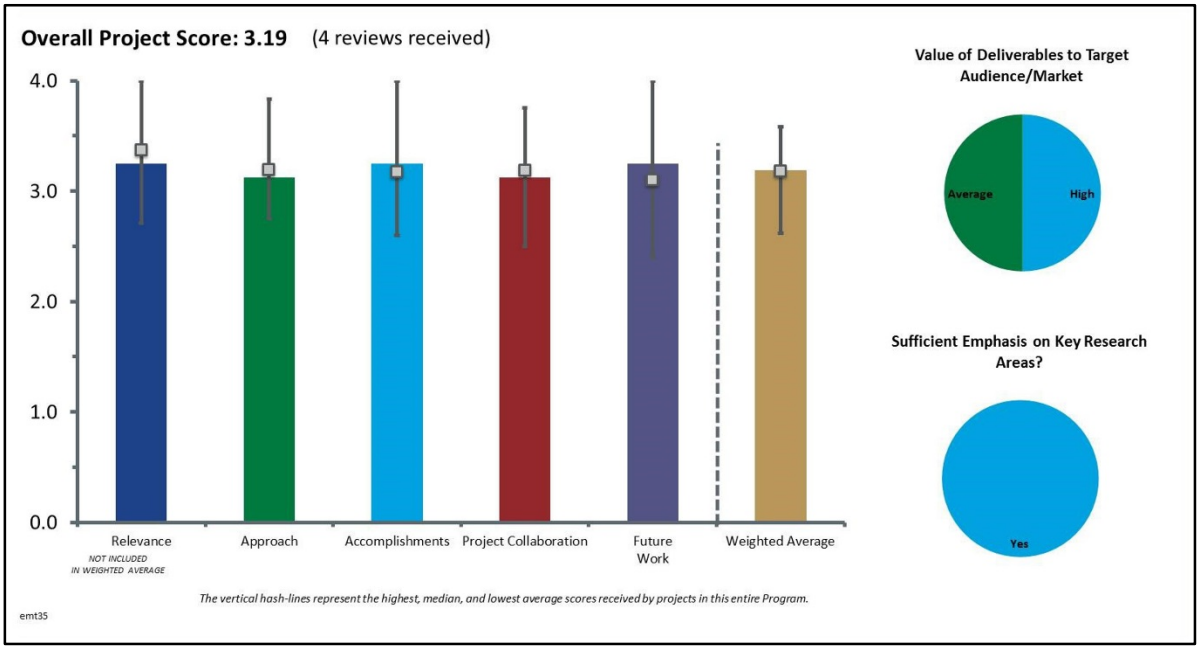
Presenter: Reinhard Radermacher, University of Maryland, raderm@umd.edu
DOE Manager: Antonio Bouza, antonio.bouza@ee.doe.gov, 202-586-4563

Project Description

This project is developing miniaturized air-to-refrigerant heat exchanger designs that are more compact and more energy efficient than current market designs. These heat exchanger designs will feature at least 20% less volume, 20% less material, and 20% better performance, and they will be in production within 5 years. The heat exchangers, which can act as an evaporator and a condenser, will have applications in commercial and residential air conditioning and heat pump systems with various capacity scales. Prototype 1 kW and 10 kW designs will be tested and then improved as necessary for final tests and demonstration in a 3-ton heat pump.

Summary of Review Comments

Most reviewers commended the project for its potential impact, noting a 20% improvement in heat exchanger performance, volume, and material would contribute significantly toward national energy reduction goals. Several reviewers noted that the project has realistic future plans that are in line with the project goals and timeline. However, one reviewer felt it is unclear how the research will be directly applied to the market in the near term and therefore questioned the project's near-term impact. Most reviewers felt the project has a strong, well-rounded team with representation from all key stakeholders, but one reviewer stated that collaboration with industry (including heat exchanger manufacturers) should be enhanced. In addition, many reviewers found the project to have a good technical approach, with one noting that the approach of using "virtual" product design has the potential to significantly reduce the length of the product design cycle. However, one reviewer pointed out that, because the initial prototype has not yet been tested to confirm predicted performance, the approach has not been validated. While several reviewers commended the project's efforts to address the issue of cost-effective manufacturability, one reviewer recommended the project team enhance its focus on manufacturing issues, particularly the cost-effective fabrication of the heat exchangers. In addition, reviewers recommended the project team (1) use Web-based tools and American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) handbooks to disseminate data and standardized correlations, and (2) use normalized and standardized performance variables.



Project # ET-66: Stone Mountain Technologies: Low-Cost Gas Heat Pump For Building Space Heating

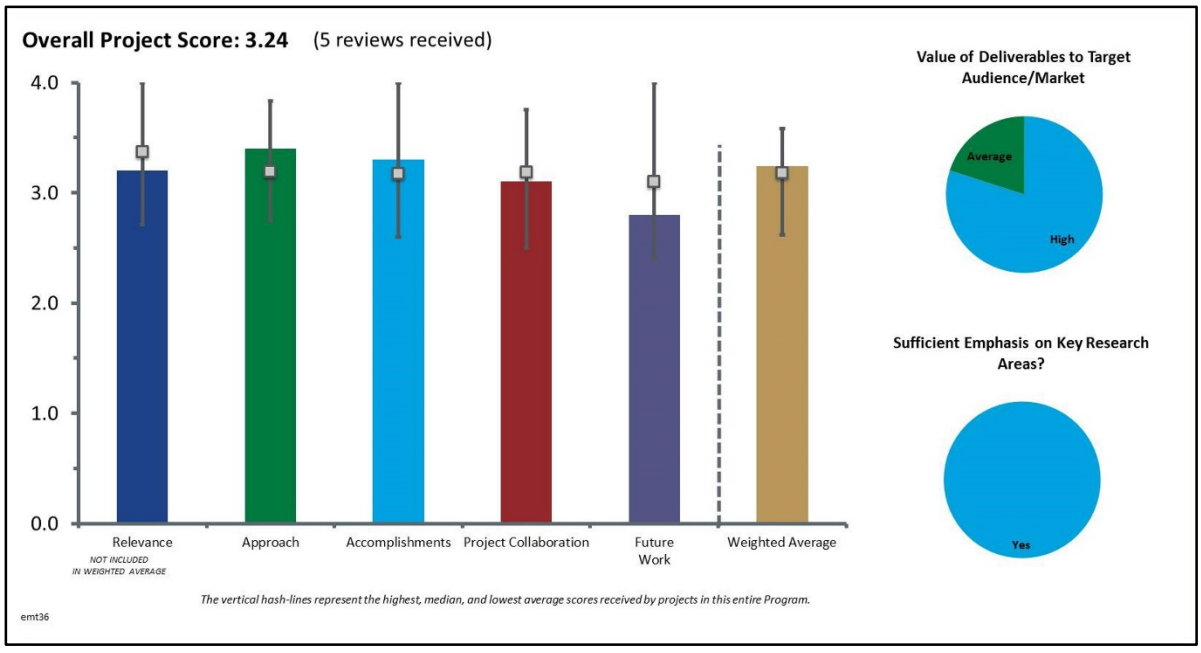
Presenter: Michael Garrabrant, Stone Mountain Technologies, mgarrabrant@stonemtntechnologies.com
DOE Manager: Antonio Bouza, antonio.bouza@ee.doe.gov, 202-586-4563

Project Description

Stone Mountain Technologies is developing a gas-fired cold climate heat pump prototype with a nominal capacity of 80,000 Btu per hour at a standard ambient temperature of 47°F. The technology reduces heating costs by 30%–45% compared to conventional gas furnaces and boilers. It reaches a coefficient of performance of 1.4 at 47°F and 1.2 at -13°F using a simple, single-effect ammonia-water absorption cycle. The prototype will be tested over a range of ambient temperatures to verify its efficiency and manufacturing cost. Ideal for northern, heating-dominated climates, the heat pump will offer a simple payback, without incentives, of 3–5 years.

Summary of Review Comments

Reviewers praised the project for demonstrating strong results, including achieving 95% of the performance target with the first prototype, and they were also encouraged by the low-cost gas heat pump's high energy-saving potential if successfully commercialized. Reviewers generally agreed the project team's focus on cost competitiveness is a considerable strength and crucial for achieving market success. In addition, reviewers indicated the proposed future work has a high probability of successfully bringing the technology to market, but there was concern about the project's schedule, with a reviewer noting the extensive remaining work (including testing of two prototypes) and the project's scheduled end date of August 2015. Comments on the project's collaborations were mixed; two reviewers felt collaboration is a strong point of the project, and that the team has forged relationships with influential industry/manufacturing partners and incorporated their feedback into the approach, but several reviewers stated that collaboration is limited and suggested that adding more partners (e.g., additional original equipment manufacturers and gas utilities) is necessary to achieve wide market penetration. Individual reviewers expressed concern about the lack of (1) total life-cycle cost data and (2) detailed discussion on the expected cost and economics involved. Recommendations from reviewers include that the project team (1) use a side channel pump, with a reviewer noting it is more efficient than a customized piston pump, and (2) consider focusing commercialization efforts on achieving significant and measurable adoption within a single application/market segment, as opposed to attempting to displace technologies across a wide range of sectors/cases.



Project # ET-72: NREL: Vacuum Insulation for Windows

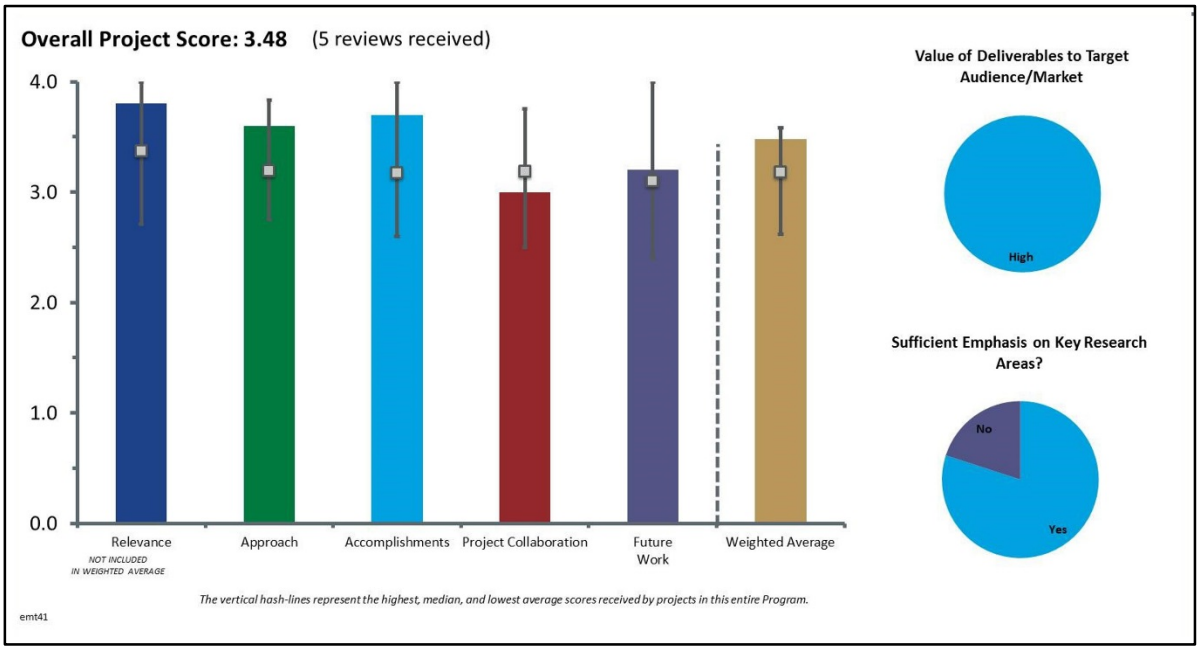
Presenter: Lin Simpson, National Renewable Energy Laboratory, lin.simpson@nrel.gov
DOE Manager: Bahman Habibzadeh, bahman.habibzadeh@ee.doe.gov, 202-287-1657

Project Description

This project is developing vacuum insulation for window applications using novel evacuated materials—so small that they are invisible—integrated with low-e-coated plastic films. The materials will have better insulation values than vacuum-insulated glass and have the correct form factor for easy integration with installed windows. The life expectancy of installed windows is greater than 30 years; decades and tens of trillions of dollars would be required to replace all U.S. windows with highly insulating windows. Thus, there is a substantial need for ways to retrofit windows to improve their insulation. The National Renewable Energy Laboratory estimates this technology could save 2–3 quads of energy annually. This technology will have initial manufacturing cost estimates that demonstrate a simple payback of less than 5 years.

Summary of Review Comments

General consensus among the reviewers was that this is an excellent project with high potential for improving the energy efficiency of windows, high value for building applications, and a good track record of progress. Per the reviewers, the project has thoroughly explored the relevant issues and uses a scientific approach to address important aspects, including characterization, modeling, development of new materials, and low-cost manufacturing. The team's use of nanoscale vacuum capsules as insulated coating was described as having demonstrated exceptional insulating properties with excellent transparency and good stability, as well as being innovative, economically feasible, and amenable to large-scale processing. One reviewer noted the lack of a clear commercialization strategy and plan; however, others stated that discussions are now underway with potential manufacturing companies to form key strategic manufacturing and market alliances. Reviewers agreed that, as the project draws to a close, engaging manufacturers is increasingly important. Other recommendations include (1) addressing the adhesion on polymer substrate, (2) exploring potential issues of the material's degradation over time, and (3) measuring and quantifying the coating's response to infrared radiation.



Project # ET-75: LBNL: Fluorescent Pigments for High Performance Cool Roofing and Facades (w/ PPG Industries)

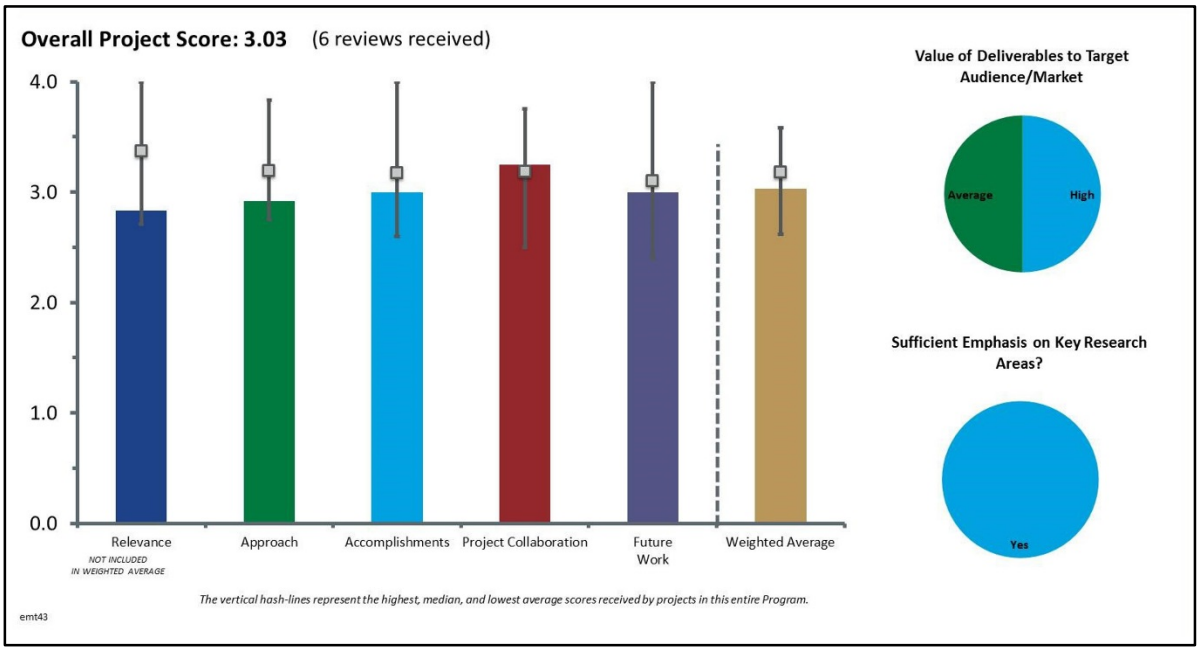
Presenter: Mike Zalich, PPG Industries, Inc., mzalich@ppg.com and Paul Berdahl, Lawrence Berkeley National Laboratory, phberdahl@lbl.gov
DOE Manager: Bahman Habibzadeh, bahman.habibzadeh@ee.doe.gov, 202-287-1657

Project Description

This project is developing dark-colored cool pigments that combine near-infrared (NIR) fluorescence with NIR reflectance. These pigments will obtain unprecedented effective solar reflectance (ESR) values for dark-colored coatings used in the building envelope. Metal coatings will be formulated and characterized in dark red and near-black colors with ESR values of 0.50–0.70, a significant improvement over standard dark coatings, which have ESRs of only about 0.10–0.30. Such coatings would satisfy consumer demand for dark colors on building surfaces and also save 0.17 quads of energy annually.

Summary of Review Comments

While some reviewers felt the project could greatly improve the thermal performance of roofing materials, others questioned whether the target market (residential metal roofing in climate zones 4 and 5) might be too narrow for a significant impact on overall U.S. energy use. Several reviewers praised the project's potential to provide more color choices for cool roof coatings, but one reviewer questioned whether the desired level of solar reflectance could be achieved without significantly altering the roof color. Reviewers generally commended the project's collaborations, although some reviewers suggested adding partners—specifically potential users (e.g., architects), vertical wall assembly partners, and automotive sector representatives. Regarding the latter, one reviewer wondered whether data from highly reflective car paint studies might be applicable to this project. Another reviewer suggested exploring research from or collaboration efforts with Oak Ridge National Laboratory and/or the Florida Solar Energy Center to prevent duplicative efforts. Views of project progress ranged from noting "significant accomplishments, progress, and impact" to concern that the project is behind schedule. Some reviewers also felt the future plans are not entirely clear. Suggestions included scanning the nanomaterials regulatory market prior to commercialization, as toxicity issues could be a barrier to entry, and testing the nanomaterials in a manufacturing environment as well as a field setting to determine the risk to exposure.



Project # ET-77: ISTN: A New Generation of Building Insulation by Foaming Polymer Blend Materials

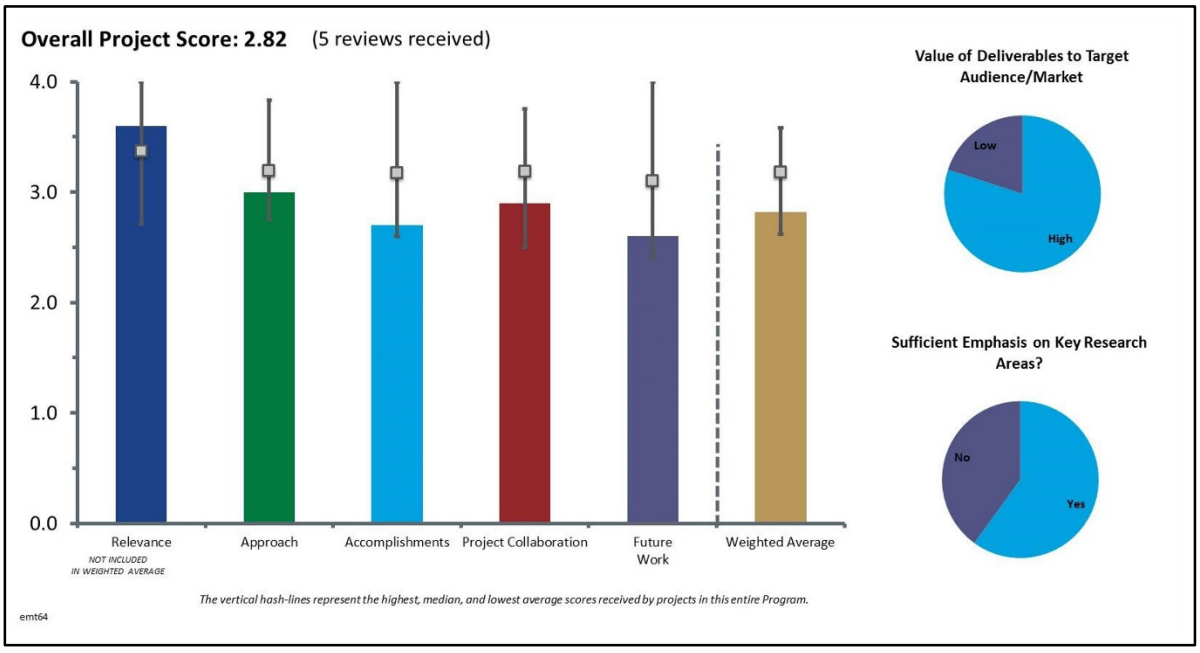
Presenter: Arthur Jing-Min Yang, Industrial Science & Technology Network, ajyang@istninc.com
DOE Manager: Bahman Habibzadeh, bahman.habibzadeh@ee.doe.gov, 202-287-1657

Project Description

This project aims to develop a new, environmentally clean, cost-effective building insulation with superior performance (R-9 to R-10 per inch) compared to existing insulation. Instead of hydrofluorocarbon, it uses carbon dioxide as the blowing agent. This technology represents a highly valuable market opportunity given its ability to achieve maximum energy savings (at equal or lower cost) across a variety of thermal insulating applications, such as building foundations and walls, and refrigeration and heating, ventilation, and air conditioning (HVAC) applications. The Industrial Science & Technology Network estimates the commercialization of this technology would reduce U.S. energy consumption related to building envelope components by 7%, which equates to annual U.S. energy savings of 0.361 quads, or $8 billion in annual economic savings.

Summary of Review Comments

Reviewers praised this project for its innovative technology development efforts and its potential to significantly reduce building energy use, but several reviewers felt the plans for future work are unclear. Reviewers commended the project for (1) conducting tests at factory scale; (2) improving a product that is already well received within the building industry; and (3) developing new materials that will have applications in other fields (e.g., automotive), in addition to buildings. Reviewers had mixed views on the project's collaborations; they generally praised the collaboration with an insulation manufacturer and an equipment supplier, but suggested that additional collaborations be established with U.S. based companies. Identified weaknesses include (1) issues with the manufacturing process that must be resolved, (2) lack of a detailed timeline for meeting future goals, and (3) weak commercialization strategy and minimal commercialization activities. Reviewers recommended that the project team (1) consider durability studies and how the product will perform in an actual assembly, (2) consider testing at a smaller (e.g., pilot) scale, (3) include U.S.-based companies as partners, (4) perform long-term stability testing, and (5) conduct more market analysis.



Project # ET-78: ANL: Acoustic Building Infiltration Measurement System (ABIMS)

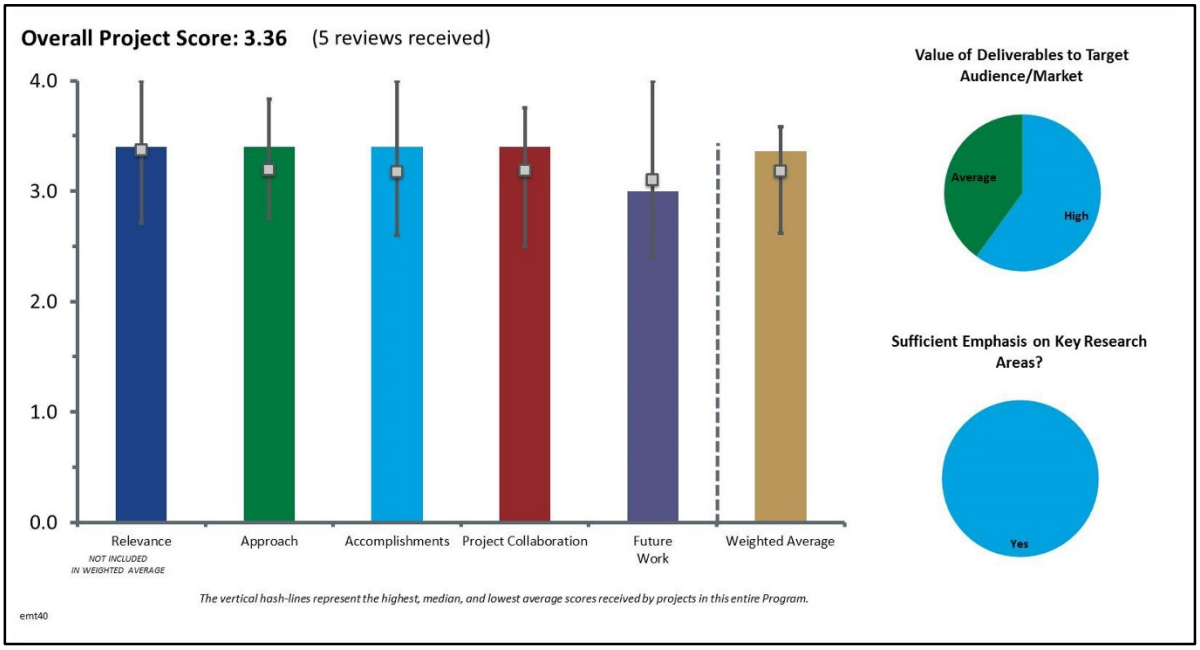
Presenter: Ralph Muehleisen, Argonne National Laboratory, rmuehleisen@anl.gov
DOE Manager: Bahman Habibzadeh, bahman.habibzadeh@ee.doe.gov, 202-287-1657

Project Description

This project is developing an acoustic method of measuring the infiltration of a building envelope. The Acoustic Building Infiltration Measurement System (ABIMS) overcomes many of the limitations of existing pressurization and tracer gas methods, including the need for completed building envelopes and the inherent size limitations of the pressurization test method. Current infiltration meaurement methodologies are limited to small buildings because pressurization tests cannot be conducted on large buildings. ABIMS enables infiltration measurement in all buildings. With ABIMS, testing for infiltration compliance could be added to building codes, increasing codes compliance rates and decreasing building energy use.

Summary of Review Comments

According to the reviewers, the project's use of sound to measure building air infiltration is innovative and fills a significant gap in available diagnostic tools. Reviewers praised the project's accomplishments—highlighting that the project team has (1) filed a patent application on acoustic detection of building leaks, (2) developed a theory to quantify flow rate through cracks, and (3) presented work at acoustic society meetings—but one reviewer noted some theoretical and technological aspects of the project have not yet been finalized, and that simulations and testing are also delayed. Most reviewers felt the technology has significant potential for improving building energy efficiency, but one reviewer felt the potential impact still needs to be better quantified. In addition, a reviewer expressed concern that field implementation may prove difficult in tall buildings because the system appears to require access to both sides of the façade to measure infiltration. Recommendations include (1) conducting more extensive validation on real building materials, (2) addressing the difference between air and sound transmission through building enclosures, (3) finding an industrial partner to help with commercialization, and (4) considering how to train field technicians in the use of this new technology.



Project # ET-85: CERC: Chinese New Commercial Building Energy Standard

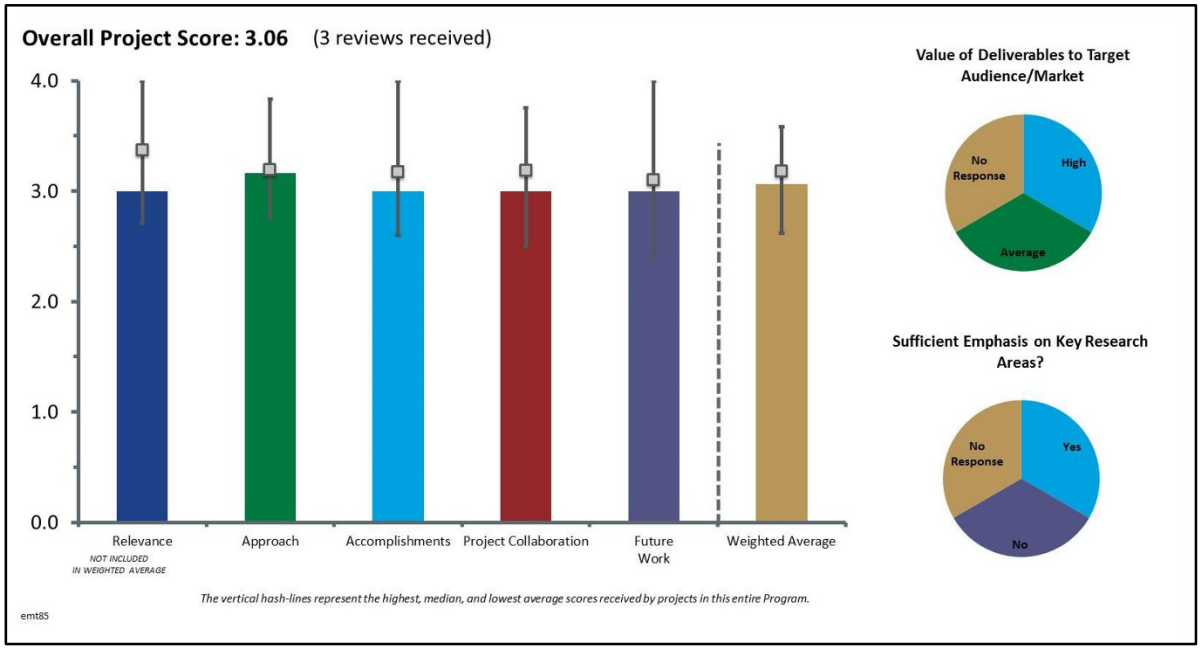
Presenter: Mark Levine, Lawrence Berkeley National Laboratory, MDLevine@lbl.gov
DOE Manager: Karma Sawyer, karma.sawyer@hq.doe.gov, 202-287-1713

Project Description

In this project, the U.S.-China Clean Energy Research Center (CERC) is evaluating the energy and cost-benefit performance of the Chinese commercial buildings standard to establish methodologies for standard performance analysis and to promote more stringent energy standards and more efficient technologies in China. Currently, there is a distinct lack of data regarding China's building characteristics and costs. Increased data will promote more efficient technologies in China and ultimately reduce technology costs, which will benefit building owners, government agencies, and Chinese and U.S. companies working in the Chinese market.

Summary of Review Comments

Although the reviewers agreed the project provides considerable insight into China's existing stock of commercial office buildings, they were divided on whether the project serves Building Technologies Office (BTO) goals and U.S. interests. One reviewer praised the project for supporting BTO goals by promoting better building energy codes in both countries, and for providing market stimulation for U.S. manufacturers serving Chinese markets. Another reviewer was skeptical that this project would improve buildings in the United States. Reviewers lauded the impressive collaboration between the United States and China and commended the project for its efforts to reduce worldwide greenhouse gas emissions. One reviewer stated that the survey described during the presentation does not seem sufficiently robust to provide the quality of data necessary to develop codes for China's diverse environment. In addition, a reviewer noted the project is only projecting potential energy savings and not actually achieving any real energy savings. One reviewer indicated the project's greatest weakness is its proposed end date (December 2015) and suggested funding the project beyond this end date. Reviewers also suggested (1) increasing collaboration with industry and manufacturing partners, (2) exploring the Chinese "culture of use" further, and (3) developing a strategic plan for follow-on work.



Project # ET-86: SNL: Rotating Heat Exchanger Technology for Residential HVAC

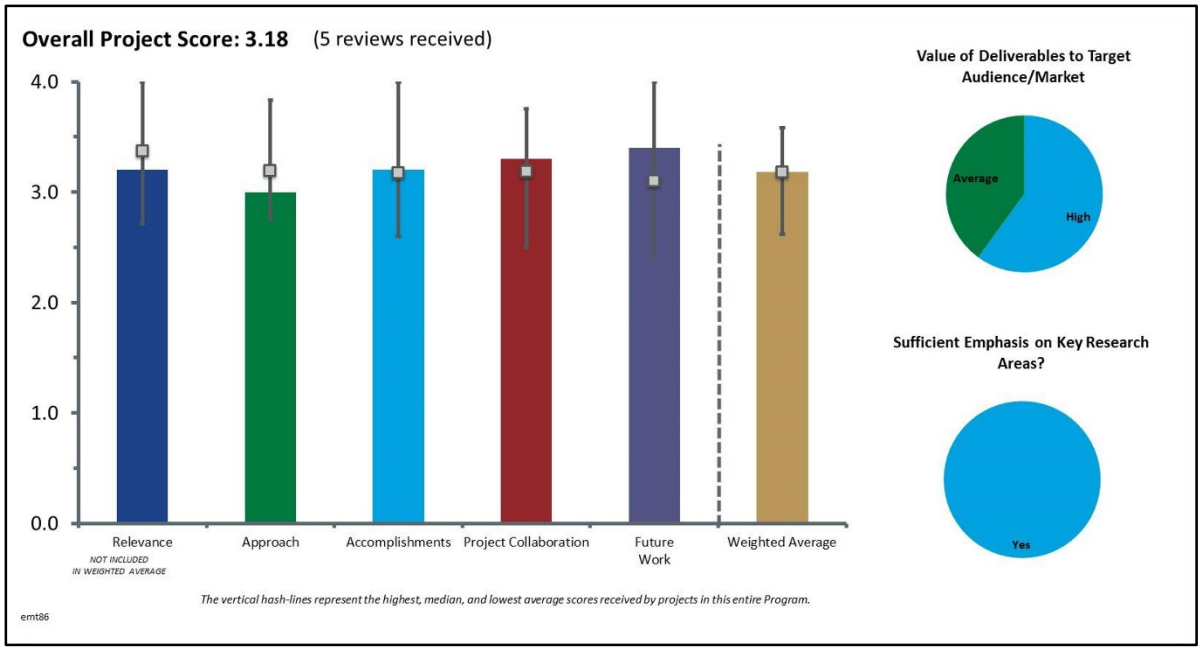
Presenter: Terry Johnson, Sandia National Laboratories, tajohns@sandia.gov
DOE Manager: Antonio Bouza, antonio.bouza@ee.doe.gov, 202-586-4563

Project Description

In this project, Sandia National Laboratories and the United Technologies Research Center are collaborating to develop a high-impact heating, ventilation, air conditioning, and refrigeration (HVAC&R) technology with significant potential for national energy savings. The project builds on SNL's recently developed air bearing heat exchanger, also known as a rotating heat exchanger, and UTRC's heating, ventilation, and air conditioning (HVAC) expertise to demonstrate the Sandia Cooler technology for residential HVAC applications. This technology will be a proof-of-concept for the HVAC&R industry. Doubling the air-side heat transfer has the potential to reduce thermal resistance by ~30% and can improve system efficiency by ~10%. Analysis shows that a 10% increase in space cooling and heat pump heating efficiency is expected to result in >0.4 quads of annual energy savings.

Summary of Review Comments

Reviewers appreciated the project's novel concept, with many noting its potential for achieving energy savings for residential consumers, but several reviewers were concerned that manufacturing and operational issues might prevent the expected energy savings from being realized. Identified strengths include the project's (1) good collaboration with strong industry and laboratory partners—although one reviewer suggested further collaborating with a university on fundamental questions about the rotating air flow—and (2) solid progress, including the completion of experiments to determine the heat transfer coefficients—though one reviewer pointed to the need for the project team to include an evaluation of additional pressure drop created on the refrigerant side. Some reviewers praised the broad applicability of the rotating heat exchanger design, noting it could lead to substantial energy savings in a variety of applications. However, one reviewer felt the rotating heat exchanger is likely to be more attractive in applications that are not as demanding as residential HVAC (e.g., refrigerator condensers and electronic cooling). According to reviewers, many challenges have not been sufficiently addressed, including the issues of cost, scalability, and reliability, as well as whole-system efficiency issues such as fouling, condensation, and frost. However, one reviewer indicated that planned future testing and modeling will sufficiently address several of these challenges. Recommendations included (1) addressing the identified manufacturability and operational issues to achieve market adoption and (2) looking at whole-system design to optimize system performance.



Project # ET-87: Sheetak: Heat Pump Water Heater Using Solid-State Energy Converters

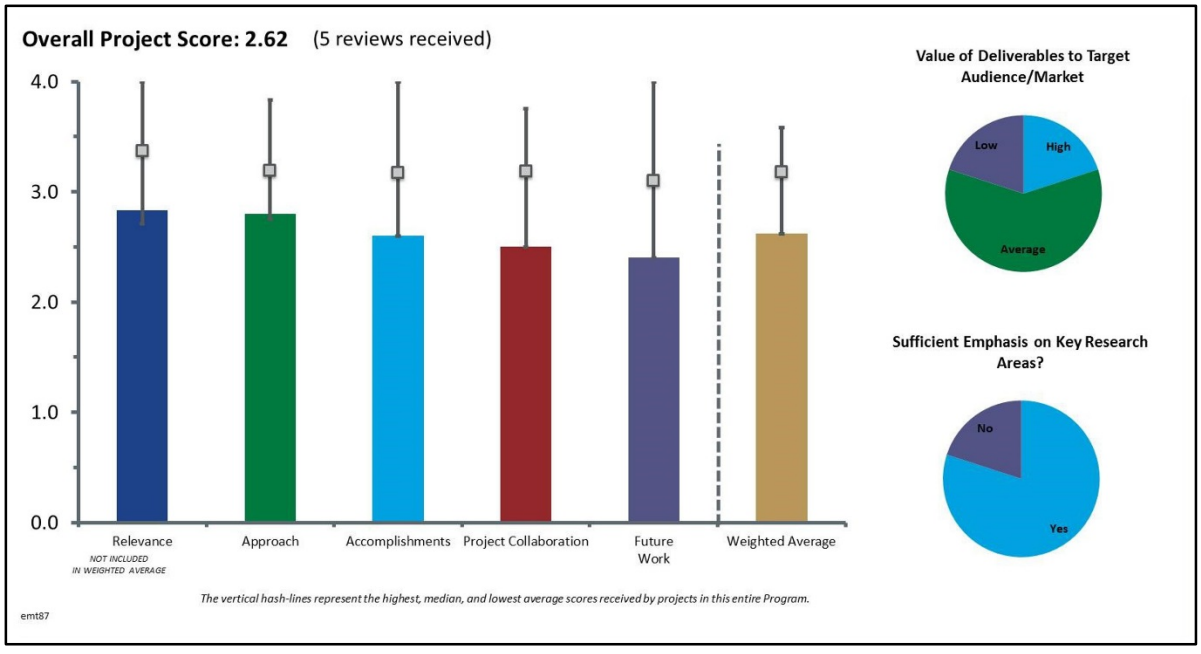
Presenter: Uttam Ghoshal, Sheetak Inc., ghoshal@sheetak.com
DOE Manager: Antonio Bouza, antonio.bouza@ee.doe.gov, 202-586-4563

Project Description

In this Small Business Innovation Research project, Sheetak is using innovative solid-state heat pump technology to develop a new generation of water heaters. This thin-film, thermoelectric (TE) technology has the potential to significantly reduce the electricity consumed in water heating—without affecting the cost. In addition, it can be used in a variety of other appliances and heating, ventilating, and air conditioning (HVAC) systems. In Phase I, Sheetak developed a scaled-down version of a solid-state water heater prototype. In Phase II, Sheetak will work on developing a full-scale prototype, using its thin-film TE modules. Sheetak plans to commercialize its U.S.-made TE modules in both domestic and international markets.

Summary of Review Comments

Reviewers praised the project's use of low-cost, solid-state TE devices to improve electric water heater efficiency as an excellent concept, but they also expressed significant concern regarding the technology's coefficient of performance (COP), indicating it is not high enough to achieve high market impact or justify added cost. Reviewers felt that (1) good progress has been made on advanced TE material development, (2) the knowledge being gained from integrating TE heat pump technology into a water-heating system could potentially be useful for other applications, and (3) the presenter has a strong background in TE technology. Individual reviewers expressed concern that the technology requires (1) two-stage heating, (2) ambient temperature higher than the inlet water temperature, and (3) tank penetration for every connected TE device. Significant parasitic heat losses were also cited as a challenge, and one reviewer noted that performance, cost, reliability, and scalability challenges were not discussed in the presentation. Reviewers recommended (1) more fully engaging with water heater manufacturers for guidance on integration, cost, and market opportunities; (2) comparing the TE heat pump water heater with conventional heater technology to help understand potential advantages and limitations; and (3) including the use of ohmic heating to augment the TE heating in the quoted COP values.



Project # ET-88: Xergy: Advanced Hybrid Water Heater Using ECC

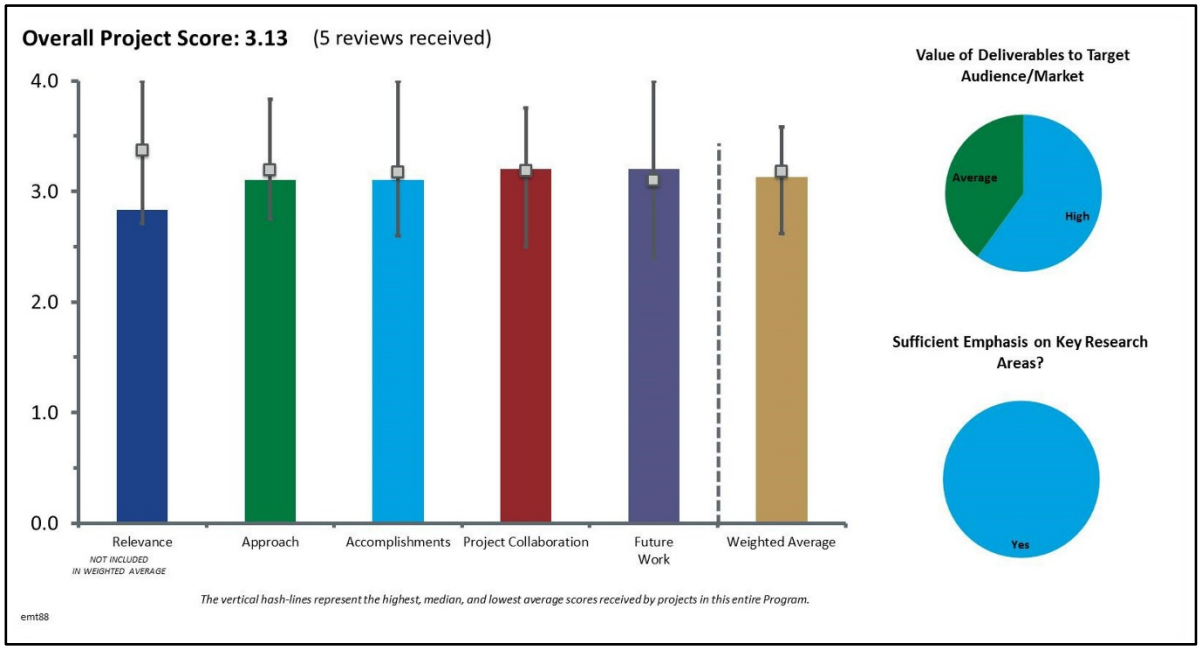
Presenter: Bamdad Bahar, Xergy, Inc., bamdad.bahar@xergyinc.com
DOE Manager: Antonio Bouza, antonio.bouza@ee.doe.gov, 202-586-4563

Project Description

In this Small Business Innovation Research project, Xergy is developing an electrochemical compressor (ECC) technology that uses water as the working fluid. Vapor-compression systems in current water heaters use chemical refrigerants, which contribute to climate change. By using water as the working fluid, ECC technology can operate a heat pump with zero global warming potential. Xergy has already developed the technology for an ECC suitable for a 50-gallon unit, which is scalable and more efficient than current mechanical compressors. A prototype heat pump hybrid hot water heater operated by ECC technology is in development.

Summary of Review Comments

According to reviewers, the project's innovative application of compressor technology has the potential for significant impact on the residential water heating market; however, they also noted the project faces potentially significant durability, cost, and performance barriers. Reviewers generally felt the project has made good progress on the development of a membrane and membrane manufacturing and that the future work is well defined. Reviewers lauded the collaboration with GE Appliances and indicated this manufacturer is actively engaged and provides an effective route to commercialization. While reviewers praised the use of water as a refrigerant, one reviewer noted the use of water presents many challenges, including issues due to its poor mass flow properties, and that freeze protection and a high degree of sealing are required. Reviewers offered a number of recommendations, including (1) engaging a third party for additional testing, (2) discussing risk mitigation strategies in case targets are not met, (3) increasing the focus on testing to show the viability of the concept, (4) evaluating heating rates to determine whether electric resistance backup heat is needed, (5) using a less expensive catalyst, and (6) addressing the minimum pressure difference needed to pass water refrigerant in a cycle.



Project # ET-90: Eaton: Print-Based Manufacturing of Integrated, Low Cost, High Performance SSL Luminaires

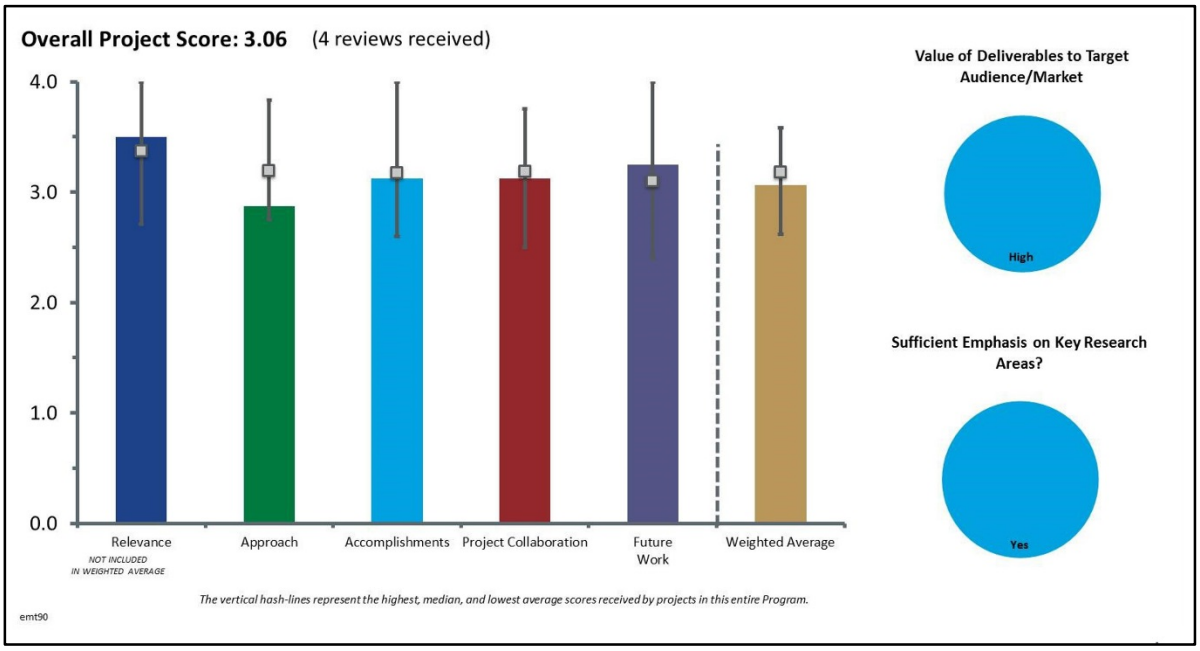
Presenter: Sri Nimma, Eaton Corporation, sridharrnimma@eaton.com
DOE Manager: James Brodrick, james.brodrick@ee.doe.gov, 202-586-1856

Project Description

This project is using an innovative manufacturing process to develop a new, low-cost, high-efficiency method to place the light-emitting diode (LED) package, chip, or chip array directly on a fixture or heat sink. The resulting ultra-compact chip-level package architecture will have both high efficacy and high color quality, which will benefit luminaire platforms ranging from bulbs to troffers. The project is investigating flexible manufacturing for planar, non-planar, and recessed product designs through the development of non-traditional thick-film processes. The manufacturing process innovations will improve thermal performance, reduce materials and parts, reduce process time, and enable automation and manufacturing flexibility—all of which will allow for cost reductions.

Summary of Review Comments

According to reviewers, this project is leveraging collaborations with an excellent team of diverse partners in its effort to reduce the cost of LED lighting. Reviewers also commended the project for (1) supporting Building Technologies Office objectives, (2) having high value for the LED market and consumers, and (3) having a high cost-share percentage. Most reviewers praised the project's progress, noting it is on track to achieve its goals and characterizing the reductions in costs and manufacturing time as significant, but one reviewer was not sure whether milestones have been reached. One reviewer thought the presentation did not clearly explain (1) what the main barriers are, (2) the team's plans for addressing the barriers, or (3) how reliable the solution will be compared to incumbent technologies. A reviewer wondered how much of this work could be completed using three-dimensional (3D) design and simulation tools paired with 3D printing capabilities to reduce development and improvement time cycles. Reviewers did not offer many recommendations, but one suggested the project team consider some field study prior to full production to determine whether the technology is robust enough to be effective in long-term applications.



Project # ET-91: Philips: Development and Industrialization of InGaN/GaN LEDs on Patterned Sapphire Substrates for Low Cost Emitter Architecture

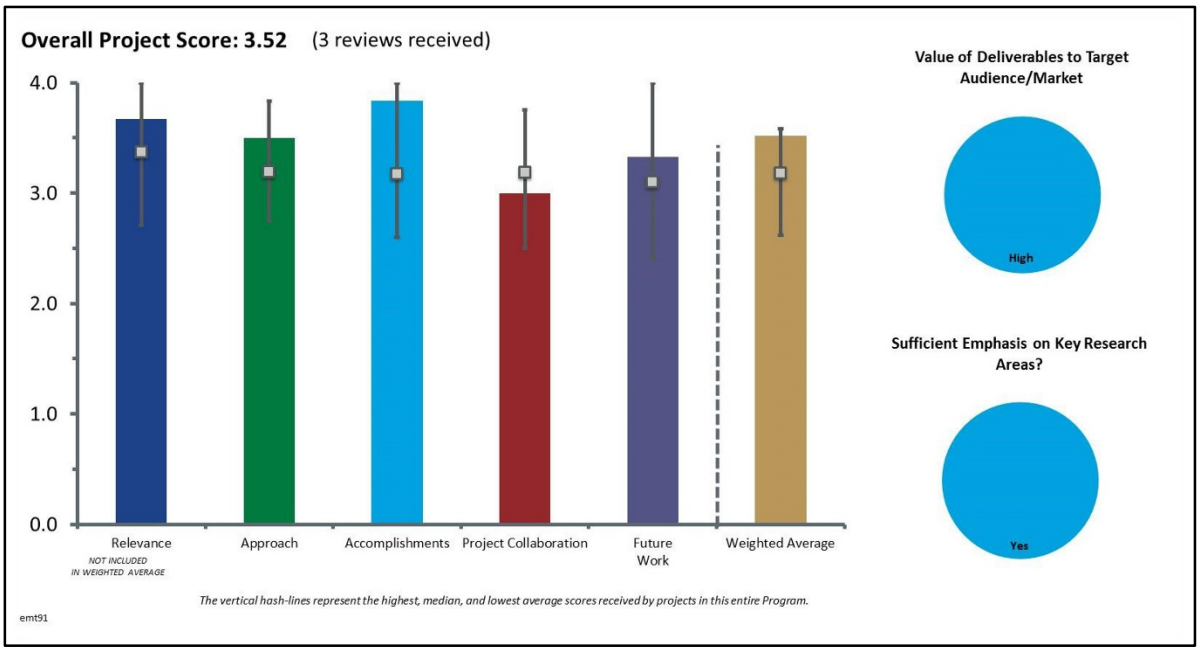
Presenter: Joseph Flemish, Philips, joe.flemish@philips.com
DOE Manager: James Brodrick, james.brodrick@ee.doe.gov, 202-586-1856

Project Description

This project is working to reduce light-emitting diode (LED) manufacturing costs by establishing a patterned sapphire substrate (PSS) fabrication process with demonstrated epitaxial growth of indium gallium nitride (InGaN) layers capable of producing high-efficiency LEDs when combined with chip-on-board packaging techniques. The proposed cost reductions would result from eliminating some of the complex processes associated with current flip-chip technology and using lower-cost packaging methods that take advantage of the stability of the sapphire substrate, which is removed in a standard flip-chip device. This approach has the potential to reduce the cost of high-brightness LED lamps and modules that are used across a wide range of lighting and illumination applications.

Summary of Review Comments

According to reviewers, this is a highly valuable project that is making notable progress in its efforts to lower the cost of LED production. Reviewers liked the use of PSS technology, with one noting the "excellent" use of simulation for predictive performance and rapid prototyping. Reviewers noted that the project has achieved its performance and efficiency targets to date, and one reviewer saw opportunity to achieve even higher light release. No major barriers were identified beyond the risks inherent in developing any new technology. One reviewer praised the project's high cost-share ratio and high return on federal funds. Reviewers noted the research and development is largely being completed in-house; one reviewer characterized this as a strength while another saw it as potentially limiting innovation opportunities. One reviewer pointed out that not as much information was provided on cost improvements as was offered on performance improvements.



Project # ET-92: OLEDWorks: Innovative High-Performance Deposition Technology for Low-Cost Manufacturing of OLED Lighting

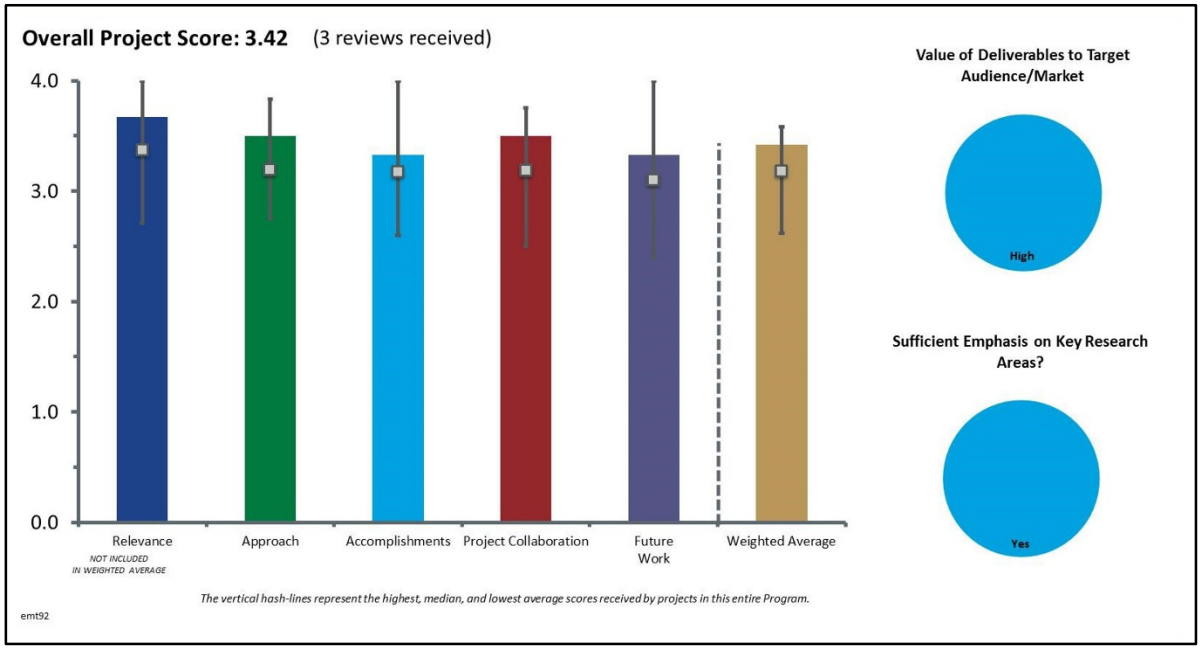
Presenter: John Hamer, OLEDWorks LLC, johnwhamer@oledworks.com
DOE Manager: James Brodrick, james.brodrick@ee.doe.gov, 202-586-1856

Project Description

This project is developing innovative, high-performance deposition technology to help reduce the manufacturing costs of organic light-emitting diodes (OLEDs). Currently, the high manufacturing cost of OLED lighting is a major barrier to market acceptance. The proposed deposition technology provides solutions to the two largest aspects of the manufacturing cost problem: (1) the expense of organic materials per area of usable product and (2) the depreciation of equipment. The project's goal is to supply affordable, high-quality products to help grow the emerging OLED market.

Summary of Review Comments

Reviewers felt this project is making good progress in reducing OLED production costs, while also improving resource utilization efficiency. Reviewers praised the project team for (1) leveraging the experience of project partners; (2) looking critically at each step of the process to determine the optimal application and overcome barriers as they appear; and (3) using three-dimensional thermal modeling instead of trial-and-error physical testing, significantly reducing the cost of development and improving the use of organic chemical resources. Areas of weakness cited by individual reviewers include (1) limited discussion on quality control of the end product, (2) the inherent risk that refining the vapor application could increase the cost of materials because reuse is not possible, and (3) the difficulty in evaluating the project because of its proprietary nature. Reviewers did not offer any recommendations.



Project # ET-93: PPG Industries: Manufacturing Process for OLED Integrated Substrate

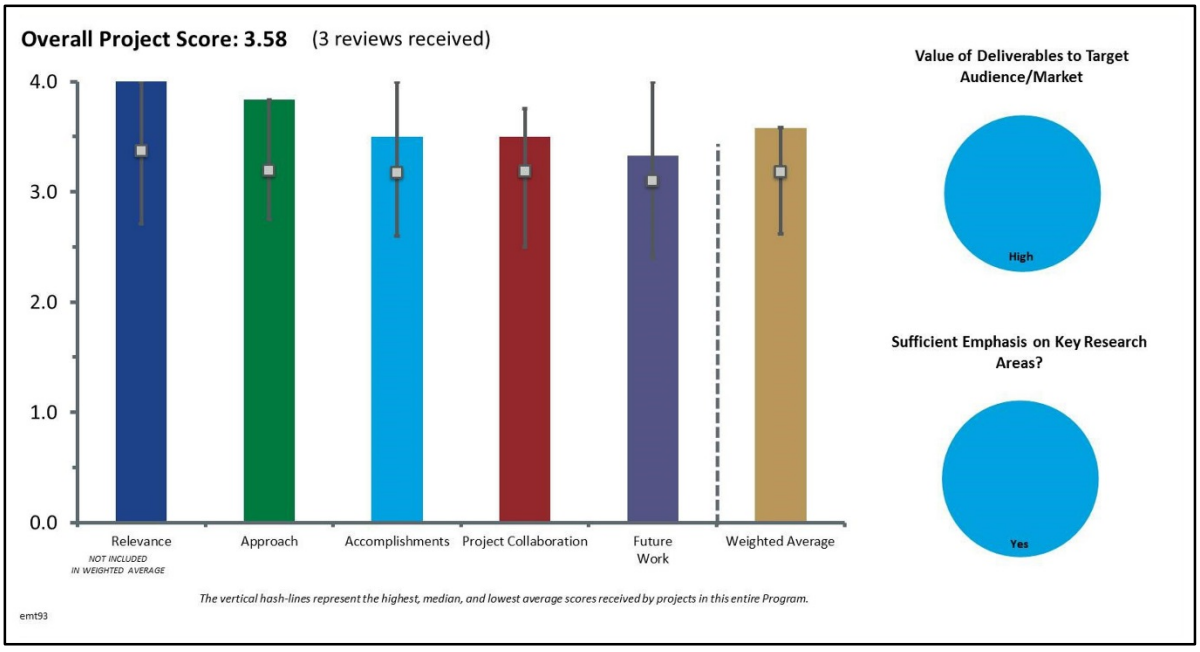
Presenter: Cheng-Hung Hung, PPG Industries, hung@ppg.com
DOE Manager: James Brodrick, james.brodrick@ee.doe.gov, 202-586-1856

Project Description

This project is developing manufacturing processes that will enable commercialization of a large-area and low-cost integrated substrate for rigid organic light-emitting diode (OLED) solid-state lighting. The integrated substrate product, which will consist of a low-cost, float glass substrate combined with a transparent conductive anode film layer and light out-coupling layers, will meet or exceed 2015 performance targets for cost, extraction efficiency, and sheet resistance. In addition, PPG Industries will partner with Universal Display Corporation to fabricate and characterize devices made using the integrated substrates for manufacturing process optimization studies.

Summary of Review Comments

Reviewers agreed the project has made good progress in its efforts to improve OLED output efficiency through a low-cost production system, noting that this work is of great value to the target audience and highly relevant to Building Technologies Office objectives. Reviewers commended the project team for improving light output (to >70% haze) and successfully adding the internal extraction layer (IEL) without reheating the glass, remarking that this lowers production time and costs. The project's focus on continuing to perfect the commercial manufacturing process for the technology and its potential to substantially improve OLED technology were also applauded. Most reviewers found the project's collaborations—including the work with a glass manufacturer—to be strong, but one reviewer thought it was difficult to evaluate the level of collaborations and partnerships. Reviewers commented that the project encountered delays when moving from the laboratory to manufacturing scale, but they felt most issues related to the scale up have been resolved. One reviewer thought new obstacles could appear when production is moved to a different facility. A reviewer suggested prioritizing the continued focus on in-line IEL production process development to allow larger panels with high quality control, and another recommended demonstrating improvements of the OLED devices with and without extraction layers rather than using a single photography method to demonstrate light output.



Project # ET-94: Cree Inc.: Scalable Light Module for Low-Cost, High Efficiency LED Luminaires

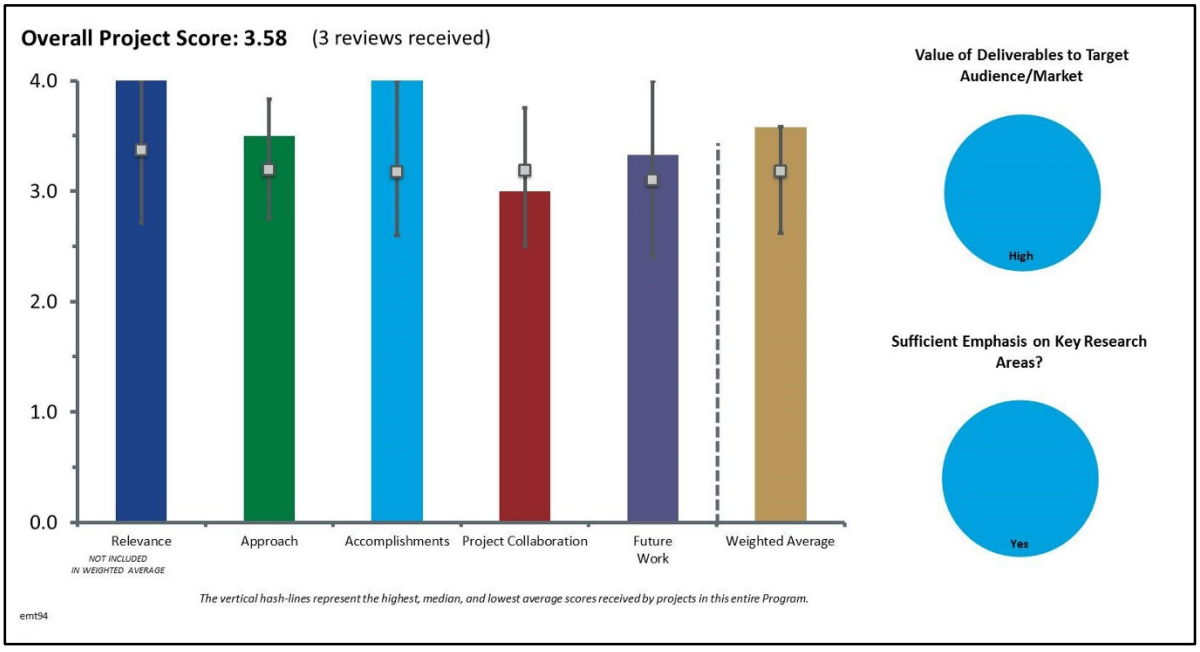
Presenter: Paul Fini, Cree Inc., paul_fini@cree.com
DOE Manager: James Brodrick, james.brodrick@ee.doe.gov, 202-586-1856

Project Description

This project is developing a versatile, low-cost, low-profile light-emitting diode (LED) light-module architecture that facilitates the assembly of a variety of high-efficacy, broad-area LED luminaires. The light module will be driven by a novel, compact LED package for a combination of high color rendering index and high efficacy over a wide range of color temperatures. To do this, Cree will employ a vertically integrated approach to develop the LED component and light module, as well as optical, electrical, and mechanical subsystems for optimal light generation, distribution, extraction, and diffusion.

Summary of Review Comments

Reviewers concurred this project contributes to Building Technologies Office goals related to solid-state lighting, noting it has an experienced team that is developing more efficient and cheaper LEDs. The reviewers appreciated the focus on light output quality; use of off-the-shelf, readily available products; and holistic approach to product commercialization. They noted the project has achieved its stated milestones and encountered no major barriers, and one reviewer stated there are no weaknesses. A reviewer commented that the technology is very popular with consumers and installers because the technology is easier to install in existing buildings and provides high-quality light output. This reviewer felt there is a huge opportunity for the technology in the existing building market. Reviewers did note that most of the work is being conducted in-house, and while the manufacturer was described as multifaceted, well established, experienced, and highly competent, there was some sentiment that working with outside resources (e.g., lighting designers or outside consultants) could yield fruitful discussions for product development. In addition, a reviewer suggested that focusing on new form factors and variable module size should be a high priority.



Project # ET-95: NREL: Grid Connected Functionalities

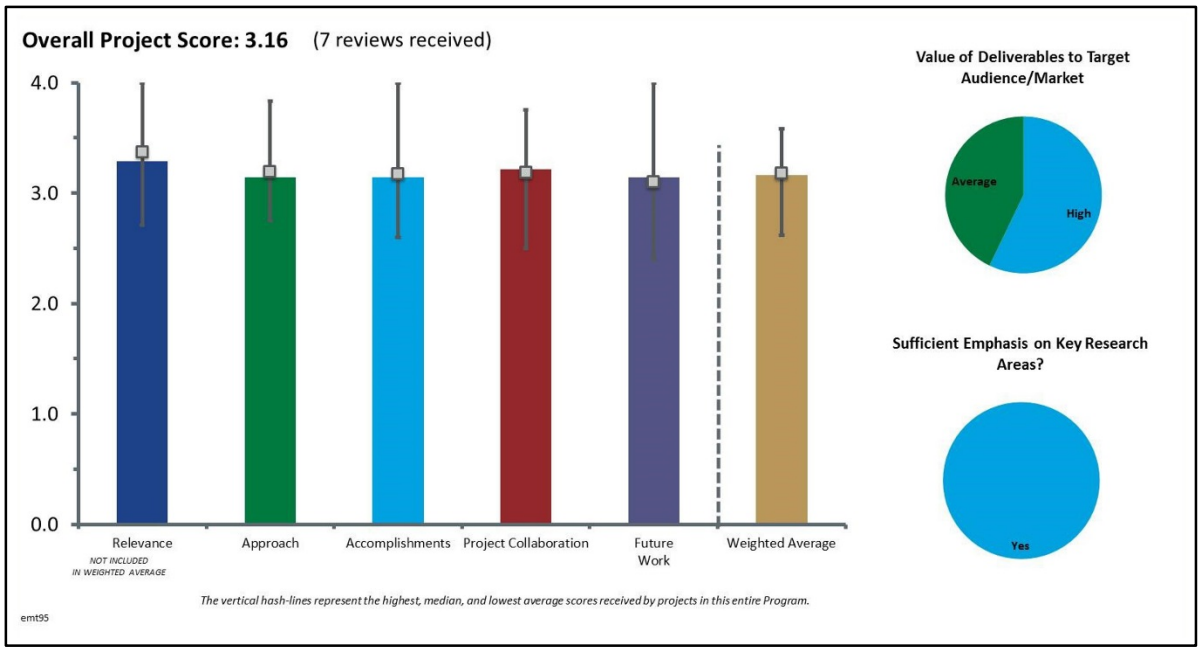
Presenter: Dane Christensen, National Renewable Energy Laboratory, dane.christensen@nrel.gov
DOE Manager: Joseph Hagerman, joseph.hagerman@ee.doe.gov, 202-586-4549

Project Description

This project is fostering planning efforts, establishing strategic directions, and supporting framework documents—vetted by public engagement with industry and other stakeholders—that support and inform future research, development, and deployment of critical building-grid transactional frameworks. The project supports the Building Technologies Office's (BTO's) engagement with the emerging market for connected building systems and related services, as well as clearly defines near-term research opportunities for BTO to pursue.

Summary of Review Comments

Reviewers agreed the project has the potential to inform BTO planning efforts during a time when the market is shifting to smart grid/homes/buildings/cities. In addition, most reviewers felt the project is in its very early stages and thus is difficult to assess. Reviewers generally agreed that the barriers and issues involved in performing the project tasks are well defined, but a few noted that early engagement with industry and the yet-to-be-completed scoping reports will better define technical barriers to connected building systems. In other areas, opinions diverged. While several reviewers commended the project's tasks for being clear, relevant and critical, others sought more clarity on the specific activities to be performed (e.g., whether policy issues related to grid connectivity would be addressed and how data mining, analysis and expert review would be conducted). Some reviewers thought the project would provide BTO with needed guidelines for directing research, whereas another reviewer suggested the project's goals should be more aggressive (but did not offer specific recommendations towards this end). While one reviewer did not think a clear understanding of the stakeholders has been demonstrated, the others saw stakeholder identification and interaction as a project strength. Individual reviewers suggested the project needs (1) to include more demonstrations and case studies, (2) a more comprehensive approach to achieve market penetration, and (3) engagement with more appliance companies.



Project # ET-97: Heliotrope: Low-Cost Near Infrared Selective Plasmonic Smart Windows

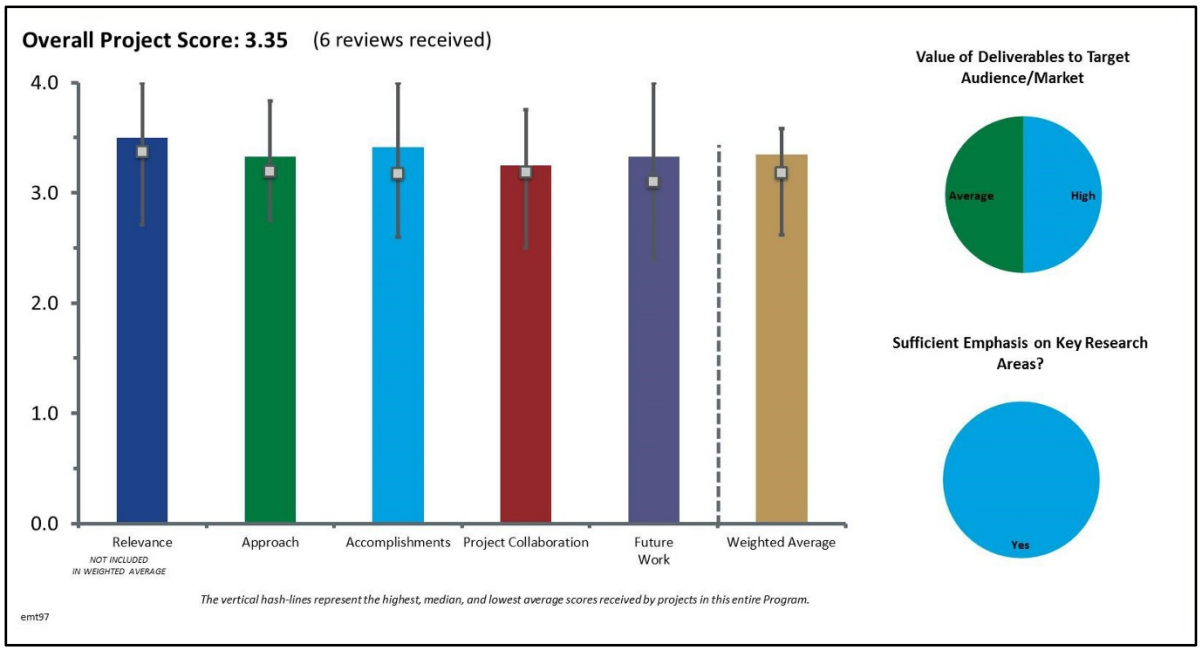
Presenter: Guillermo Garcia, Heliotrope Industries, memo@heliotropetech.com
DOE Manager: Bahman Habibzadeh, bahman.habibzadeh@ee.doe.gov, 202-287-1657

Project Description

Heliotrope is developing a low-cost, near-infrared (NIR)-selective, plasmonic smart insulating glass unit that reduces building energy consumption by dynamically optimizing solar gain without affecting natural light. The project will utilize scalable solution-based techniques to create unique nanocrystal electrochromic layers for the construction of solid-state energy-efficient windows. Upon successful fabrication, Heliotrope expects to achieve enhanced solar modulation at fast switching speeds. Heliotrope estimates that the use of electrochromic windows in buildings can achieve a 50% reduction in peak energy demand and a 30% reduction in overall energy use. Currently, electrochromic windows have not reached their market potential because of their high cost. This project's innovative design reduces production cost while also increasing lifetime and performance.

Summary of Review Comments

Overall, reviewers saw development of low-cost dynamic windows as having good energy savings potential and good marketability, and the project was seen as having made good progress. According to the reviewers, the team has achieved a 4"x4" prototype that meets the goals of greater than 60% NIR modulation, less than 10% visible modulation, and a switching time of less than 5 minutes; and the project is now moving on to scale-up and integration, in line with its work plan. The team and technology were both described as "technically sound." However, there were points about which reviewers were unclear. One did not think the project has identified the target markets; one wanted to know the estimated costs compared to those of the competition; one requested more information about energy modeling; and one was not confident about the scalability of the fabrication techniques. One reviewer wondered whether the project will use ASTM International standards as pass/fail criteria or will push the technology to its limits with continued research and development. Reviewers had few recommendations. One recommended keeping the shared cost model of $23 per square foot because the presenter indicated this value was significant to the value chain and downstream partners.



Project # ET-98: Creative Light Source: High-Efficiency Solar Cogeneration with TPV & Fiber-Optic Daylighting

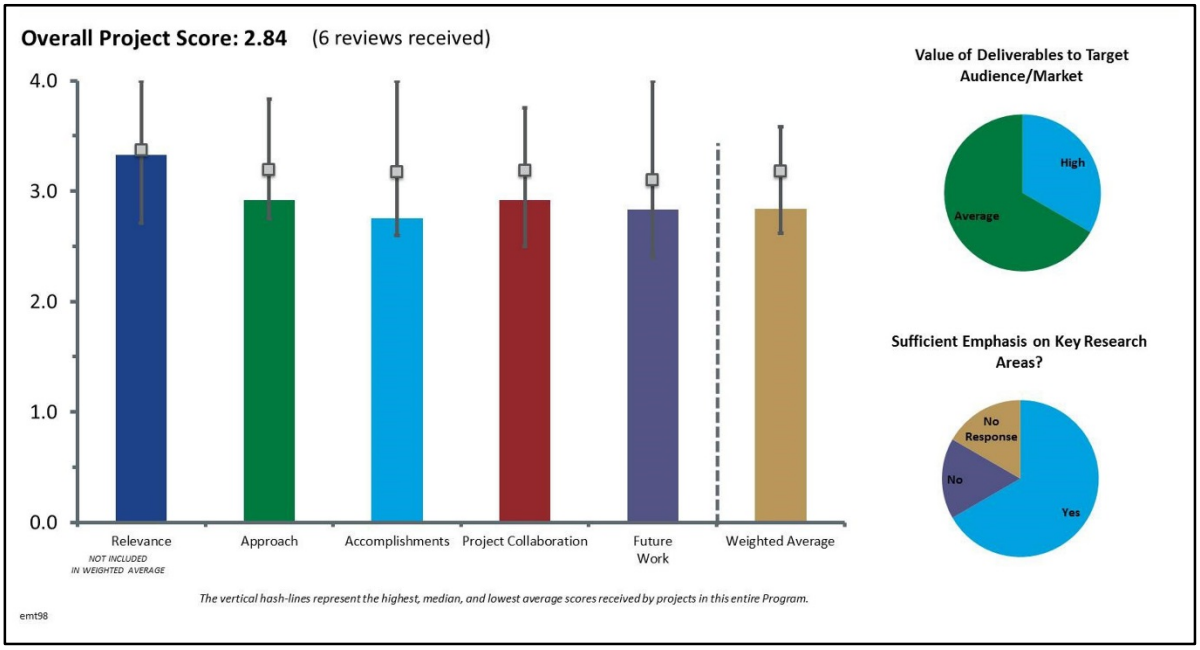
Presenter: Joseph DiMasi, Creative Light Source, joseph@creativelightsource.com
DOE Manager: Bahman Habibzadeh, bahman.habibzadeh@ee.doe.gov, 202-287-1657

Project Description

This project is developing a low-cost approach to mitigate electricity demand by illuminating indoor spaces with sunlight channeled deep into the building via flexible fiber-optic cables. Currently, lighting represents the greatest electricity demand in buildings. The technology developed by this project can help decrease this demand by eliminating electricity consumption during daylight hours, significantly increasing light-emitting diode (LED) luminous efficacy, and cogenerating electricity from the sun's infrared spectrum. The project is looking to complete a full working installation that would illuminate several thousand square feet and generate several kilowatts of electricity.

Summary of Review Comments

Overall, reviewers saw this effort as pursuing a worthwhile technology but found the approach, progress, and presentation somewhat lacking. Consensus was that co-generating photovoltaics and daylighting is an innovative concept that could significantly reduce building energy usage. One reviewer was very positive about the project as a whole, particularly praising the efforts to capitalize on the 2007 "Sunlight Direct" beta product, which both provides groundwork and indicates an existing market. However, other reviewers had a range of concerns, including (1) limited cost and market information, (2) insufficient communication with vendors, and (3) uncertainty about building integration. Several reviewers commented on the lack of clear, detailed information in the presentation, specifically in regards to technologies, barriers, costs, and a revised schedule/work plan. Per the reviewers, the project schedule has slipped and milestones have been missed, and reviewers were not confident the project could achieve the reworked milestones. One reviewer wondered whether the team had considered the risks involved in installing a primary lighting system that could have "down time," as well as whether building owners would actually implement such a system. Recommendations included (1) onboarding a downstream value chain partner with influence in the building and construction industry to proactively address marketing concerns and (2) developing a strategy for implementing the proposed technology in existing buildings.



Project # ET-99: LBNL: Window Attachments

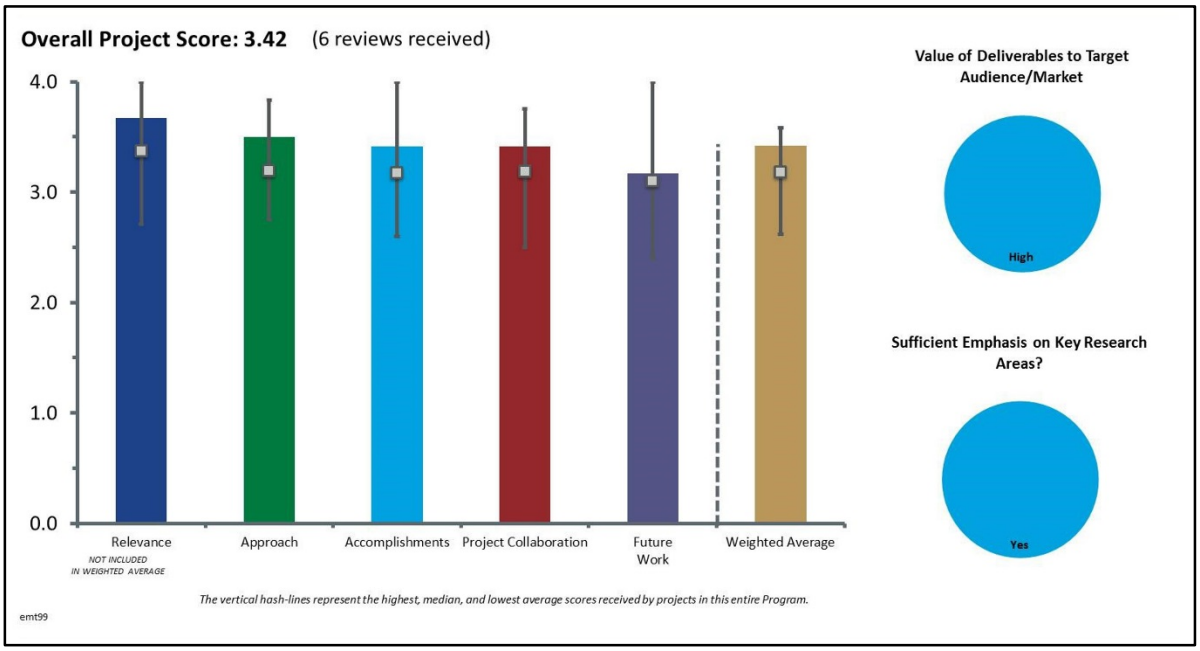
Presenter: Charlie Curcija, Lawrence Berkeley National Laboratory, dccurcija@lbl.gov
DOE Manager: Karma Sawyer, karma.sawyer@hq.doe.gov, 202-287-1713

Project Description

This project is developing and validating simulation models and procedures for characterizing a wide range of window attachments. The algorithms developed and validated during this project will inform and provide important credibility for simulation tools used by a new U.S. Department of Energy-supported fenestration attachments rating and certification program. Window attachments represent a cost-effective opportunity to save energy in new and existing buildings in both the residential and commercial sectors; however, the current lack of performance rating mechanisms for these products prevents consumers from identifying the top-performing products and realizing energy savings.

Summary of Review Comments

Reviewers agreed that simulation models and procedures for characterizing window attachments can make an immediate and significant contribution to energy savings and affect a wide range of stakeholders (e.g., manufacturers, consumers, academics, and standards development organizations). The approach was described as sound, effective, and comprehensive, covering (1) modeling, testing, and development of computer tools; (2) a test procedure for U-value and condensation resistance in window attachments; and (3) a product rating system. One reviewer also lauded the project team's expertise. Consensus was that substantial progress has been made, with successful development of simulation models and the new test procedure. Reviewers stated that the project has good collaboration with industry, shading manufacturers, and testing/standards organizations; although one reviewer pointed out that there are no window manufacturing partners, which would be important for validation and achieving market acceptance. While most reviewers indicated the future work was clearly focused on building on past progress and continuing its modeling efforts, there was confusion about a range of factors, e.g., future milestones and success factors. A few project challenges were identified, including (1) a dependence on standards organizations that could delay milestone achievement and (2) the fact that window attachment performance may depend on the window itself. One reviewer suggested that the project team should be more transparent with its findings.



3. Commercial Buildings Integration

3.1 Program Overview

BTO's Commercial Buildings Integration (CBI) Program accelerates energy performance improvements in existing and new commercial buildings by developing, demonstrating, and deploying a suite of cost-effective technologies, specifications, design and management tools, and other solutions. The CBI Program partners with and supports market decision makers such as building owners, managers, investors, and tenants. CBI catalyzes the commercial building industry to adopt underutilized yet proven technologies that meet performance standards, provide positive economic returns, and reduce energy usage.

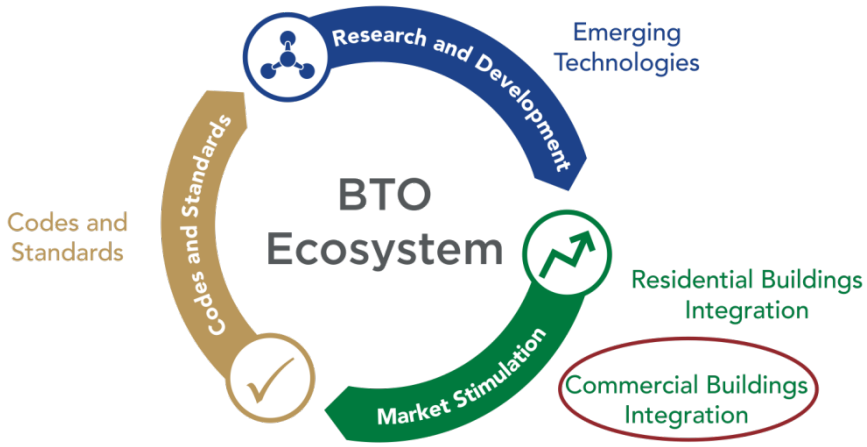


Figure 5. The role of the Commercial Buildings Integration Program in the BTO Ecosystem

The Program's *mission* is to accelerate voluntary adoption of significant energy performance improvements in existing and new commercial buildings.

The Program pursues goals for both new and existing buildings. For new buildings, the Program is working on solutions that will empower market leaders[3] to design and build commercial buildings that consume 50% less energy per square foot relative to typical commercial buildings in 2010, while also lowering life cycle costs. For existing buildings, the Program wants to see market leaders achieve a 30% reduction in energy use intensity (EUI) by 2025. If both of these goals are achieved, the Program expects that by 2025 the EUI of market leaders in the commercial sector will be 35% lower than the commercial sector average in 2010.

The Program achieves these goals through the following strategies:

- Demonstrate the performance of highly energy-efficient technologies in commercial buildings and drive adoption with market leaders.
- Prove energy-saving solutions in new and existing buildings that can greatly reduce the EUI of commercial buildings through market partnerships on a national scale.
- Accelerate adoption of energy-saving solutions by developing the market infrastructure to enable markets to deliver greater investment in energy efficiency.

[3] Market leaders own and operate the 20% most efficient buildings in the United States (measured on a square footage basis).

3.2 Summary of Peer Review Feedback

Project # CBI-04: NREL: DOE Technology Performance Exchange

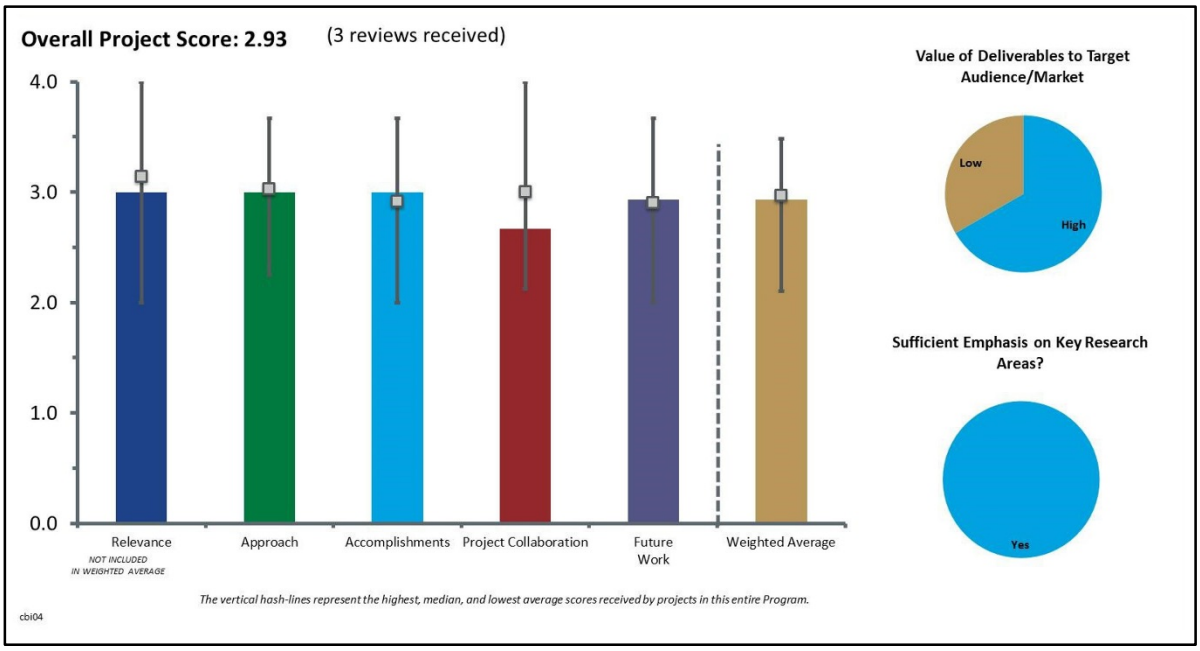
Presenter: Daniel Studer, National Renewable Energy Laboratory, daniel.studer@nrel.gov
DOE Manager: Amy Jiron, Amy.Jiron@ee.doe.gov, 720-339-7475

Project Description

This project provides a centralized, Web-based portal for building-related product energy performance data submitted by manufacturers and High-Impact Technology (HIT) Catalyst demonstrations to be quickly vetted, analyzed, and utilized by utilities and building owners. Characterization of products via their intrinsic energy performance data reduces the need for extensive (and often duplicative) field testing and can help utilities, government organizations, and private-sector companies reduce the time and cost necessary to evaluate a given technology. This project helps spur the adoption of energy-efficient technologies by enabling product manufacturers and testers to easily provide transparent product performance data to market stakeholders. Users can leverage this data to (1) identify promising new products and technologies, (2) reduce analysis time and cost, and (3) improve confidence in project savings estimates before moving forward with procurement. The long-term goal is for utilities to use the measurement and verification functionalities of the Technology Performance Exchange to establish product rebates and incentives, which helps spur broad adoption of new, energy-efficient technologies.

Summary of Review Comments

Reviewers praised the project for addressing a need faced by utilities, state agencies, and large institutional and retail buyers—easily accessible and comparative technology performance data. They also commended the project for (1) offering an engaging, intuitive interface and (2) utilizing a logical flow and management structure. Reviewers had mixed feelings on the project's collaborations; while one reviewer considered the outreach to major collaborators to be thorough, another felt the project will need a broader group of manufacturers and utilities to contribute and vet data in order to reach its goal, and a third suggested engaging a major retailer or property management firm to assess their interest in using and adopting this tool. Reviewers also had mixed opinions on the project's chances of achieving success; while one reviewer thought the project has a high likelihood of success, another felt the project has achieved little progress to date toward the articulated project goal (i.e., providing a pipeline for product-specific performance data to be quickly vetted, analyzed, and adopted by utilities and building owners), and was unsure how that would change. One reviewer felt the project has mostly benefitted Bonneville Power Administration to this point and wondered whether it would be more appropriate for utilities or product manufacturers to fund the project. It was suggested that DOE might need to provide more incentives to encourage additional entities to participate.



Project # CBI-23: CBEI: Enhancing OpenStudio for Airflow and Daylight Modeling

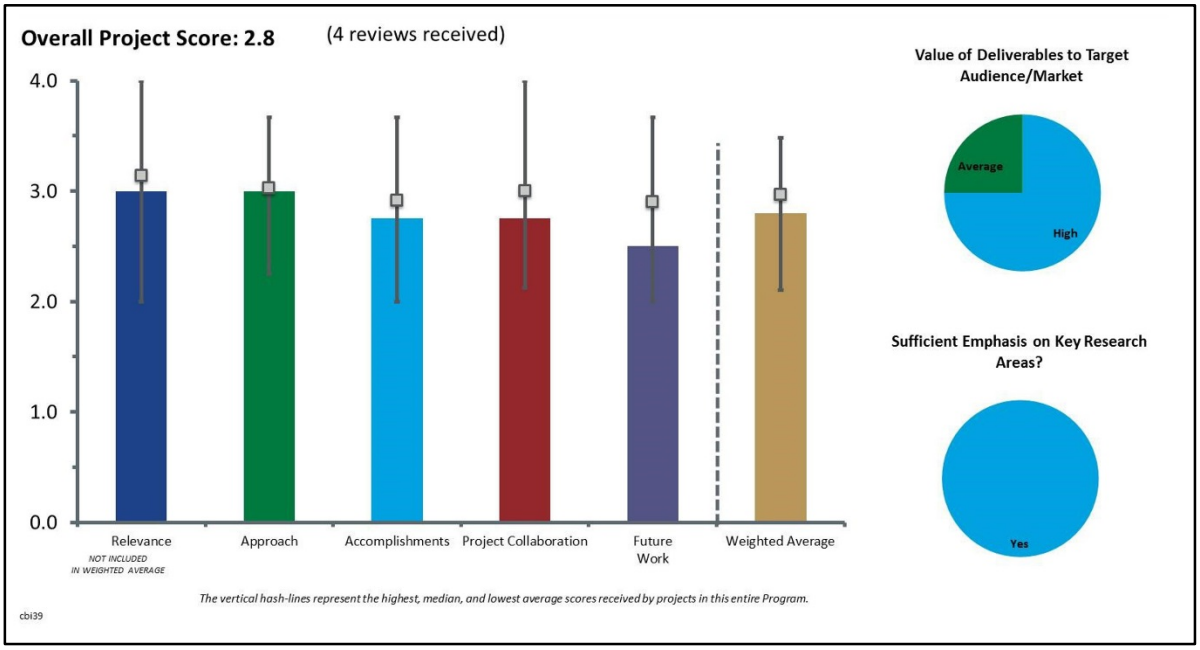
Presenter: John Messner, Pennsylvania State University, jmessner@engr.psu.edu
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project is working to enhance the functionality of OpenStudio, a cross-platform (Windows, Mac, and Linux) collection of software tools that support whole-building energy modeling. To this end, the project aims to support retrofit projects and enable project teams to easily integrate energy, daylight, and airflow modeling into their design workflows. Energy modeling is often inconsistently applied in the small and medium-sized commercial building (SMSCB) market, in part because existing models are either too complex relative to the project size or because models are not interoperable with other retrofit design tools. The improvements made by this project will encourage greater adoption of modeling in SMSCB projects, which will yield improved designs that consume less energy.

Summary of Review Comments

According to reviewers, this project is relevant to Building Technologies Office objectives and could increase access to energy modeling tools for smaller-scale projects. Reviewers applauded the project's model development; integration efforts; collaboration with major stakeholders; highly qualified teams; and open-source capacity, which will allow a broader range of users to access energy modeling tools for smaller-scale projects. Multiple reviewers praised the project's approach and accomplishments, noting that it has met its technical modeling and software goals. Others questioned how it is addressing the particular needs of retrofits in small and medium-sized commercial buildings and whether it has overcome the problems related to coupling airflow and energy simulations in OpenStudio. Reviewers wondered what role airflow modeling capacities will have in the future work and encouraged the project team to continue with these efforts as they could have major retrofit and energy-saving potential. Reviewers recommended demonstrating the functionalities of the code that has been developed thus far, including usability studies in the next tasks, and engaging design professionals and users for the actual development of the tools.



Project # CBI-27: LBNL: Architecture 2030 District Toolkit

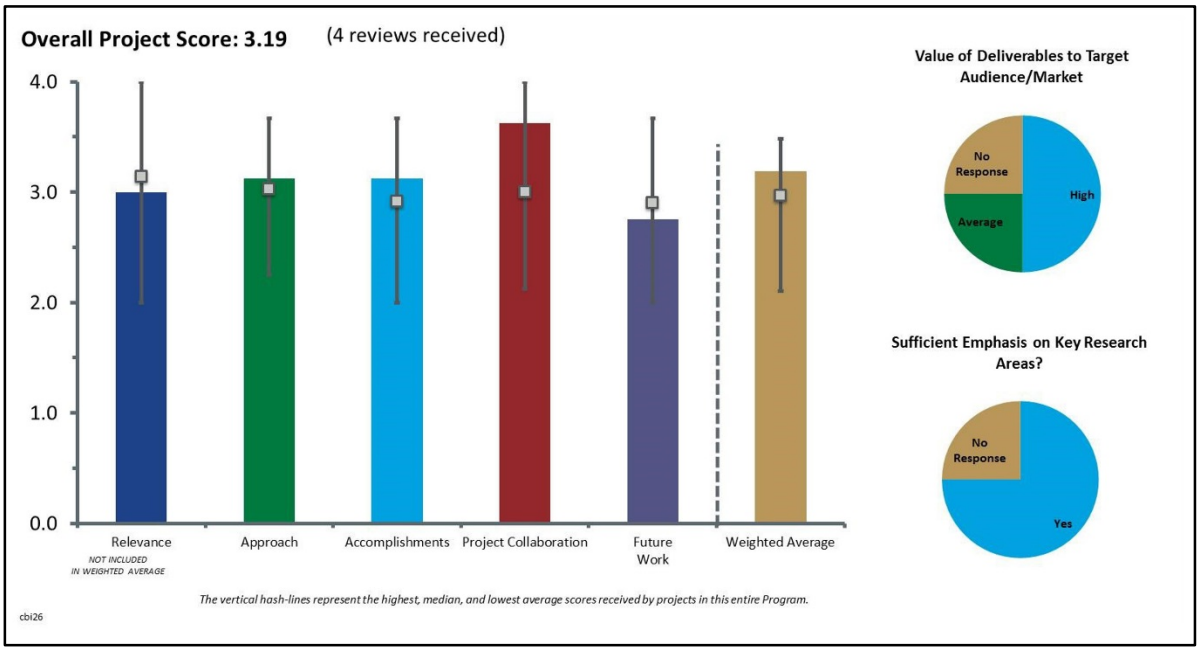
Presenter: Cindy Regnier, Lawrence Berkeley National Laboratory, cmregnier@lbl.gov
DOE Manager: Priya Swamy, priya.swamy@ee.doe.gov, 202-287-1875

Project Description

This project aims to create programmatic guidance and a technical toolkit to support the promotion, development, and execution of 2030 District energy efficiency programs for small commercial buildings across the nation. The program guides and technical toolkit address the specific energy efficiency needs of the small commercial building sector, providing a suite of organizational, analysis, implementation, and verification methodologies, tools, and resources to meet Architecture 2030's targets for more than 20% energy reductions in small commercial buildings. The program guides build on Architecture 2030's past work to address small commercial building needs, while the toolkit leverages existing energy efficiency resources. For example, one of the toolkits, the Energy Management Package, guides users on how to benchmark and monitor energy usage, identify low- and no-cost energy efficiency opportunities, and track results. The energy analysis is designed to be done using free or inexpensive, already available software tools, and it includes specific resources for heating, ventilation, and air conditioning (HVAC) contractors to offer the Energy Management Package as part of an annual maintenance contract.

Summary of Review Comments

According to reviewers, the project provides useful tools and guidance to encourage small businesses to reduce their energy usage. Noted project strengths include (1) the focus on the small commercial office and retail building market, which reviewers characterized as a challenging market; (2) the adoption of the materials by the target audience; and (3) leveraging key stakeholders in 2030 Districts. Reviewers had mixed views on the proposed future work; one felt a clear path for the remaining project period had been identified, while another reviewer stated that better information about how the project will reach the 20% savings goals would have been useful. One reviewer also noted the lack of proven project impacts as a weakness. In addition, a reviewer stated marketing efforts may need to overcome the initial impression that this effort is duplicative of similar programs and show its particular value to small business owners. No future recommendations were specified; however, a reviewer did comment that the stakeholder engagement bodes well for the project's future beyond its funding period.



Project # CBI-28: Southface Energy Institute: Advanced Commercial Buildings Initiative

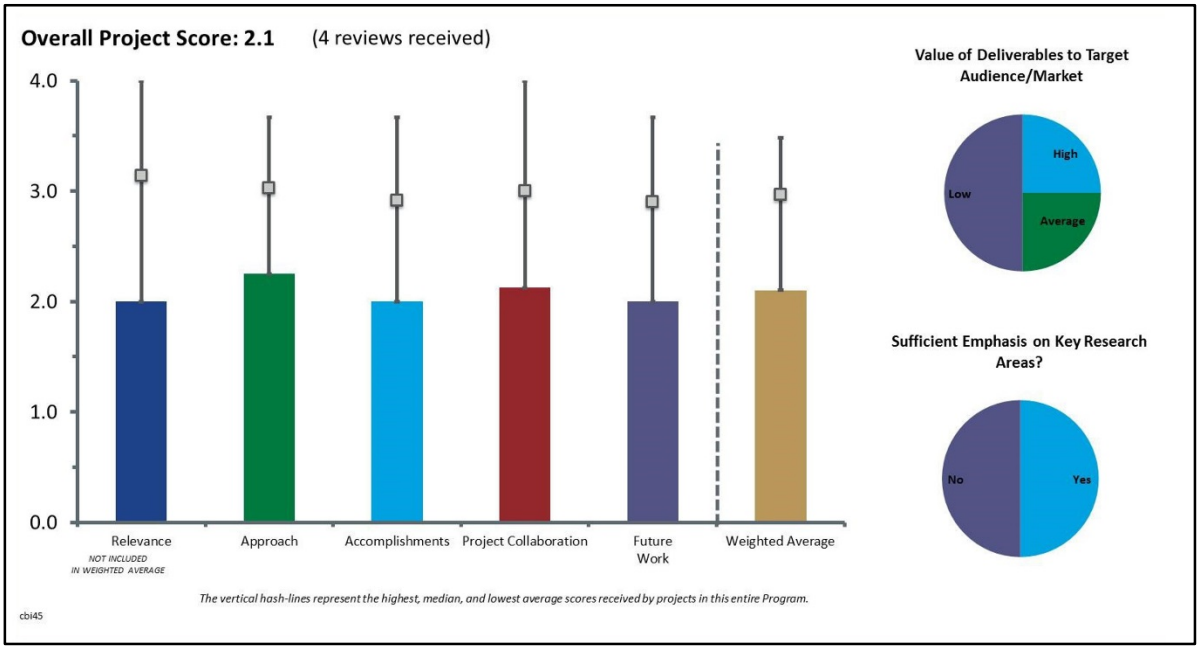
Presenter: Sydney Roberts, Southface Energy Institute, sroberts@southface.org
DOE Manager: Priya Swamy, priya.swamy@ee.doe.gov, 202-287-1875

Project Description

This project utilizes a comprehensive strategy to overcome market barriers with cost-effective, research-driven solution packages that achieve aggressive energy-savings targets in new and existing small commercial buildings. The project leverages existing programs via cost-effective engagement with third-party building performance experts to develop proven, scalable solutions. The target market includes the building industry, municipalities, utilities, and financial institutions. To date, the program has benchmarked all of the city of Atlanta's fire stations, partnered with the city on energy and water tracking process, and provided technical assistance to the City of Decatur to adopt building codes requiring energy efficiency and other green building attributes for commercial and residential buildings.

Summary of Review Comments

Reviewers expressed sharply different views on many aspects of this project, including its relevance to Building Technologies Office goals, approach, accomplishments, collaborations, and future work. One reviewer praised the project for developing and demonstrating the effectiveness of thorough energy efficiency improvement programs; however, others questioned whether the project is contributing new ideas and whether the tools will impact the market. Regarding accomplishments, one reviewer noted that benchmarking of municipal buildings and the recognition received from the local government is very positive. Others reported the accomplishments (1) seem to be the discovery of technical and program elements that have been known for decades and (2) do not relate to the project approach with any detail. Feedback on collaboration ranged from praise for having a good mix of partnerships to questions about who is doing what and which efforts the funding is supporting. Most reviewers found the direction and value of the proposed future work to be unclear, while a few commended plans to develop the public purpose energy service company model. One reviewer recommended talking with the Boys & Girls Club and other current or potential project sites to determine what the customer perceives as the value of the project—the tools or the personal attention.



Project # CBI-30: National Trust for Historic Preservation: America Saves! Energizing Main Street's Small Businesses

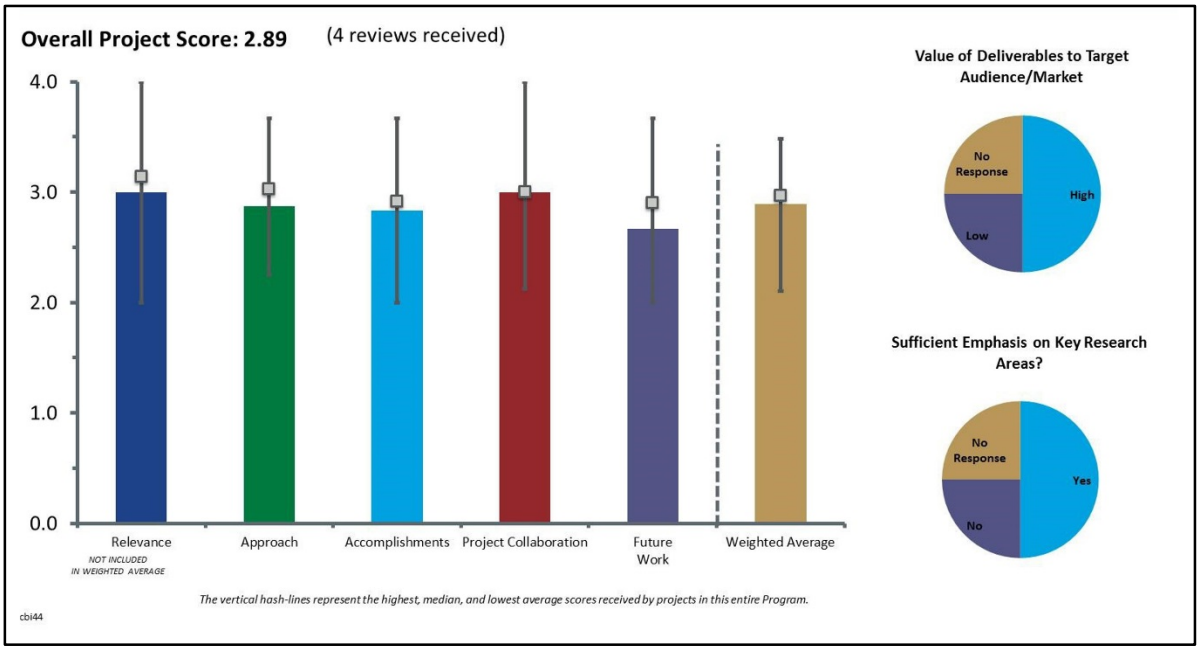
Presenter: Sara Stiltner, National Trust for Historic Preservation, sstiltner@savingplaces.org
DOE Manager: Priya Swamy, priya.swamy@ee.doe.gov, 202-287-1875

Project Description

This project is developing a model for retrofit implementation in millions of small businesses nationwide by aligning small businesses and utilities through large-scale data acquisition, cost-effective building analytics, and community-based retrofit delivery. The goals of this project are to (1) demonstrate a community-based approach to business engagement that enhances small business participation in energy retrofit programs and (2) evaluate technology-based tools to reduce cost and technical barriers to retrofit delivery in small businesses. The project is important because while small businesses and owners of small buildings represent the great majority of commercial properties in the United States, they are often underserved in the energy efficiency marketplace.

Summary of Review Comments

According to reviewers, this project deserves praise for connecting local utility programs with Main Street districts and adding an energy efficiency element to the Main Street program. Other cited strengths include (1) using surveys and local knowledge from the individual districts to guide implementation of the project; (2) connecting with small businesses in small cities; and (3) leveraging existing, trusted groups to communicate with building owners. One reviewer noted the project was most successful when collaborating with a motivated program administrator who can co-market and wondered whether such a collaboration should be a required element for future funding. However, one reviewer felt the results to date, rather than providing significant new insights, appear to be well-known observations about the utility business and some incremental improvements on analytic methodologies that have been available for decades; the reviewer also questioned the effectiveness of promoting energy efficiency and customer data transparency to reluctant utilities. Another reviewer inquired why the project spent the time to create new utility data-gathering software when multiple companies offer a similar service; it was suggested that future efforts focus on making connections between utilities and Main Street districts rather than trying to automate energy audits. A third reviewer felt the project was too broad, applying a similar approach to both urban utilities with aggressive energy efficiency programs and to small-town municipal utilities with strong economic incentives to oppose energy efficiency.



Project # CBI-31: BlocPower: Crowdsourced Microfinance for Energy Efficiency in Underserved Communities

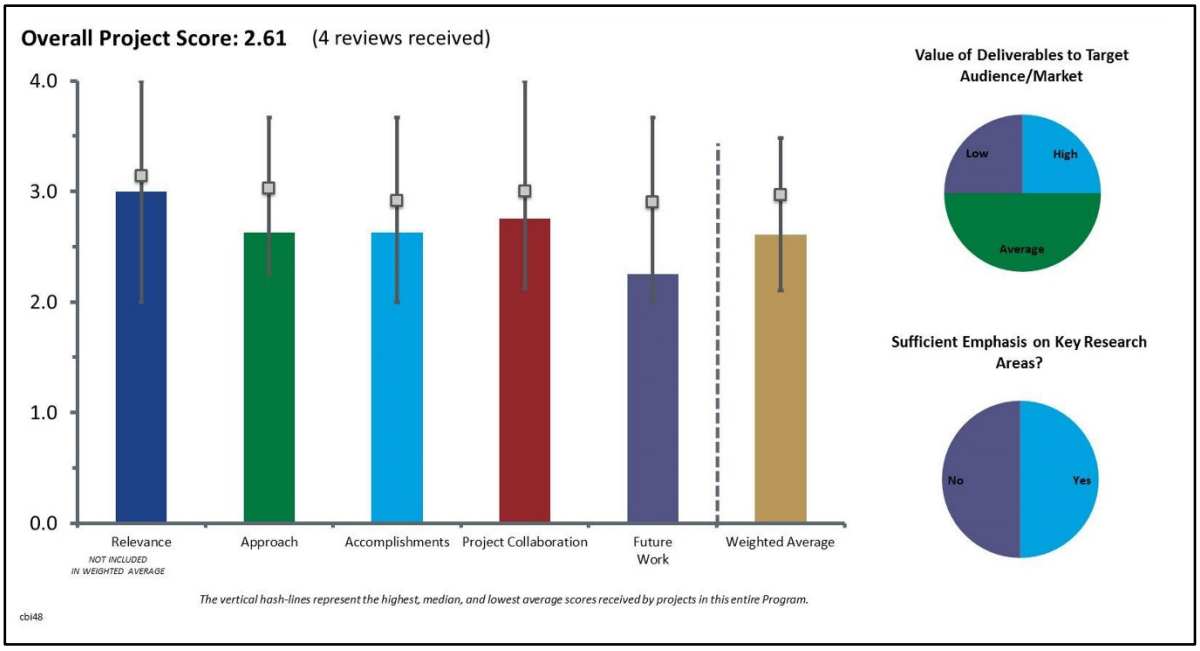
Presenter: Donnel Baird, BlocPower, Donnel@blocpower.org
DOE Manager: Priya Swamy, priya.swamy@ee.doe.gov, 202-287-1875

Project Description

BlocPower is developing a crowdsourcing online platform to help market, finance, and install energy efficiency retrofits for 1,000 small commercial buildings (under 50,000 square feet)—including buildings for religious organizations, schools, small businesses, and nonprofit organizations—in financially underserved communities. The platform connects individual and institutional investors who focus on social or environmental issues with energy efficiency project financing or investment opportunities. The project addresses two main problems: (1) the inability of traditional energy efficiency and clean energy entities to access a $43 billion underserved market and (2) the inability of 60 million Americans who are concerned about climate change to invest in energy efficiency. The project also creates energy efficiency job opportunities for low-income workers in the communities it serves.

Summary of Review Comments

Reviewers expressed drastically different views on this project. One reviewer called it the most impressive approach for reaching small businesses presented at the peer review, noting that a viable business model for reaching underserved energy efficiency opportunities has been demonstrated. However, another found the focus unclear and listed several possible barriers that this project may (or may not) be addressing; these ranged from small-market energy efficiency in existing facilities to crowdfunding online platform design to the finance gap to workforce training. While one reviewer found the accomplishments impressive, another stated that the project has retrofitted only 12 buildings (out of a targeted 1,000) and seemingly has no projects in the pipeline. Reviewers generally agree that the project has impressive connections to stakeholders and the targeted underserved markets. However, one reviewer questions how much benefit these connections have actually created, and another notes that many project partners are in New York City—the project location—hampering expansion. One reviewer called for additional projects to be funded in other major U.S. cities, while another expected the project's impact to be limited because of the market. It was noted that similar past efforts have failed because they underestimated risk and did not address key barriers: overstated energy returns, understated non-energy project costs, and quality assurance issues with audits and contractors. One reviewer requested more information about the online marketplace, and another requested a detailed project pipeline.



Project # CBI-32: Ecology Action: Small Market Advanced Retrofit Transformation Program

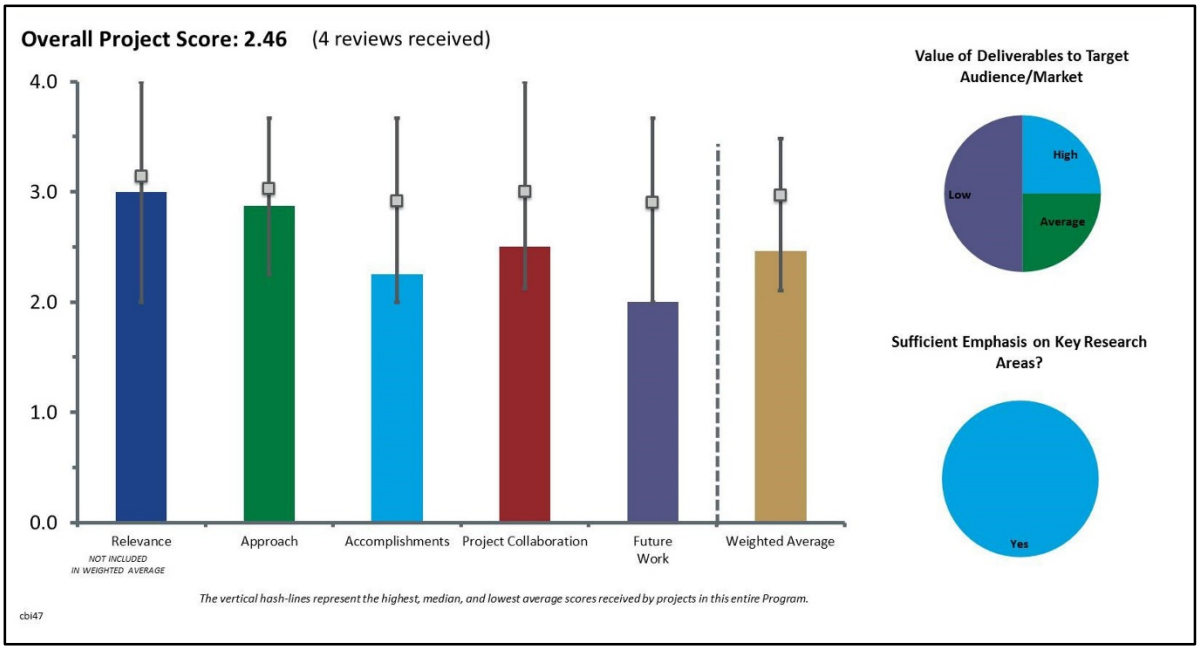
Presenter: Colin Clark, Ecology Action, CClark@ecoact.org
DOE Manager: Priya Swamy, priya.swamy@ee.doe.gov, 202-287-1875

Project Description

This project is developing a platform designed for utility and government administrators of energy efficiency programs for small and medium-sized buildings that achieves average energy savings of 20% per building. The platform will achieve these savings by offering a comprehensive set of measures, integrated financing tools, and expedited project measurement and verification via a contractor-driven delivery model. The project also aims to provide contractors with the ability to deliver deep retrofits and ensure they can reach an average of at least 20% savings at scale.

Summary of Review Comments

While reviewers praised the project for targeting the important small building market for energy efficiency advancements, there were some concerns regarding the project's sustainability and scalability. Reviewers commended the project's understanding of the key barriers in the market, specifically applauding use of a controls-based retrofit as a work-around to building owners' reluctance to do full heating, ventilation, and air conditioning (HVAC) replacements. The relationships between the project team and its partners were seen as excellent; however, some stated that the model is highly dependent on these relationships, so there is little evidence that the approach is replicable or viable at the national level. Views on accomplishments to date were mixed; one reviewer felt the project has made good progress in terms of achieving savings, while another found the results to be on a par with those of leading utility programs. Two believed the top results were the work of one highly motivated contractor, but without knowing what makes that contractor distinctive, the results will be hard to replicate. Reviewers question the project's ability to attain energy savings consistently without including end uses beyond lighting and refrigeration. The proposed expansion to an HVAC retrofit pilot is seen as a sensible next step. One reviewer suggested leveraging the work of other projects seeking to advance HVAC retrofits for the small business market, and another suggested that the project team discuss its plans with a larger stakeholder group to determine scalability.



Project # CBI-50: QM Power, Inc.: Commercial Refrigeration Fan Applications

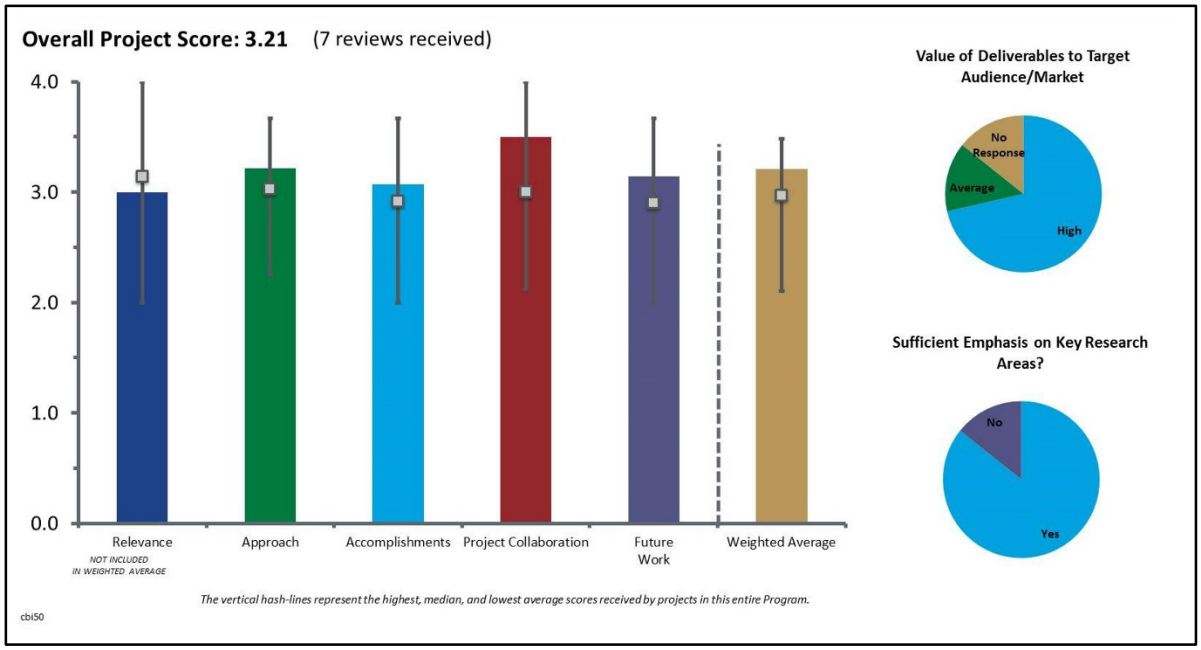
Presenter: Patrick Piper, QM Power, Inc., pjpiper@qmpower.com
DOE Manager: Charles Llenza, charles.llenza@ee.doe.gov, 202-586-2192

Project Description

The project is demonstrating, testing, and deploying replicable, cost-effective, low-risk, higher-efficiency Q-Sync fan motor solutions with market leaders such as commercial refrigeration original equipment manufacturers (OEMs), retrofit contractors, utilities, and grocery sites. Up to 10,000 motors will be installed in up to 50 sites nationwide during the course of the project. The demonstrations will expedite customer adoption and the development and use of these technologies in other heating, ventilation, air conditioning, and refrigeration (HVACR) fan applications. If fully commercialized and adopted, QM Power's technologies have the potential to achieve more than 0.6 quads and more than $1 billion of energy savings in building applications.

Summary of Review Comments

According to reviewers, this project is developing a fan motor solution suitable for both new and retrofit systems with strong potential to be extended beyond display cases into other applications such as furnaces and compressors. Reviewers commended the project's comprehensive approach that uses high-visibility demonstrations in multiple sites, allowing for analysis of a range of issues and facilitating market penetration—although one reviewer warns that control integration may be a barrier to this new technology. The reviewers note that the project is on budget and ahead of schedule, having obtained UL approval, gained OEM acceptance, and completed its initial technology-to-market and deployment plans. Collaborations are generally described as strong and broad, with "all the players involved," including building owners, original equipment manufacturers, contractors/installers, academia, trade organizations and utilities. Future plans are described as comprehensive and ambitious and include scaling applications, product extensions, Wi-Fi integration, and fault detection integration. Low net margins were identified as a concern, especially as they make the project overly reliant on stakeholders for financing—as well as on mass purchases that will likely require end users to have a good understanding of a complex technology's benefits. Although two reviewers said the technology's low cost was a strength, another felt the cost–benefit and reliability ratios were insufficient. Individual suggestions included developing improved fan technology to take advantage of motor characteristics, considering a variable-speed solution for OEMs, and presenting information on motor lifetimes.



Project # CBI-51: A.O. Smith: Demonstrate Underutilized Micro-CHP

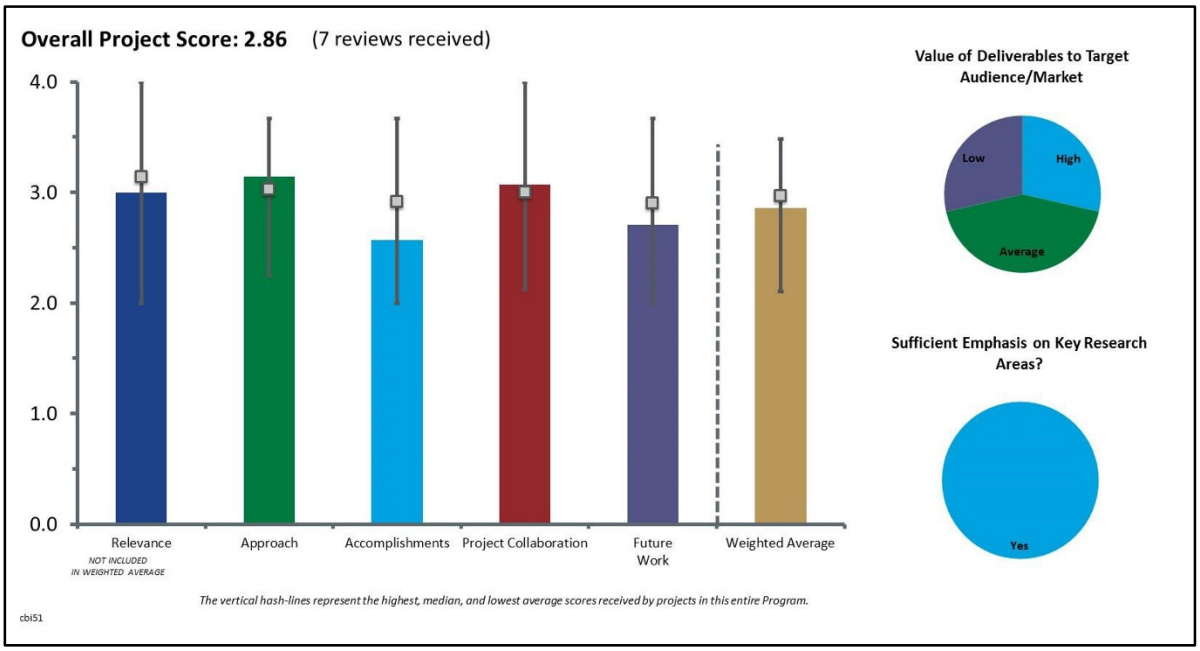
Presenter: Kris Jorgensen, A.O. Smith, kjorgensen@aosmith.com
DOE Manager: Charles Llenza, charles.llenza@ee.doe.gov, 202-586-2192

Project Description

This project is demonstrating the use of micro-combined heat and power (μCHP) in light commercial hot water applications. The project will commission eight μCHP field demonstration systems in target markets with high daily hot water demands (>3,000 gallons per day) and in geographical regions with favorable μCHP criteria. The project seeks to provide stakeholders with the information they need to make informed decisions regarding deployment of this technology. The project will accomplish this by (1) verifying the value proposition of a three-year installed cost payback, (2) identifying and simplifying installation and maintenance, and (3) creating effective training for installation and maintenance personnel. The expected outcomes are to provide stakeholders (manufacturers, building owners/national account companies and installers) the information they need in order to make informed decisions regarding deployment of this technology with a total potential primary energy savings potential of 0.5 quads per year.

Summary of Review Comments

Reviewers praised the use of μCHP as an excellent means of reducing the energy used for commercial water heating. However, there were concerns that the technology's adoption rate will be restricted by high costs, unproven and complex technology, limits of applications to certain types of buildings and regions, lack of sales and installer training, and the current regulatory environment. It was generally agreed that the project team has a good understanding of the technology and the issues and has a plan for addressing most of the barriers, but few expressed confidence that all such challenging barriers would be overcome, and one stated that the plan does not address the market limitations or regulatory hurdles. The project has outlined its approach and identified collaborators and demonstration sites, which most thought reasonable progress for a difficult project in early stages—although it was noted that having a significant end user as a partner would have helped with challenges such as identifying appropriate demonstration sites. Two reviewers recommended starting with a limited number of demonstration sites so as not to spread resources too thin and so that lessons learned could later be applied to site selection. One reviewer suggested that the U.S. Department of Energy (DOE) produce a white paper and then leave this technology's advancement to the niche market; one reviewer suggested that DOE work with regional energy organizations to simplify the regulatory environment to allow this technology to be utilized.



Project # CBI-53: BuildingIQ, Inc.: Predictive Energy Optimization

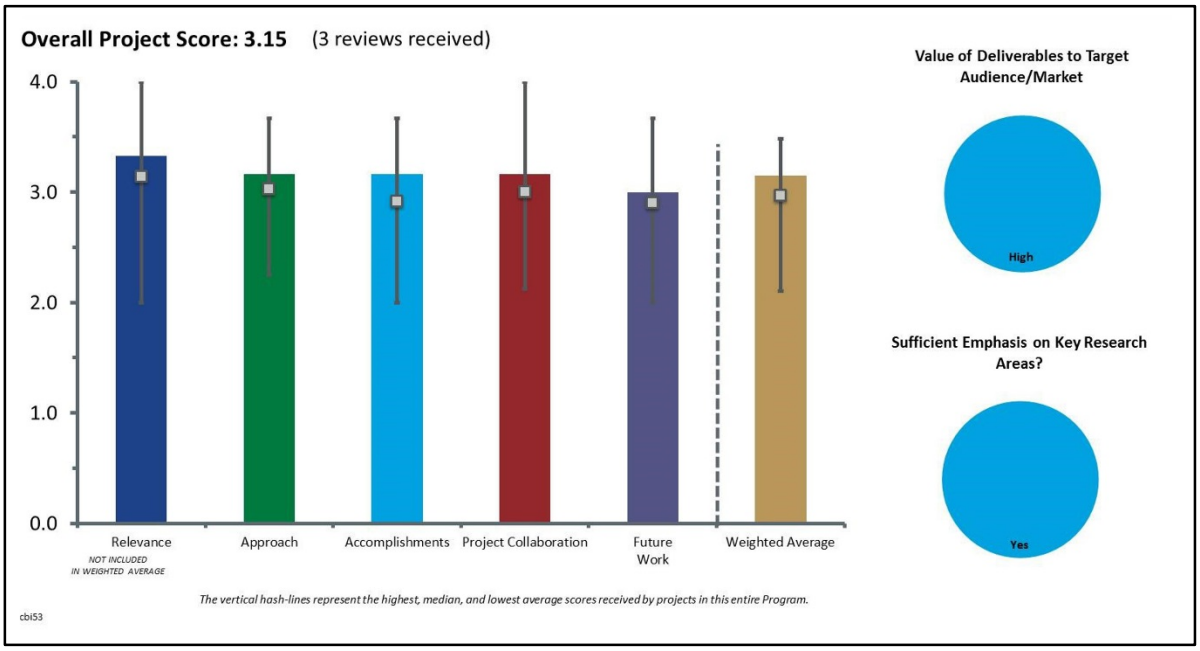
Presenter: Michael Nark, BuildingIQ, Inc., michaeln@buildingiq.com
DOE Manager: Charles Llenza, charles.llenza@ee.doe.gov, 202-586-2192

Project Description

This project seeks to promote the use of predictive energy optimization (PEO) and automated demand response as tools to reduce energy use in heating, ventilation, and air conditioning (HVAC) systems in U.S. commercial buildings. The BuildingIQ software, which overlays existing building automation systems (BASs), provides a measurable and immediate impact on energy use and peak load, reduces the need for staff intervention to achieve savings, and generates positive cash flow—all without upfront capital. The project is demonstrating PEO performance in diverse buildings; monitoring and verifying performance; and analyzing energy and peak power savings, as well as the overall economics.

Summary of Review Comments

According to reviewers, this is a high-value project that could uncover significant energy savings in the "continuous" commissioning space through BuildingIQ, which helps facility managers and building owners reduce energy use and increase thermal comfort in their buildings. Reviewers praised the project for offering a low-/no-capital-cost approach with little/no disruption to customers. Reviewers noted that the project is in early stages but has identified Stage 1 deployment sites and created checklists. There were mixed views about the sites, with one reviewer noting a very good number and diversity of buildings, one concerned about the small number of sites, and one wondering whether those sites have been "cherry-picked" for optimal results that may not be representative of the target portfolio. One reviewer stated that the priority now is proving the technology works and that the project has set up measurement and verification (M&V) for this purpose, but another was not clear about plans/needs for external M&V. The project features good collaborations with key channel members as partners, although one reviewer suggested more utility involvement. Other individual reviewer concerns included whether modeling is sufficiently robust, whether focus on occupant comfort is sufficient, and whether BuildingIQ could become obsolete as building controls evolve. This last reviewer felt that directly incorporating the platform with original equipment manufacturers might be a better solution, especially considering the challenges involved in overlaying the technology with existing BASs.



Project # CBI-54: LBNL: NYC Office Demonstration

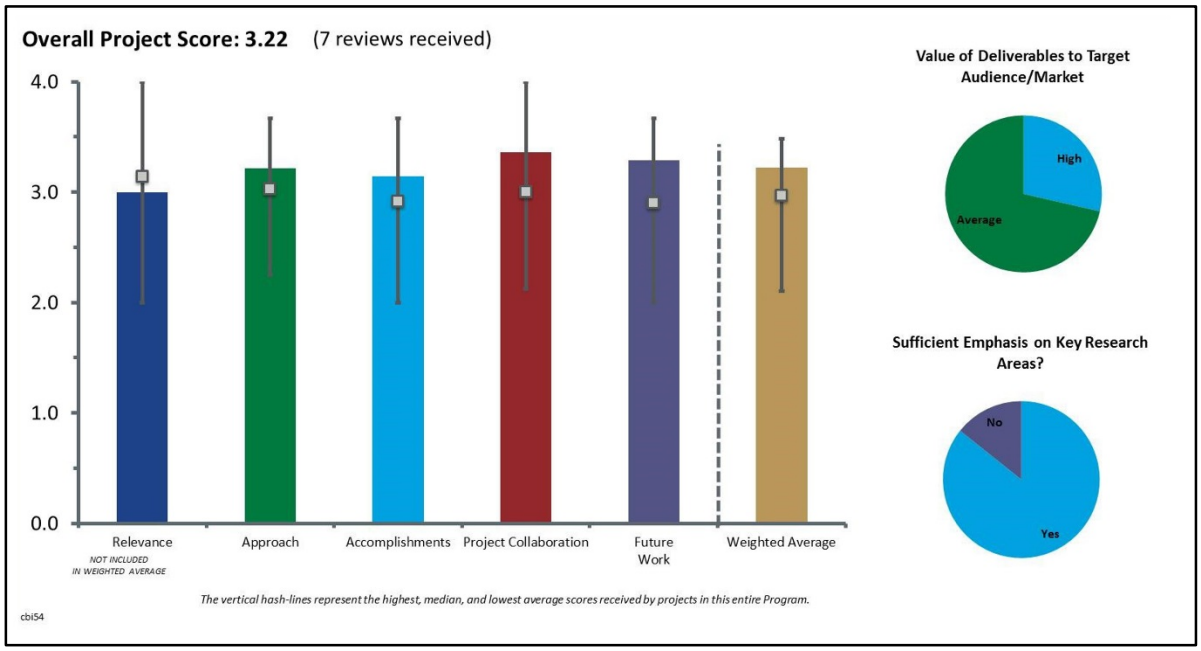
Presenter: Eleanor Lee, Lawrence Berkeley National Laboratory, eslee@lbl.gov
DOE Manager: Amy Jiron, Amy.Jiron@ee.doe.gov, 720-339-7475

Project Description

This project seeks to demonstrate the market feasibility of implementing cost-effective, energy-efficient retrofits for lighting, shading, and daylighting systems in existing office buildings. The project is identifying shading, daylighting, and lighting technology upgrades that can be retrofitted into existing buildings and provide significant energy savings, increased comfort, and added amenity to owners, facility management teams, and end users. In the near term, in addition to technology solutions, the project will identify key design, bid, and procurement strategies that can be broadly deployed in the market. In the long term, the project aims to promote widespread adoption of integrated shading, daylighting, and lighting systems for retrofit application.

Summary of Review Comments

Reviewers felt this demonstration project raises visibility, shows feasibility, and provides information about energy efficiency retrofits for lighting and daylighting. The project has installed and monitored systems, and it remains to be seen whether two key partner building owners opt to deploy the technologies throughout their portfolios—without which, says one reviewer, the impact would be limited to "just another demonstration." The same reviewer felt that the project should address labor and cost issues to build the business case, but others state that the project scope is solid and valuable for existing urban buildings. Reviewers praised the project's efforts to tackle barriers (e.g., building owner education) by building confidence in the market. Also commended was the substantial collaboration with appropriate partners, although it was suggested that a partnership with an electrical installer or a transformative organization such as Green Light New York would have been useful. One reviewer also commended the project for a well-identified process for verification. Reviewers generally saw value in the "living laboratories," although some thought they could be better leveraged through broader access. Individual critiques included no discussion of building codes and no clear plan to market the effort outside of New York. Suggestions included implementing the technology on more buildings, doing a comparative analysis once data are available from multiple buildings, and determining how to bundle the measures in other weather zones.



Project # CBI-55: Northeast Energy Efficiency Partnerships: Advanced Lighting Controls

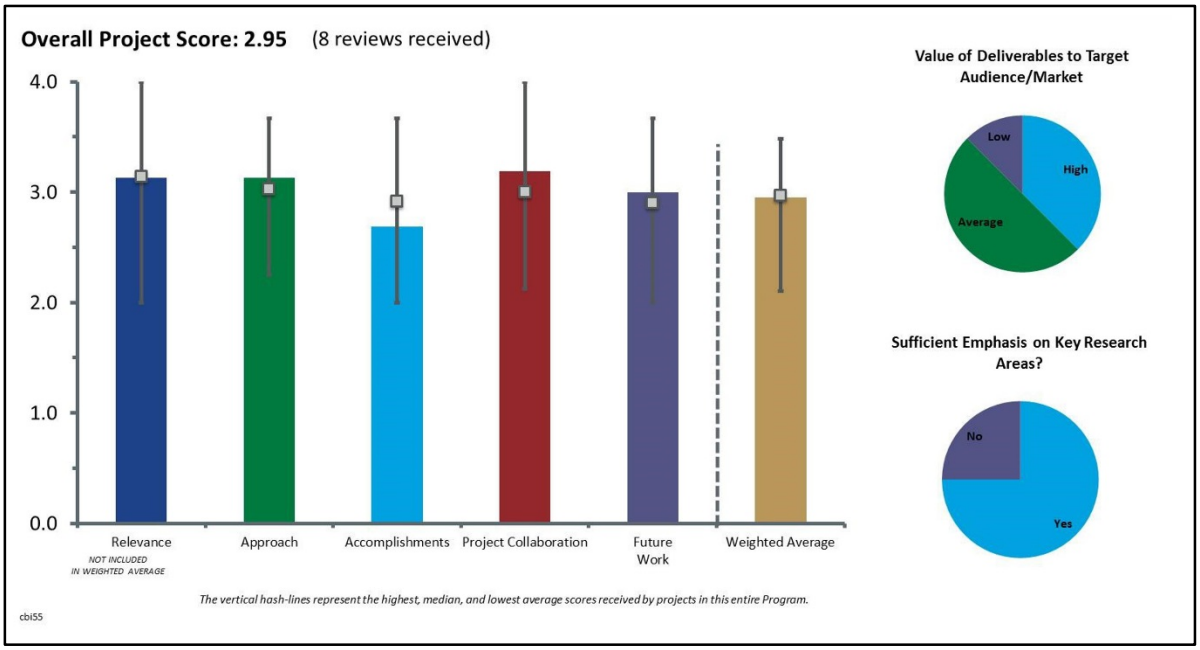
Presenter: Gabe Arnold, Northeast Energy Efficiency Partnerships, garnold@neep.org
DOE Manager: Charles Llenza, charles.llenza@ee.doe.gov, 202-586-2192

Project Description

This project seeks to accelerate the deployment and market adoption of advanced lighting controls (ALCs) in commercial buildings by addressing market barriers. The project includes many activities, not all of which are funded by the U.S. Department of Energy (DOE). The specific DOE-funded activities include (1) implementing 10 demonstration projects and generating associated case studies; (2) developing and implementing scalable training programs for designers and installers; and (3) developing and implementing replicable, system-based energy efficiency program offerings for advanced controls. If ALCs were installed in all U.S. commercial buildings, $10.4 billion in energy costs could be saved annually.

Summary of Review Comments

Reviewers had mixed views on whether the project will overcome barriers to market adoption for ALCs. Some praised the project for providing excellent information to help break down barriers for entry (e.g., perceived complexity), while others noted the difficulty in establishing a business case or questioned the project's plans to address certain barriers. Cited strengths include the project's (1) diverse, multifaceted approach and (2) demonstration projects and training programs. Most reviewers felt the project has strong collaborations, but some critiqued the project for failing to involve key stakeholders such as designers, installers, and building operators. Some reviewers disagreed on whether the project team is collaborating with building owners; one reviewer cited the lack of engagement with building owners as a weakness, while another reviewer noted that good collaboration exists between the project team, manufacturers, and building owners. Reviewers generally felt it is too early to evaluate the project's progress. Individual reviewers expressed concern that (1) the project's success depends on changing perceptions and attitudes toward lighting efficiency and (2) the research analysis is not strong enough. Recommendations from reviewers include (1) involving lighting designers and engineers in the training; (2) gathering comments and verified data from end users on why adoption of ALCs is so poor, and then addressing those needs, (3) installing or including a simple, accessible manual override; and (4) developing a plan to sustain the training after the end of the project.



Project # CBI-56: LBNL: Getting Beyond Widgets

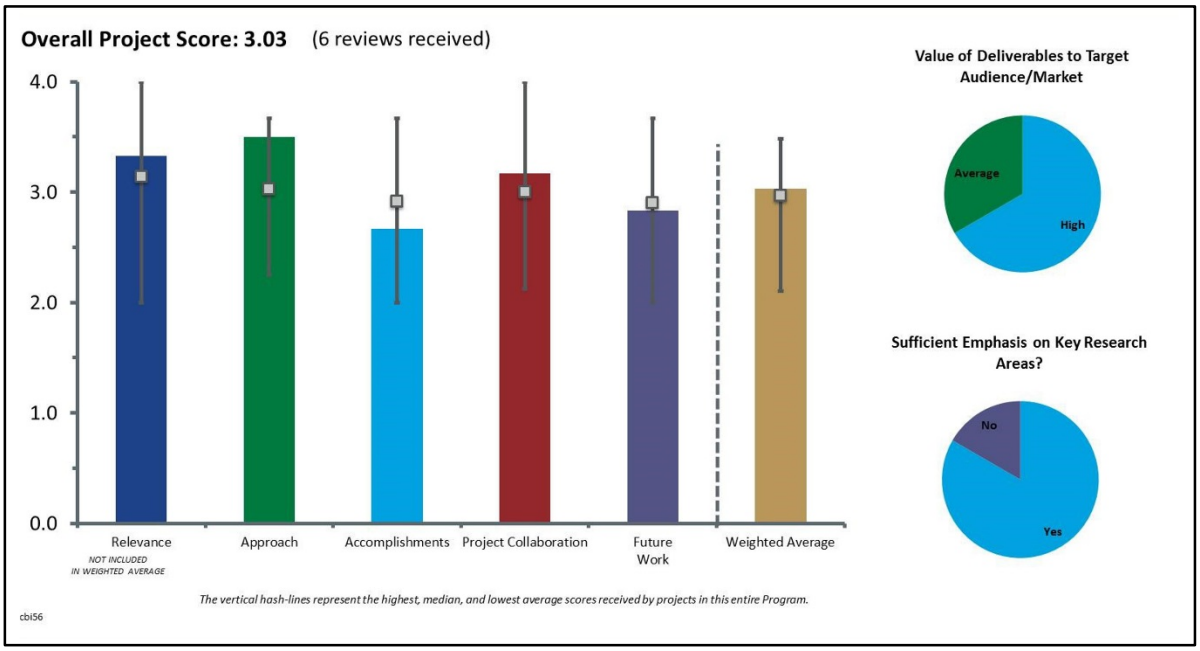
Presenter: Cindy Regnier, Lawrence Berkeley National Laboratory, cmregnier@lbl.gov
DOE Manager: Kristen Taddonio, Kristen.Taddonio@ee.doe.gov, 720-356-1779

Project Description

This project seeks to develop FLEXLAB-validated protocols—performance metrics, as well as measurement and verification, operations, and savings persistence protocols—for specific building systems in utility incentive programs. The project expands the savings available through established utility incentive programs by moving beyond component-based approaches to a systems-based approach, while also leveraging these utility incentive programs to promote deployment of integrated systems. The project team collaborates with utility partners, with the goal that each partner utility launches a systems incentive program applicable to at least 25% of its total commercial sector energy use. The project's baseline and proposed systems metrics, measurement protocols, and testing could also inform the development of outcome-based codes.

Summary of Review Comments

According to reviewers, this project addresses a long-time problem for energy efficiency programs and regulators and permits a more complete evaluation of systems versus individual widgets. Reviewers generally felt that while the project is in an early phase, it has a strong approach that addresses critical barriers (e.g., system incentives, more stringent code baselines, and the difficulty of field-verifying system savings), collaboration with utilities, and potential impact. Reviewers also stated that understanding the energy-saving impact associated with integrated solutions is critical to achieving deep energy savings, and they praised the project for providing a testing area for companies. Individual reviewers expressed concern about (1) FLEXLAB's limited ability to assess results across climate zones; (2) insufficient emphasis being placed on support for utility uptake; and (3) a lack of clarity on how many systems will be selected for each integrated package, how they will be specified and tested, how long tests will be conducted, and how the results will be annualized and normalized. Reviewers did not offer many recommendations, but they did suggest (1) the deliverables should include a commissioning guideline, a recommended field verification plan, and an outline for impact evaluation; and (2) making securing actual test projects the next major milestone.



Project # CBI-57: LBNL: High Performance Active Perimeter Building Systems

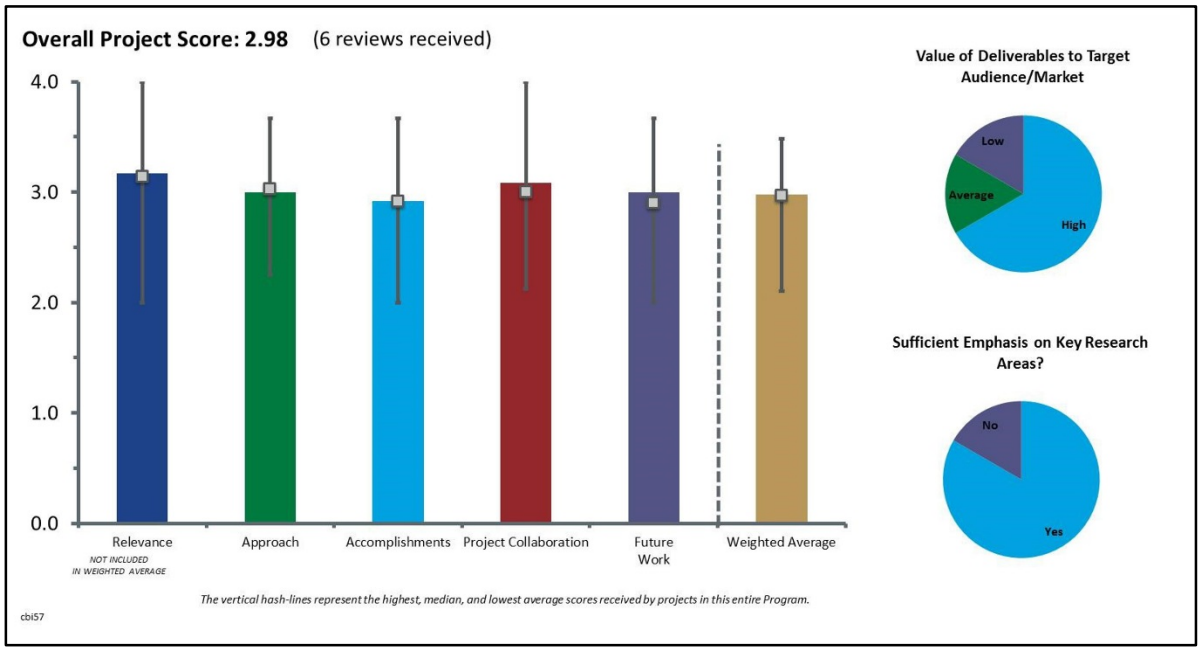
Presenter: Eleanor Lee, Lawrence Berkeley National Laboratory, eslee@lbl.gov
DOE Manager: Karma Sawyer, karma.sawyer@hq.doe.gov, 202-287-1713

Project Description

This pilot tech-to-market initiative enables the technical and commercialization advances necessary to overcome barriers between research and development and deployment efforts for highly efficient lighting and building envelope systems. The project's overall technical goal is to enable reliable, less complex, and cost-effective interoperable façade and lighting technologies that lead to reductions in energy use and peak demand at the perimeter zone in commercial buildings. The overall cost goal is for the market to produce a range of competitively priced, interoperable products that reduce utility operating costs; curtail peak perimeter zone loads; reduce mechanical system capacity requirements; and for dynamic systems, offer the ability to respond to utility load management and demand response programs.

Summary of Review Comments

Most reviewers found the project to be valuable and supportive of Building Technologies Office objectives, praising the project's efforts to help building owners control and reduce their energy use. Reviewers commended the project for (1) having a substantive technical approach that takes a holistic view of building operational design and (2) developing a system that directly controls energy consumption in buildings while also improving occupant comfort. Several reviewers praised the project's collaboration with a broad range of stakeholders; however, others suggested the team engage (1) building communities to gauge their willingness to integrate these types of systems in their properties and (2) private companies to learn more about existing commercial technologies that try to integrate these solutions, including the technologies' barriers to entry. One reviewer expressed concern that code requirements may lessen utility incentives to support these technologies. Another reviewer found many aspects of the project to be unclear, such as how integrated systems of the interoperable façade and lighting devices will be deployed and how the development of nonproprietary systems will be ensured. Reviewers did not offer many recommendations, but one suggested testing across other climate zones (initial efforts are in New York City), and another encouraged collaboration with utility incentive programs to stimulate market adoption.



Project # CBI-59: PNNL and LBNL: RCx Sensors Suitcase (CBI/ET Open Call)

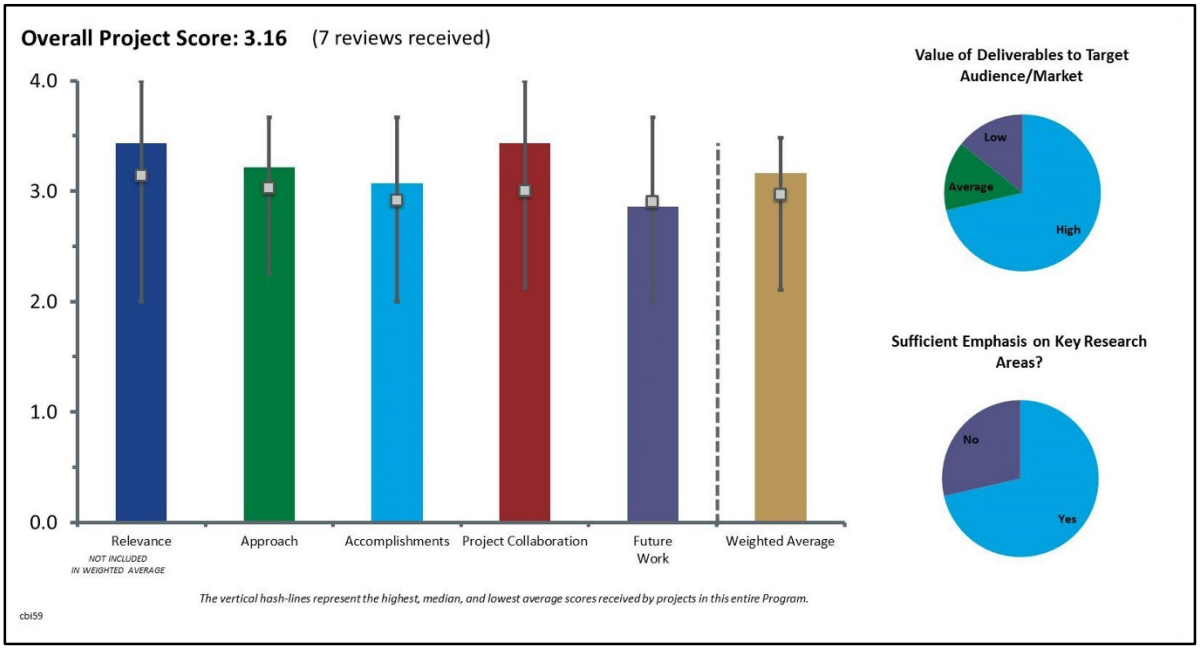
Presenters: Michael Brambley, Pacific Northwest National Laboratory, michael.brambley@pnnl.gov;
Jessica Granderson, Lawrence Berkeley National Laboratory, JGranderson@lbl.gov
DOE Manager: Amy Jiron, Amy.Jiron@ee.doe.gov, 720-339-7475

Project Description

Through laboratory–industry tech-to-market partnerships, this project addresses the technical and business planning activities needed to move the Retro-Commissioning (RCx) Sensor Suitcase technology from early prototype testing to commercial availability. The RCx Sensor Suitcase technology is a turnkey hardware/software solution that offers a degree of simplicity and automation that promotes RCx at scale in small commercial buildings. Specifically, this technology allows small-building RCx at scale by (1) enabling those without engineering expertise to identify energy-saving operational and comfort opportunities and the associated cost impacts and (2) offering commissioning providers the means to streamline existing processes and reduce costs, making it possible to expand their market to smaller buildings.

Summary of Review Comments

Reviewers generally praised the project for having an innovative approach of developing an easy-to-use, cost-effective RCx toolkit for small and medium-sized buildings, noting that it could provide an energy-saving solution for building owners/operators who have limited budgets and limited technical expertise. Specific strengths identified by reviewers include the project's (1) cleverly designed measurement system that will allow nonprofessionals to conduct the testing, (2) significant energy-saving potential, and (3) applicability to a large percentage of existing buildings. However, reviewers also questioned (1) whether the performer's background/training/quality could affect the RCx quality, (2) the lack of quantitative data demonstrating the product's impact, and (3) lack of consideration for impacts on indoor environmental quality. In addition, one reviewer noted there are more capable and potentially less expensive tools already on the market, while another reviewer expressed concern that the project team had not clearly determined who will use the product—owners or service providers. Reviewers suggested (1) demonstrating the technology in additional buildings, (2) considering different business models, and (3) developing training materials and quality control procedures.



Project # CBI-60: PNNL: VOLTTRON Commercialization (CBI/ET Open Call)

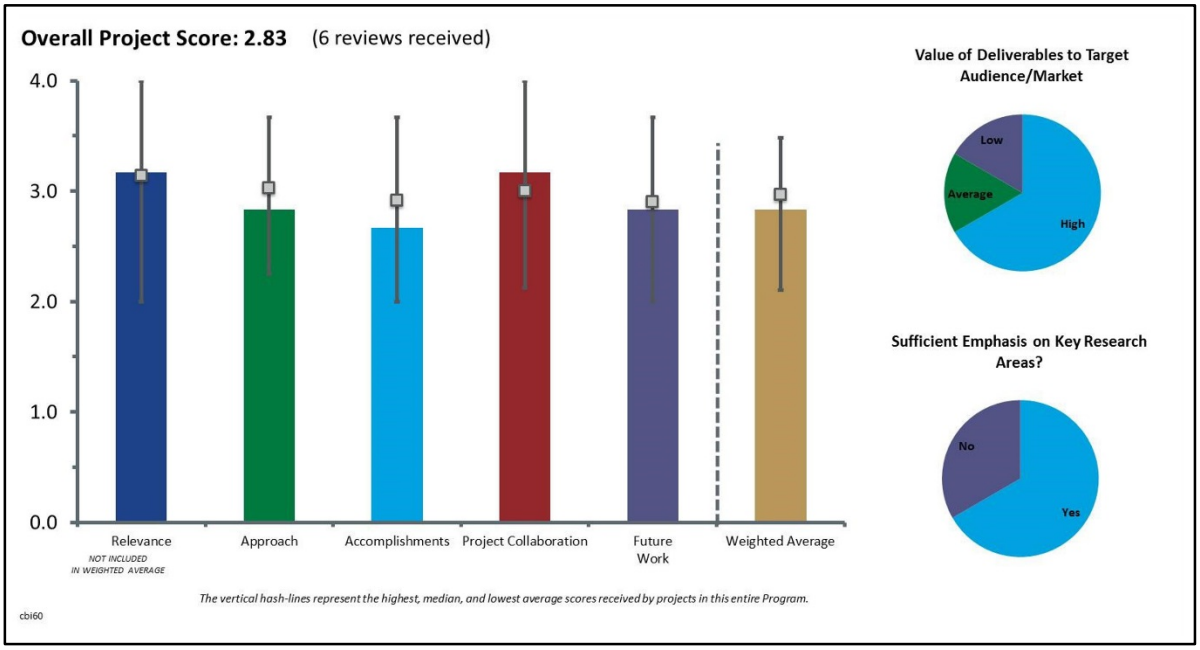
Presenter: Srinivas Katipamula, Pacific Northwest National Laboratory, Srinivas.Katipamula@pnnl.gov
DOE Manager: Marina Sofos, Marina.Sofos@EE.doe.gov, 202-586-3492

Project Description

This project aims to commercialize the VOLTTRON operating system, an agent-based strategy for autonomously controlling and coordinating large numbers of building energy assets while continually responding to real-time signals from building occupants, building operators, and external market signals (e.g., energy price changes). This highly interoperable reference platform directly supports the Building Technologies Office's transactive energy vision by creating transactive energy applications. It supports deployment of low-cost, turnkey control systems for small and medium-sized commercial buildings at scale, while also providing a cost-effective gateway for integrating commercial and residential buildings with the electricity grid. The project seeks to utilize laboratory–industry partnerships to address technical and business planning activities to move VOLTTRON from an early prototype to commercial availability.

Summary of Review Comments

Most reviewers felt this project is pursuing important work with great potential to improve services across buildings and the electrical grid, but a couple reviewers had trouble understanding what the deliverables are and how the project can benefit the target audience/market and lead to energy savings. Cited strengths—offered by a majority of reviewers, who found value in the project—include (1) the project's strong team, (2) the use of a powerful open-source platform (VOLTTRON) as the basis of the technology, and (3) the technology's use in enabling a wide range of functions relevant to utility/building communication and energy savings. Two reviewers did not see any major weaknesses, but other reviewers critiqued the project for (1) not explaining how it will address existing building management systems or entry costs for the technology, (2) having incomplete knowledge of the market, and (3) not clearly detailing the roles of the laboratory and partners in product development and collaborative plans. In addition, while reviewers noted that the project is new, one expressed concerns about its progress. Reviewers recommended (1) actively encouraging developers to create applications, (2) providing more details on the project's specific challenges and potential impact, and (3) adding more commercial partners.



Project # CBI-61: CBEI: AHU FDD in Small and Medium Sized Commercial Buildings

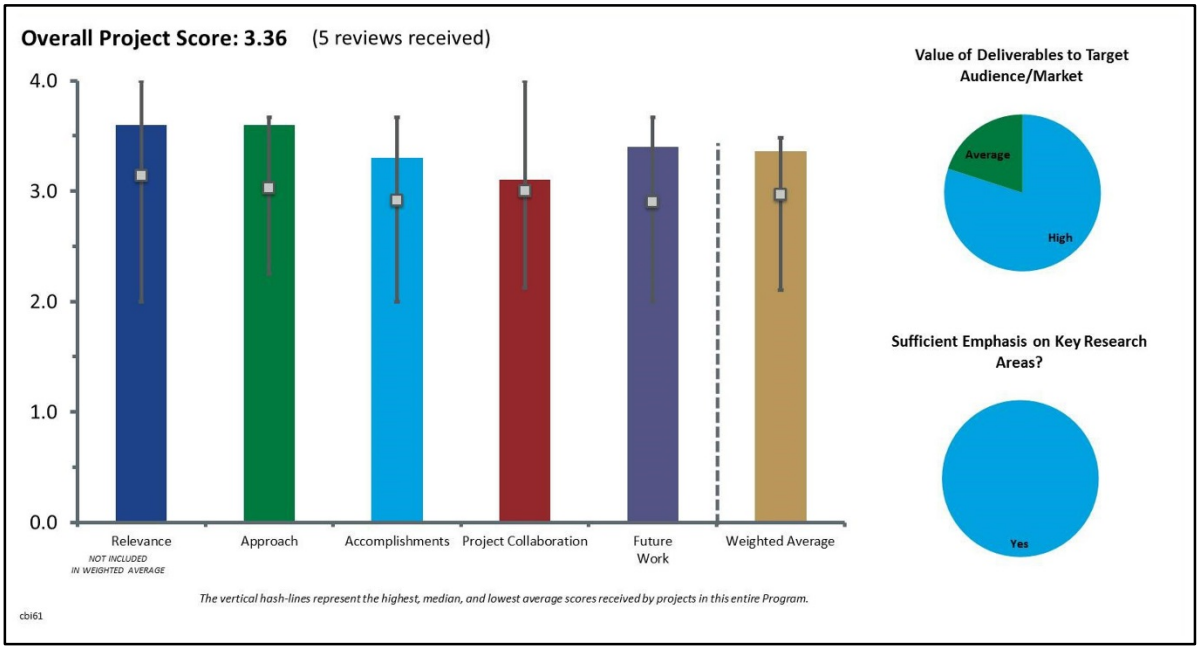
Presenter: Jin Wen, Drexel, jinwen@drexel.edu
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project is developing a suite of automated fault detection, fault diagnosis, and fault impact estimation strategies for air handling unit (AHU)–variable air volume (VAV) / constant air volume (CAV) systems that are typically used in small and medium-sized commercial buildings. These cost-effective and VOLTTRON-compatible strategies will have the potential to reduce heating, ventilation, and air conditioning (HVAC) system energy use by at least 10%–30%; have a payback period of 2–3 years; and require no additional operator training. They can be used as integrated or stand-alone software products for AHU–VAV/CAV systems.

Summary of Review Comments

Overall, reviewers found great value in the project's efforts to help end users more easily understand and detect faults in their AHU systems. The reviewers praised the project team for pursuing a low-cost "plug and play" system with wide-ranging applications for buildings with AHU systems, addressing an unmet market need, and successfully demonstrating fault diagnostics in multiple buildings. One reviewer did state that the energy-saving impact relies on the corrective actions of the end user and is thus more indirect than direct. There was consensus that the project has some effective collaborations for development, such as with Pacific Northwest National Laboratory. However, some reviewers felt that this does not extend through marketing stages, i.e., no clear industry partners, established business model, detailed technology transition plan, or training plan. There were concerns about goals that are difficult to measure, false positives, and the impact noisy sensor data could have on the fault detection algorithm; and one reviewer noted cybersecurity concerns. In addition, reviewers noted the project has targeted a payback period of 2–3 years but has not indicated how the payback will be achieved. Recommendations included resolving the weather variable if it is an issue for performance.



Project # CBI-62: CBEI: Aligning Owners and Service Providers

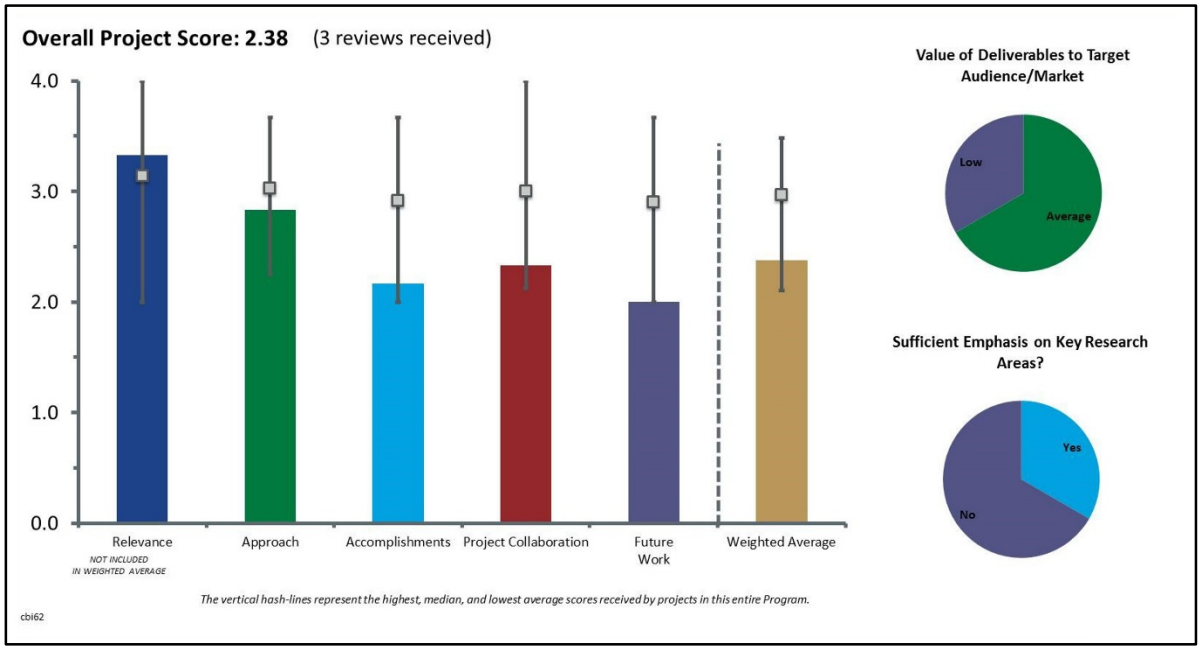
Presenter: Leslie Billhymer, University of Pennsylvania, leslieab@upenn.edu
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project seeks to leverage the Consortium for Building Energy Innovation's (CBEI's) relationships with small and medium-sized commercial building (SMSCB) owners and service providers to develop business models and guides that the market can use to implement 50% or greater energy-efficient retrofits. In addition, the project aims to provide pathways into the market for testing content so it can be developed according to advanced energy retrofit (AER) market stakeholder end uses. Specific project activities include developing (1) stakeholder engagement platforms, (2) the CBEI Commercialization Center, (3) SMSCB business models, and (4) integrated design AER roadmaps.

Summary of Review Comments

Reviewers had mixed views on many aspects of this project, including its coordination, progress, and potential market impact. One reviewer praised the project's (1) systems approach to retrofits, (2) decision to include testing of content prior to full delivery/release to the market, (3) collaborations with stakeholders from many facets of the retrofit process, (4) accomplishments in engaging multiple players within the retrofit market, and (5) potential impact. However, others expressed concern, stating that the project has not demonstrated (1) many measurable impacts or accomplishments, (2) a strong management plan for how its multiple activities fit together, or (3) success in engaging stakeholders (building owners, real estate companies, or service providers). Reviewers supported the decision to discontinue elements of the project or fold them into other projects; one reviewer remarked that the presenter did not make a compelling case for why the project should continue to receive U.S. Department of Energy funding. Recommendations shared by reviewers include (1) explaining why the project has evolved over multiple years, and (2) featuring utility incentives and financing as another module in the final stage of the project.



Project # CBI-63: CBEI: Benchmarking Analytics Tools

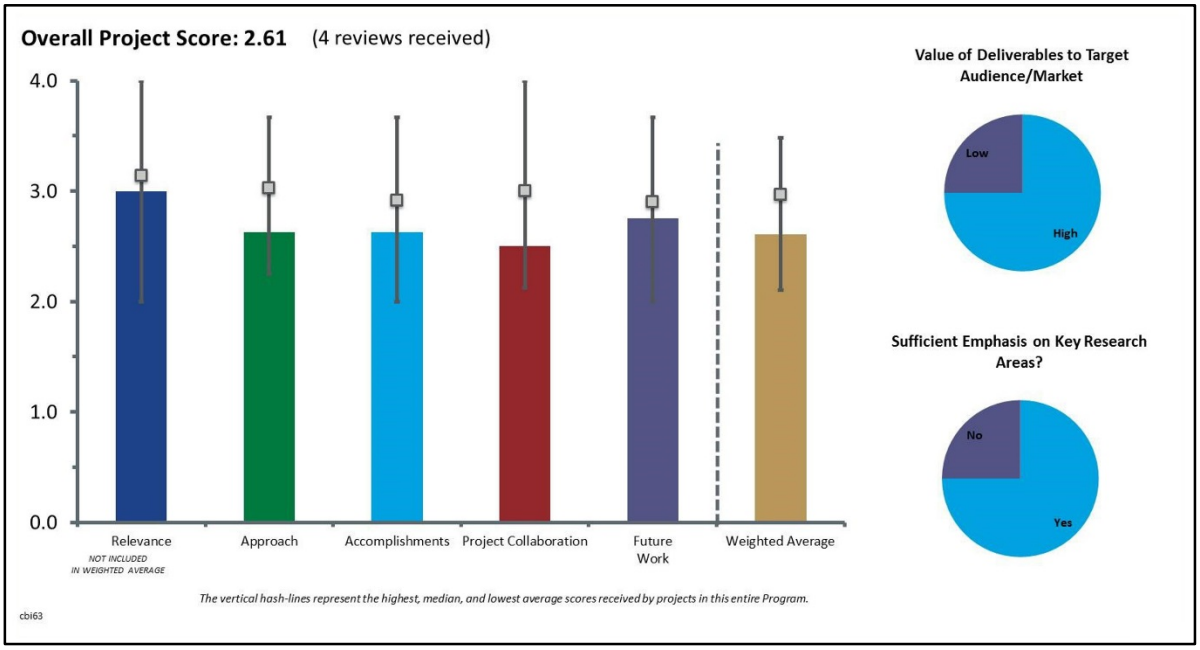
Presenter: Clinton Andrews, Rutgers University, cja1@rutgers.edu
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project seeks to make energy benchmarking data more useful and relevant for real estate market actors on the local, regional, and national scales. In doing so, the project aims to improve use of energy information in the institutional practices of different local, regional, and national real estate sectors; improve usability and dissemination of energy disclosure data; and increase energy efficiency retrofits. In addition, the project engages stakeholders to identify benchmark data use and reporting needs, and also to inform marketing approaches that encourage the use of energy benchmarking data in transactional decision making (e.g., acquisition, leasing, and disposition).

Summary of Review Comments

Reviewers shared mixed opinions on the project's potential market impact. Some reviewers praised benchmarking analytics for their value in real estate transactions and other decision-making processes; however, one reviewer questioned whether better benchmarking scores can really impact the market. Cited strengths include (1) providing data to stakeholders in a manner they can both understand and use to drive action; (2) creating standard methodologies, approaches, and report templates; and (3) conducting work that the private sector would not have time to complete. Reviewers wondered whether the project team will engage other communities or types of stakeholders, such as service providers, energy efficiency consultants, or policymakers. In addition, reviewers noted that the project team's decision to target specific building types might limit widespread adoption of the project's tools and techniques, and that the presenter did not discuss the project's results in detail. Reviewers recommended (1) engaging other stakeholders in the real estate market (e.g., service providers, energy efficiency consultants, and policymakers), (2) measuring and verifying the performance of the process and products, and (3) formulating a plan for wide-scale adoption and use of the process and products by the appropriate stakeholders.



Project # CBI-64: CBEI: Broker Training - Placing Value on Energy Retrofits

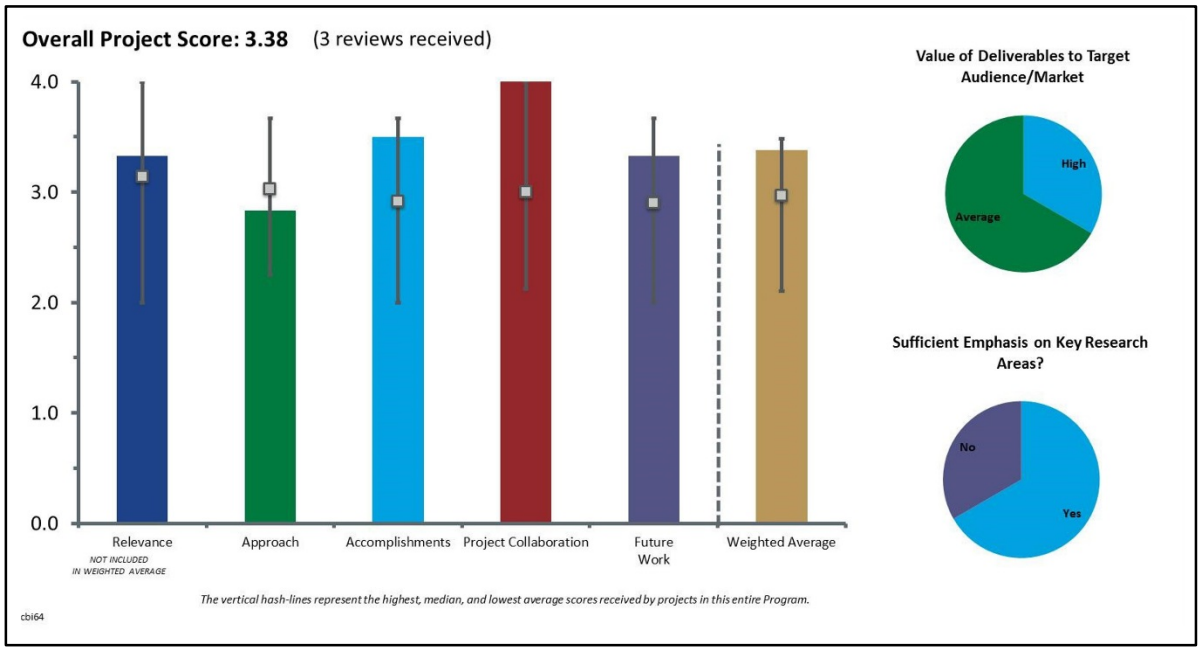
Presenter: Susan Wachter, University of Pennsylvania, wachter@wharton.upenn.edu
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project is increasing commercial real estate brokers' understanding of energy efficiency measures, allowing them to better serve both building owners and tenants. Specifically, it is creating and presenting a training course for commercial real estate agents focused on energy efficiency and the impact of benchmarking regulations. This training provides commercial brokers with a competitive advantage in terms of sustainability, energy efficiency, green credentials, and market knowledge. It also increases uptake of energy efficiency investments by helping market participants become better informed.

Summary of Review Comments

Reviewers praised the project's strong interactions with a broad spectrum of commercial real estate stakeholders; however, they were mixed on how much value it will provide to these stakeholders. One reviewer felt it will provide high value to stakeholders due to the curriculum becoming part of the continuing education requirements for brokers, while two others felt it will provide average value, noting the uncertainty about how brokers will value the project and stating the need for a method to cost-effectively scale the results to other states/regions/etc. Cited areas of strength include the project's (1) innovative approach of integrating training with broker certification and licensure, and (2) efforts to increase awareness of energy efficiency measures among broker groups. Reviewers had a variety of opinions on the certainty of the project cost-effectively scaling and deploying the training to other states—one reviewer stated that the awareness campaign will work and the effort will expand nicely throughout the country without too much difficulty, while another said the project's success depends largely on the design and execution of a deployment strategy. One reviewer felt that as an awareness project, the project has an inherent weakness of not necessarily producing actionable or measurable results outside of the area of awareness. Reviewers recommended that the project team (1) demonstrate benefits in terms of profit margin, (2) work to integrate the training material in higher-education real estate business programs and construction management programs, and (3) increase efforts to work with developers.



Project # CBI-65: CBEI: Building Retuning Training

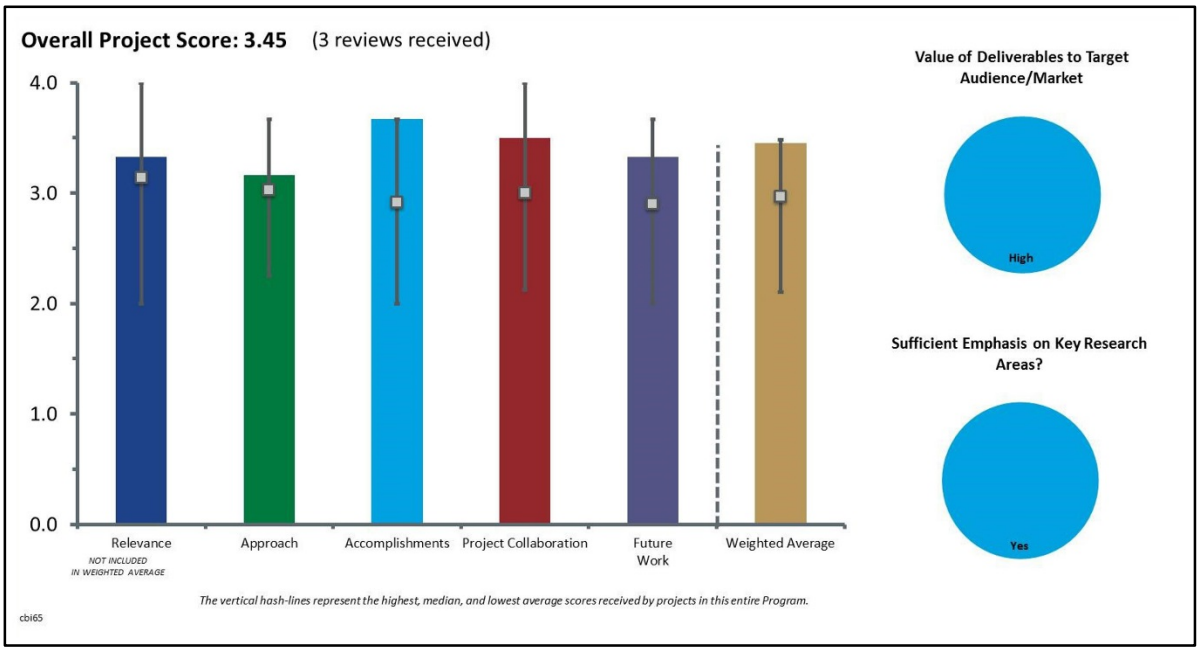
Presenter: Lisa Shulock, Pennsylvania State University, lshulock@engr.psu.edu
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project is positioning the Building Re-Tuning Training (BRT) program originally developed by Pacific Northwest National Laboratory (PNNL) to achieve widespread adoption by building operators/engineers nationwide. The BRT program is a critical tool for identifying and correcting building operational problems that lead to energy waste. This project will contribute to saving 3.7 quads of energy by (1) providing a modified/enhanced curriculum for end users and train-the-trainer audiences, (2) delivering two pilot train-the-trainer programs, (3) establishing a training distribution partnership with a national organization, and (4) developing a sustainable deployment model with a national partner.

Summary of Review Comments

According to reviewers, this project has high value and could lead to noticeable energy savings with limited upfront capital investment. Reviewers also praised the project for its (1) creative approach of using and refining PNNL's programs, (2) focus on addressing barriers (e.g., training adults, establishing the right partnerships, differentiating a "train the trainer" model that people will redeliver from straightforward training, and developing a consistent training model that can be delivered repeatedly with similar results), (3) achievements to date in developing the train-the-trainer material, and (4) potential to spur job growth. Reviewers generally felt the project has strong collaborations, but one reviewer suggested a need for more interactions with trade unions or related industry association groups. Weaknesses identified by individual reviewers include (1) a lack of clarity on how the project team will reach building operators, (2) a failure to look at the material/programs developed by the recommissioning industry, and (3) that several steps remain (e.g., the deployment of the learning management system for consistency, a three-dimensional module to replace building walkthroughs, and moving from two trainings to hundreds) that could produce unforeseen challenges. Reviewers recommended (1) the U.S. Department of Energy conduct a scaled rollout prior to full deployment to identify issues and make changes before the effort is turned over to outside organizations that may only have enough resources for deployment, and (2) the project team provide additional rounds of train-the-trainer courses.



Project # CBI-66: CBEI: Career Pathways for the Energy Retrofit Workforce

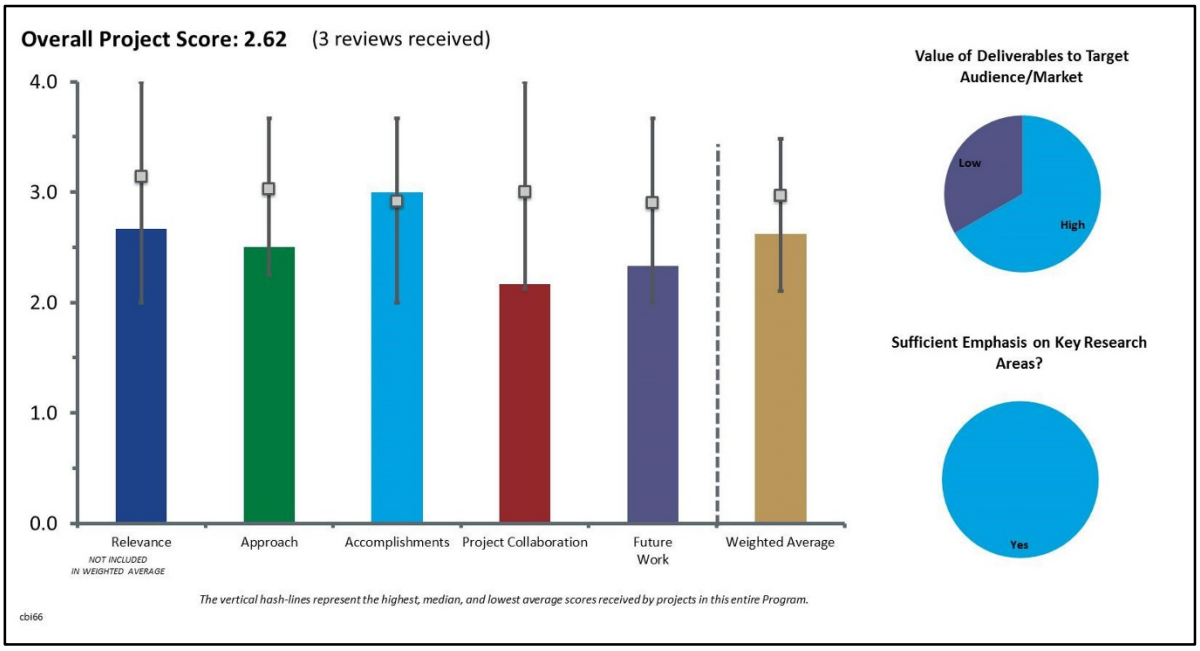
Presenter: Lisa Shulock, Pennsylvania State University, lshulock@engr.psu.edu
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project is developing career and development pathways, as well as a clear representation of the required competencies, for four advanced energy positions: energy manager, building operations professional, energy auditor, and commissioning professional. The project's outputs are aligned with the U.S. Department of Energy's recent Better Buildings Workforce Guidelines, voluntary national guidelines designed to improve the quality and consistency of commercial building workforce credentials for those four key energy-related jobs. The project will contribute to substantial improvement in workforce readiness and demand for and employment of qualified workers. The project has particular benefit for policymakers seeking to link program funding with recognized credentials, professional associations and other organizations involved in workforce development, employers seeking guidance on talent recruitment and cultivation, and job seekers seeking guidance on entry points and career advancement.

Summary of Review Comments

Reviewers expressed sharply mixed views on the value of this project. Some reviewers stated that industry will benefit from the job descriptions and competencies, and that career maps are useful tools. However, another reviewer remarked that a number of processes for certification and training already exist, and that career maps are minimally useful, at best. Cited areas of strength include the project's (1) progress toward its goals of job definition and career mapping and (2) organization and planning. Reviewers expressed concern that the project did not (1) discuss the existing certification and training programs or describe how this work differs from or improves on those programs, (2) identify many critical barriers, or (3) collaborate with several important stakeholders, including trade associations already involved with developing and implementing training and certification programs. A few reviewers also questioned the cost of the project in light of its deliverables. Individual reviewers also suggested that the project (1) connect with work being done in community colleges and a relevant National Science Foundation initiative and (2) better develop the goal of workforce development.



Project # CBI-67: CBEI: Collaborative Approaches for Integrated Energy Retrofits

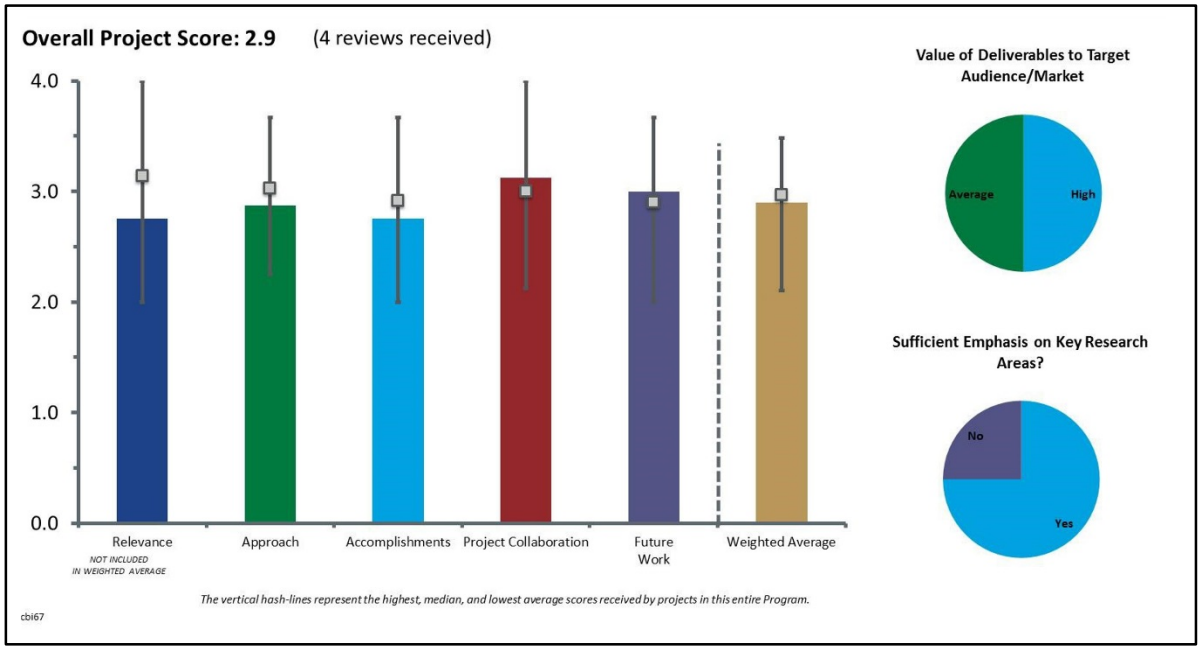
Presenter: John Messner, Pennsylvania State University, jmessner@engr.psu.edu
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project is benchmarking, evaluating, and demonstrating the use of interactive workspaces and information technology (IT) infrastructure solutions for efficiently and effectively supporting integrated design teams. Through the development of clear guidelines for creating and implementing interactive workspaces, the project aims to improve design team integration to better support design decisions that have an impact on overall building energy consumption. The demonstration leverages interactive workspace components for planning retrofits.

Summary of Review Comments

Overall, reviewers expressed hesitation about fully evaluating the project without seeing the final Interactive Workspaces Guide, which was planned for release following the peer review; however, they did share some initial feedback. They generally found the project to be aligned with Building Technologies Office objectives and commended the project team for (1) collaborating with key stakeholders and (2) identifying spaces that take advantage of interactive work environments. They had differing opinions on whether the project team identified and addressed critical barriers. While few weaknesses were identified, one reviewer felt the project should have evaluated and shared the relative value of different investments in integrated workspaces, or what the optimal investment is for different applications and different desired outcomes. In addition, some reviewers would have liked more evaluation and information on the overall performance and impact of the integrated workspace design environment. One reviewer suggested going back to the design teams with a questionnaire to determine lessons learned and measurable outcomes compared to previous design processes, although it was also noted this information might be included in the final guide. A separate recommendation was to assemble a team to test the final version of the guide.



Project # CBI-68: CBEI: Coordinating RTUs in Small and Medium Sized Commercial Buildings

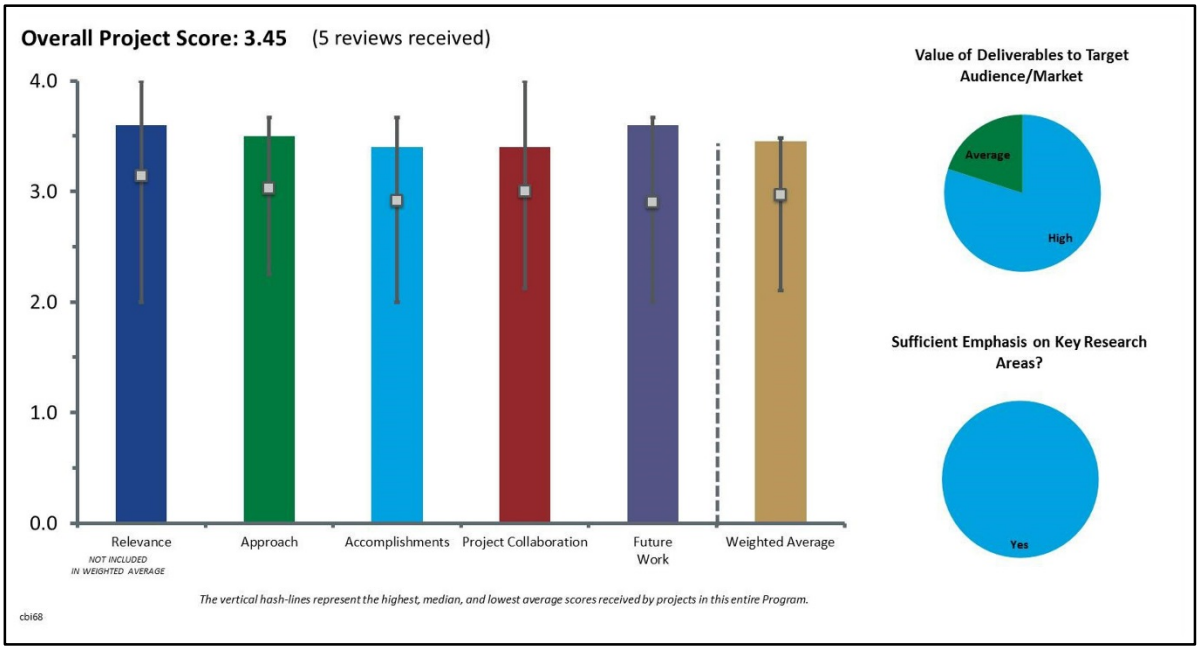
Presenter: James Braun, Purdue University, jbraun@purdue.edu
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project is developing, demonstrating, and evaluating rooftop unit (RTU) coordinator equipment for small and medium-sized commercial buildings (SMSCBs) that (1) minimizes energy consumption and peak demand, (2) does not require additional sensors, and (3) requires minimal implementation expertise. In addition, the project is further developing a simulation tool that can be used as a testbed for evaluating control approaches in open spaces served by RTUs. Currently, advanced controls for SMSCBs are rarely implemented because of poor overall economics. The advanced RTU controls produced in this project will have a variety of possible commercial applications.

Summary of Review Comments

Reviewers commended this project for addressing an important problem faced by commercial buildings and providing a solution that can lead to considerable energy savings. Cited strengths include (1) developing a low-cost solution that does not require extensive controls or implementation expertise, (2) validating energy savings and peak usage reductions, and (3) largely identifying and addressing key barriers. Reviewers wondered (1) how the technology addresses faulty sensors in RTU equipment, (2) whether the method could lead to humidity/indoor air quality issues, and (3) whether the system will include occupant comfort overrides at the thermostat. Reviewers generally supported the project's plans to demonstrate the technology in multiple building types, but one reviewer suggested that better value would be derived by placing more emphasis on developing the simulation environment. In general, reviewers encouraged the project team to continue on with its work. One reviewer suggested the overall energy-savings potential may be overstated—because the technology is not relevant for all RTU applications—and suggested refining the metrics accordingly.



Project # CBI-69: CBEI: Demonstrating On-Bill Financing to Encourage Deep Retrofits

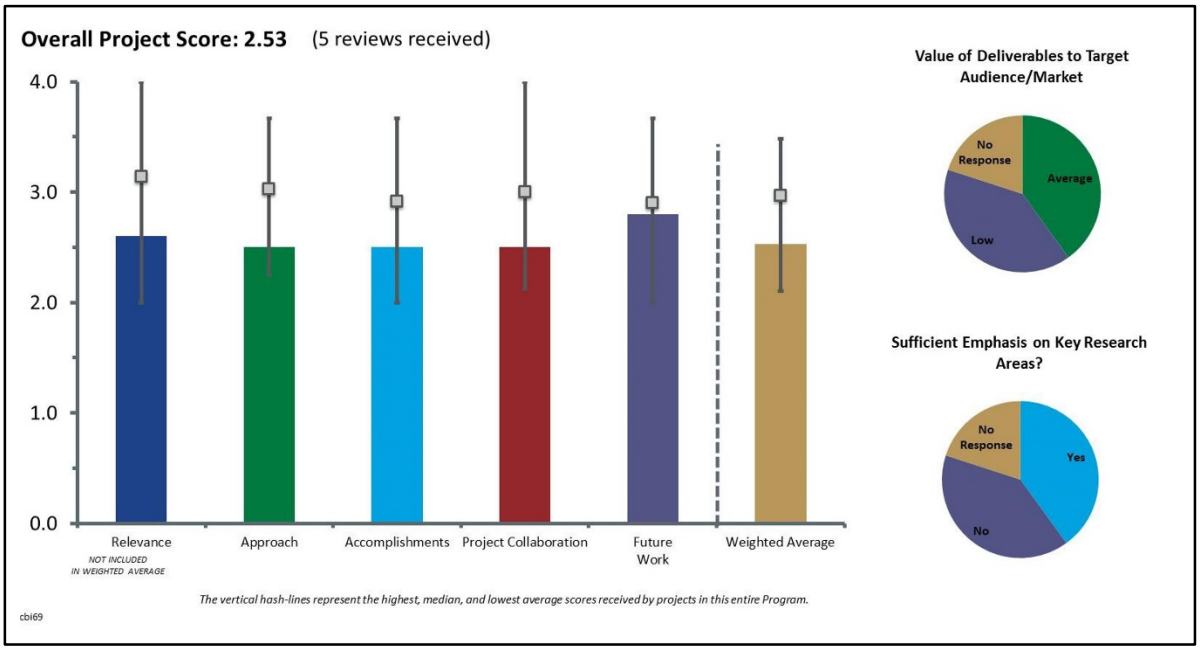
Presenter: Rudy Terry, Philadelphia Industrial Development Corp., rterry@PIDCphila.com
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project is developing a framework with national applicability for an on-bill financing (OBF) pilot program that promotes implementation of deeper energy efficiency retrofits, with payments tied to the meter to allow solutions that offer significant energy savings but tend to have longer payback periods. The project is also improving understanding of the tenant/owner perspective for deep retrofits that may exceed lease length, as well as compiling lessons learned about key drivers for adoption of an advanced retrofit and energy efficiency OBF program. This project is addressing a critical need; currently, only a few OBF programs exist for energy retrofits in commercial buildings, and they focus on simple, short payback solutions.

Summary of Review Comments

Reviewers praised the project for its efforts to develop a framework for an OBF program at The Navy Yard (TNY) that supports deep retrofits. However, they questioned the general applicability of this work, noting TNY's unique characteristics (e.g., ability to mandate actions of tenants and customers, and unique hybrid sponsor (landlord + independent, unregulated utility + bank). Reviewers commended the project for (1) providing documentation that will benefit efforts in similar jurisdictions, (2) developing a sound understanding of customers' goals regarding financing, and (3) demonstrating tenant interest. In addition to the limited national applicability, weaknesses identified by reviewers include not (1) addressing regulatory barriers to OBF, (2) requiring at least 50% energy savings, or (3) clearly indicating the value for a regulated utility. Reviewers expressed optimism in the project's ability to reach its goals, but a few reviewers questioned whether the goal of retrofitting only two buildings in fiscal year 2015 is too modest. Individual reviewers recommended (1) the project team demonstrate differences between this test site and other jurisdictions, and between financing available through property assessed clean energy (PACE) programs and OBF mechanisms, and (2) involving an energy service company to implement the project.



Project # CBI-70: CBEI: FDD for Advanced RTUs

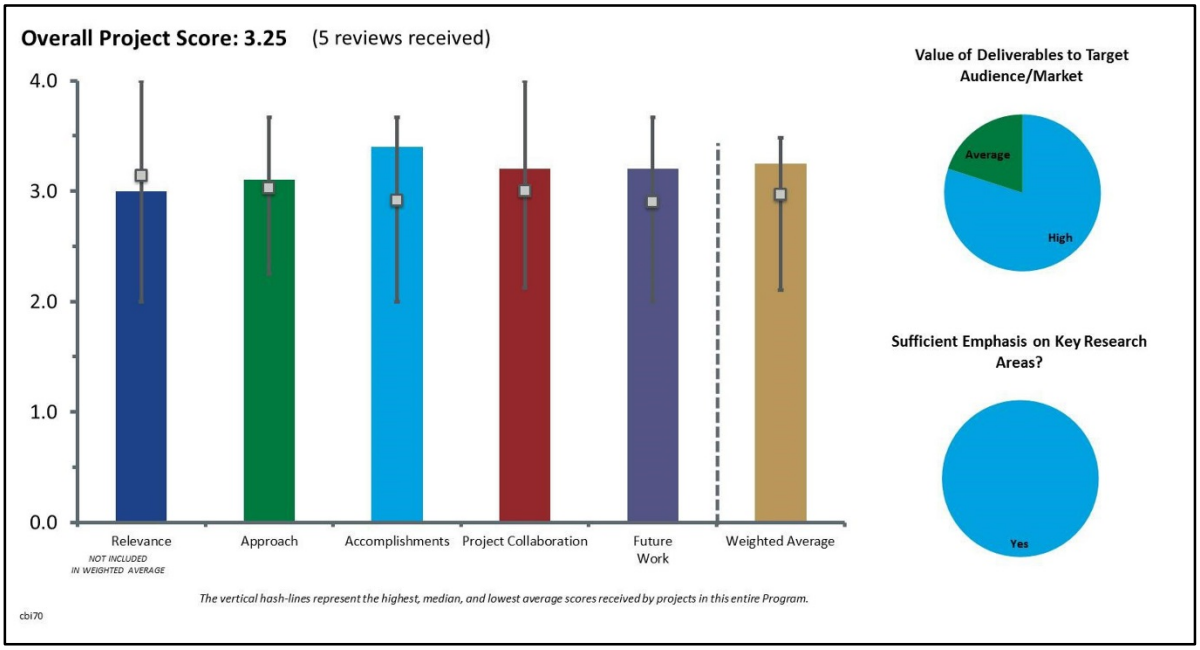
Presenter: Mikhail Gorbounov, United Technologies Research Center, gorboumb@utrc.utc.com
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project is implementing and assessing low-cost, embeddable fault detection and diagnostics (FDD) for advanced rooftop units (RTUs) that achieve a ≥90% diagnosis rate of ≥10% performance degradation, <1% false alarms, and a ≤3-year payback period. This technology targets RTU-based heating, ventilation, and air conditioning (HVAC) systems used for cooling small and medium-sized commercial buildings. Performance degradation of current RTUs due to the presence of operational faults leads to 10%–15% HVAC energy waste during the cooling season. Long term, the project seeks to facilitate widespread deployment of FDD for advanced RTUs, with potential annual HVAC energy usage reductions of 68 trillion British thermal units (TBtu).

Summary of Review Comments

Reviewers largely felt the project is developing an important energy-saving technology; however, they expressed concern that it is only applicable to "advanced" RTUs. Reviewers praised the project for (1) receiving a commitment from a national account; (2) having clear, measurable goals; (3) identifying barriers to commercialization; and (4) having a 3-year payback period. Reviewers had mixed views on the project's collaboration; they generally felt the project partners are working well together, but that more engagement of the architecture, engineering, and construction industries is needed to raise awareness about the technology. A few reviewers shared concerns about the quality of the data, but they noted field testing should resolve that issue. Other cited concerns include (1) the project's reliance on one RTU manufacturer, (2) the novelty of the approach, and (3) how noisy/incomplete data will be handled. Reviewers suggested (1) including service technicians in the evaluation of the FDD reports and (2) testing the technology in as many buildings as possible.



Project # CBI-71: CBEI: HVAC Packages for Small and Medium Sized Commercial Buildings

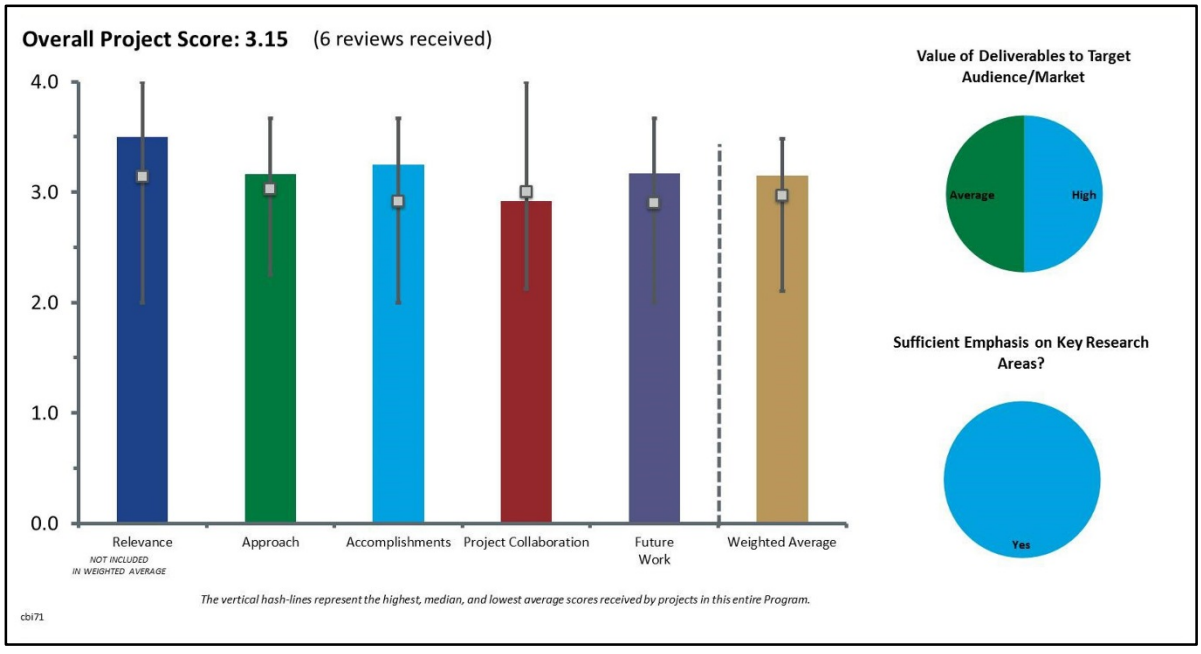
Presenter: Russell Taylor, United Technologies Research Center, taylorrd@utrc.utc.com
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project is evaluating and specifying four packaged heating, ventilation, and air conditioning (HVAC) retrofit solutions that are suitable for small and medium-sized commercial buildings (SMSCBs) in at least three different climate zones and provide 50% HVAC energy savings with a payback of less than 4 years. To accomplish these goals, the project is (1) identifying target building types and climate zones based on the Commercial Buildings Energy Consumption Survey (CBECS) database, (2) developing integrated retrofit solutions from a U.S. Department of Energy-prioritized list of technologies, and (3) analyzing the impacts of the retrofit solutions using the National Renewable Energy Laboratory's commercial building reference models.

Summary of Review Comments

Reviewers praised the project for targeting SMSCBs, characterizing them as a key market for energy efficiency retrofits. Cited strengths include the project's (1) efforts to identify retrofit packages for a variety of climates and HVAC applications; (2) development of an OpenStudio plug-in; and (3) sound approach and methodology. Reviewers generally praised the project's collaborations but suggested including entities that could help with outreach, such as those who would be directly implementing the solutions and organizations that could help share results. A few reviewers questioned the effectiveness of a webinar in disseminating results to key stakeholders and noted the importance of developing a stronger information dissemination plan. One reviewer questioned why the project selected only packaged HVAC solutions since hybrid ventilation applications may be superior in some climate zones. Reviewers recommended that the project team (1) assess the non-energy costs, benefits, and impacts incurred in the later stages of retrofit project implementation (e.g., permitting and code requirements), (2) validate the model and analysis using measured data from real buildings, (3) consider a reporting metric that reflects the possibility for improved zoning and control in some of the packages, and (4) include analysis of the overall cost-effectiveness of the packages (not just the estimated energy savings).



Project # CBI-72: CBEI: Improving Benchmarking Data Quality

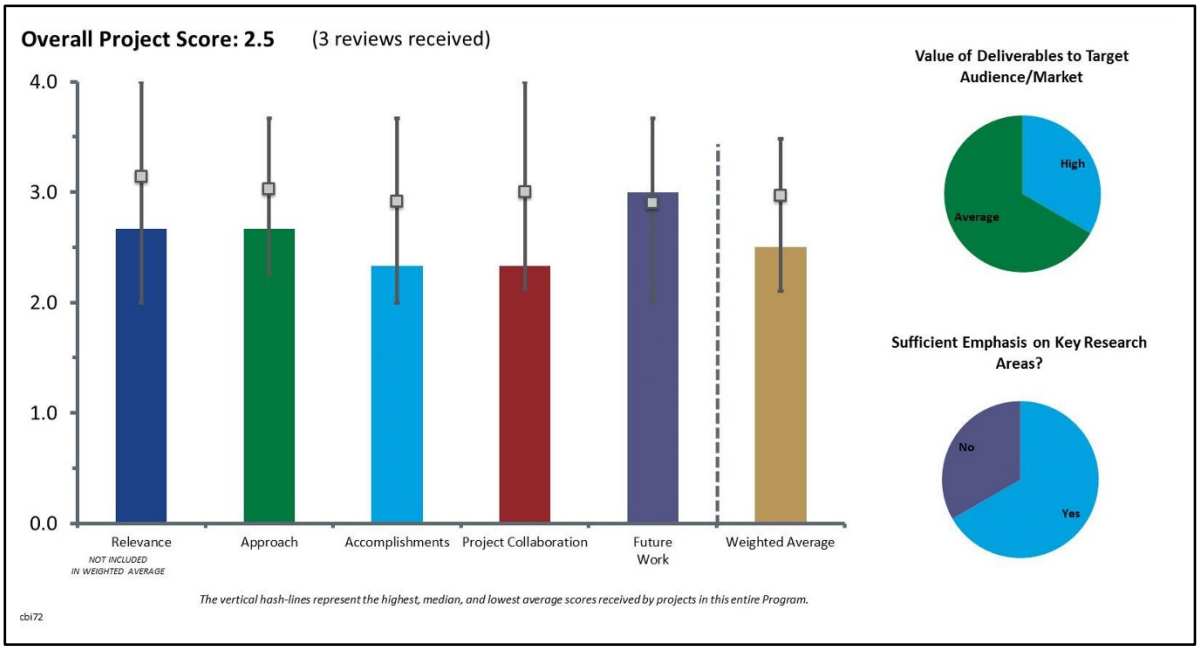
Presenter: Scott Wagner, Pennsylvania State University, swganer@engr.psu.edu
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project provides technical support to cities and other organizations that currently utilize—or plan to utilize in the near term—energy benchmarking programs as a means of improving the energy efficiency of building portfolios. The project helps these stakeholders collect and analyze the consistent, high-quality, and transparent energy performance data needed to evaluate building energy efficiency and drive energy retrofits in existing commercial buildings. Improving the quality of the data enhances the value and effectiveness of benchmarking programs, which accelerates their adoption. In addition, it allows stakeholders with energy benchmarking programs to release more useful data to the public, improving transparency.

Summary of Review Comments

Reviewers agreed that improving the quality of data in building energy benchmarking programs is a worthy goal, but they questioned whether this in itself would actually move the market to increase energy retrofits and thereby increase energy savings. The reviewers had sharply differing feedback on other aspects of the project, such as (1) how well it addresses major barriers and (2) whether its deliverables can be scaled or replicated to have national impact/applicability. Reviewers specifically cited two unaddressed barriers: (1) reducing the cost of data collection for building owners and (2) creating a compelling value proposition for reluctant benchmarking program participants (including both building owners and municipal staff). Cited strengths of the project include its recognition of the poor quality of data currently collected for benchmarking and the plan to include a benchmarking data analytics guide in the U.S. Department of Energy help desk. While one reviewer felt the project has no major weaknesses, others questioned (1) whether there are better opportunities to address data quality issues than statistical analysis, such as improving the automated billing data interface with utilities; (2) how the project's certificate program and technical assistance efforts differ from existing certification programs and technical assistance efforts; and (3) the scope of the project's collaborations. It was suggested that the project expand its collaboration with organizations outside of the Consortium for Building Energy Innovation that are actively engaged in developing and administering building energy benchmarking training programs and should incorporate learnings from the U.S. Environmental Protection Agency on the impacts and value of benchmarking scores.



Project # CBI-73: CBEI: Improving Code Compliance with Change of Occupancy Retrofits

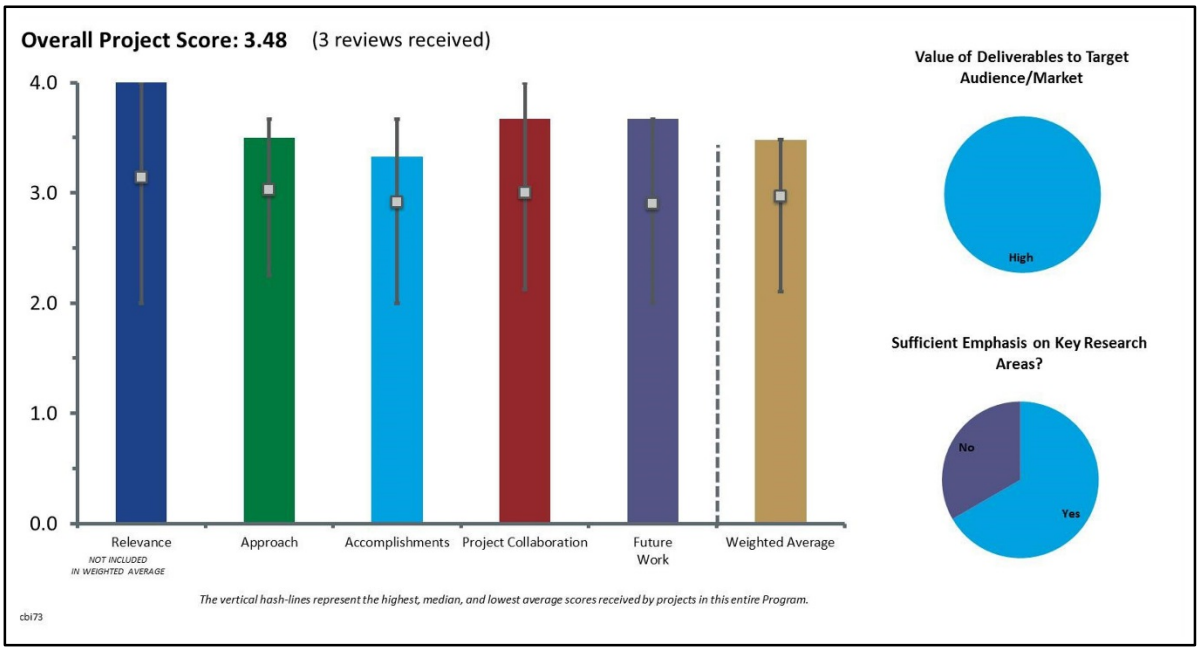
Presenter: Jennifer Senick, Rutgers University, jsenick@rci.rutgers.edu
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project is developing guidance for improved code compliance with change-of-occupancy provisions in the International Energy Conservation Code (IECC) through proof-of-concept testing. The application of the IECC to existing buildings and its relationship to the International Existing Building Code (IEBC) are not well understood by code officials. In addition, the IECC change-of-occupancy provision is hard to enforce in its current form. This project delivers stakeholder-vetted alternative change-of-occupancy compliance guidance as a test case for a code change proposal. The project is particularly important for small and medium-sized commercial buildings—they are responsible for most change-of-occupancy permits but vary in terms of their ability to cost-effectively meet current compliance guidance.

Summary of Review Comments

Reviewers found this project to be quite valuable, noting that it produces easy to understand change-of-occupancy compliance guidance with the potential for wide-scale application and impact. Reviewers commended the project for (1) focusing on the important sector of small and medium-sized commercial buildings, (2) making code enforcement and compliance in the existing building market easier for code officials, and (3) developing outputs that are well positioned for inclusion in IECC 2018. The project was also commended for including municipalities as partners, but one reviewer suggested including existing building owners and local American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) chapter(s) as well. Cited weaknesses include the project's not addressing how it will complete its measurements of long-term success (i.e., widespread adoption by jurisdictions and evidence of increased compliance) and what impacts the use of existing versus updated code would have on energy savings. Reviewers recommended getting the information into relevant codes and reference standards documents (IECC, etc.) as soon as possible.



Project # CBI-74: CBEI: Lessons Learned from Integrated Retrofits in Small and Medium Sized Commercial Buildings

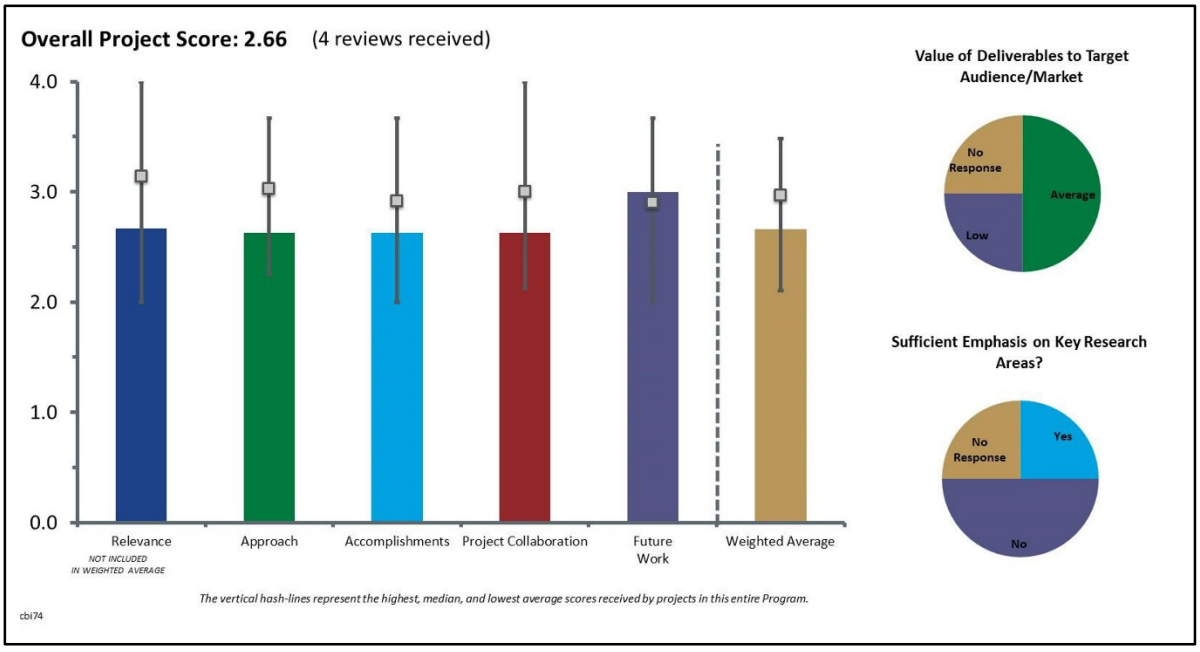
Presenter: Mark Stutman, Pennsylvania State University, mbstutman@engr.psu.edu
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project provides robust capability, in real-world testbed buildings, for pre-commercial demonstration and documentation of the performance of cost-effective, broadly applicable deep energy efficiency retrofit solutions designed for small and medium-sized commercial buildings. Testing solutions in real-world settings allows researchers to identify and overcome challenges and to develop performance data, which is critical to proving an energy efficiency retrofit solution's effectiveness to commercial partners. By providing an opportunity for solutions to be tested in real-world applications and providing real-world performance data, this project promotes the uptake of energy efficiency methods and solutions by service providers and supply chains nationwide.

Summary of Review Comments

Reviewers had mixed views on the project's overall approach and premise—some praised the potential of demonstrations to promote market acceptance, while one questioned whether providing more documentation of savings will move the market. Reviewers commended the project for (1) the nature of its collaborations with demonstration partners, which allow the researchers access to real-world testbed buildings; (2) its ability to completely follow the demonstration projects through the full retrofit life cycle while maintaining deep analysis of the results; and (3) identifying the issues of (a) contractors not adopting available advanced technologies and (b) small building owners not being able to afford the expertise of professionals who can apply integrated project design tools. Cited weaknesses include (1) insufficient vetting of projects prior to demonstration and (2) not collaborating with heating, ventilation, and air conditioning (HVAC) manufacturers or controls manufacturers. One reviewer questioned the lack of an effective plan to disseminate results to the overall marketplace, while another praised the project team for its efforts to share results. Reviewers suggested (1) adding feedback loops to ensure the project deliverables are desired by the target markets and (2) providing more formalized agreements with the building owners to ensure the systems will be maintained and functional throughout the testing.



Project # CBI-75: CBEI: Packaged Masonry Wall Retrofit Solution for Small and Medium Sized Commercial Buildings

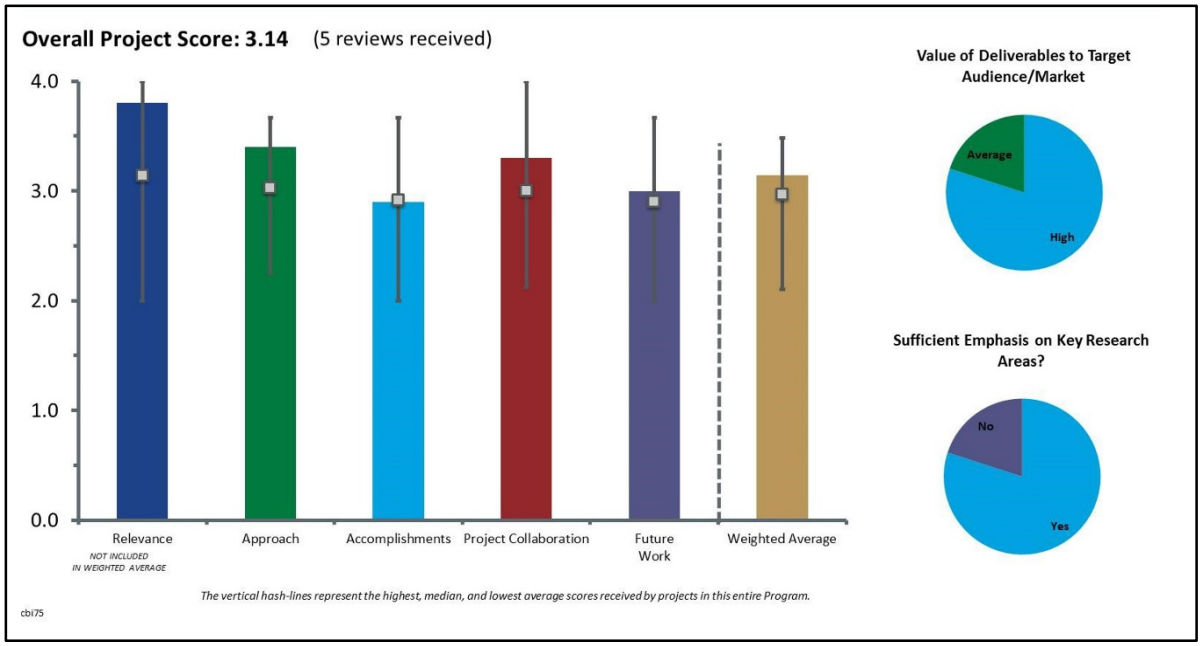
Presenter: Mugdha Mokashi, Bayer Materials, mugdha.mokashi@bayer.com
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project is developing a package of integrated wall retrofit solutions that exceeds American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1 2010 requirements and has a payback of 10–15 years, based on laboratory testing of three different package solutions. The package will be demonstrated on the Flexible Research Platform at Oak Ridge National Laboratory. The majority of old masonry constructed buildings are uninsulated and offer opportunities to achieve energy efficiency through improved envelope performance. The best practice retrofit solution identified through this project will achieve reduced air leakage, moisture management, improved durability, and good thermal performance in buildings.

Summary of Review Comments

According to reviewers, this project is developing a relevant process for enhancing the energy efficiency of existing masonry construction, which is often uninsulated and thus offers a significant opportunity for improved envelope efficiency via retrofit solutions. Reviewers praised the project for (1) considering whether proposed methods would interfere with the normal construction process and (2) having a logical dissemination plan. One reviewer commended the collaboration between government agencies, professional organizations, and industry, while another recommended adding a partner from the insulation industry. Reviewers also had mixed views on the project's future work; a few characterized it as well-thought-out and workable, while one stated that the next steps are vague. Some reviewers expressed concerns about the selection process used to determine the top-performing scenarios, noting that the project considered only cost and energy efficiency even though moisture ranks higher in the evaluation parameters and that the presentation did not clearly explain the process. Reviewers also critiqued the project for providing ill-defined metrics for success. Reviewers' recommendations included (1) conducting more laboratory tests to validate the top two retrofit scenarios and (2) addressing workforce training and quality control in retrofitting.



Project # CBI-76: CBEI: Pre-Commercial Demonstration of Cost-Effective Advanced HVAC Controls and Diagnostics for Medium-Sized Buildings

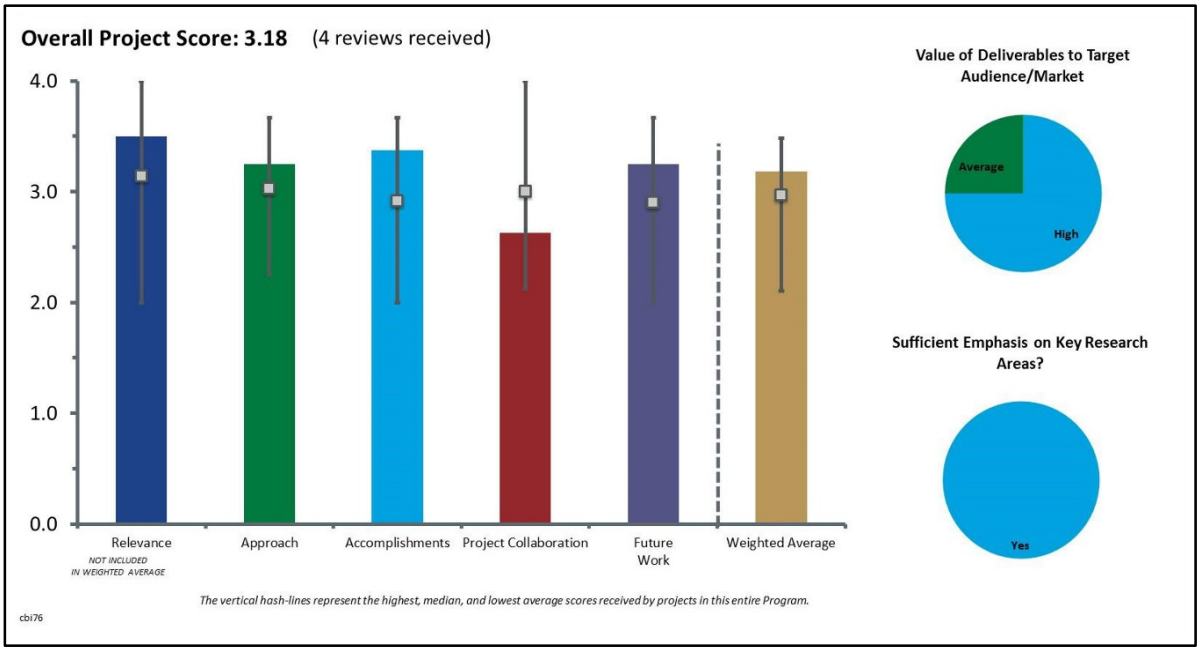
Presenter: Draguna Vrabie, United Technologies Research Center, vrabied1@utrc.utc.com
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

The goal of this project is to demonstrate the cost-effective, scalable installation of advanced heating, ventilation, and air conditioning (HVAC) controls and diagnostic solutions for medium-sized commercial buildings. The project seeks to demonstrate solutions with the potential to reduce HVAC energy use in these buildings by 15%, with a simple payback of less than 3 years. Advanced controls and diagnostics have been proven to reduce energy consumption; however, increased market adoption of these solutions will require the type of cost-effective and scalable commissioning process developed in this project to address building and HVAC system heterogeneity.

Summary of Review Comments

Reviewers praised the project for developing a low-cost system with a payback of less than 3 years, noting that it would be attractive to building owners and service suppliers. Reviewers felt that combining fault detection and diagnosis with HVAC controls to achieve energy savings is an excellent idea, but they also expressed concern that the project's lack of collaboration with industry partners would hinder its ability to achieve market adoption. Reviewers generally agreed that the project has demonstrated impressive energy savings, especially considering the project has only been active for 1 year. However, reviewers critiqued the project for only using two buildings for demonstrations and indicated that not all barriers are being addressed. Individual reviewers indicated that it was not clear how variables such as airflow and occupancy factor into the algorithm or if the considerable variation among buildings would lead to poor performance in some structures. Recommendations included (1) exploring commercialization opportunities, (2) engaging additional industry partners, (3) conducting more field tests, and (4) considering the impact on occupant comfort.



Project # CBI-77: CBEI: Stakeholder Engagement Support for the Better Buildings Energy Data Accelerator

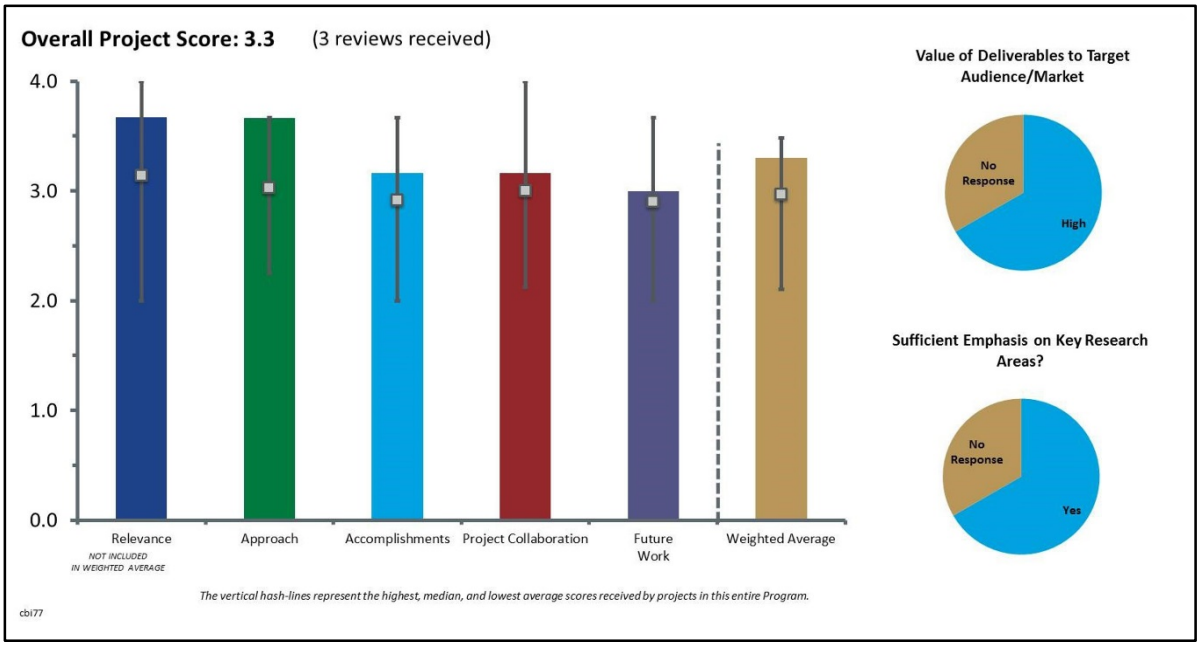
Presenter: Erica Cochran, Carnegie-Mellon University, ericadcochran@cmu.edu
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

The U.S. Department of Energy (DOE) is working to increase access to whole-building energy performance data for stakeholders participating in the Better Buildings Energy Data Accelerator (EDA) by identifying best practices and solutions, disseminating resources, and providing a platform for partner interaction. Currently, obtaining whole-building data is challenging in multi-tenant buildings, and as a result, it is difficult for building owners to achieve their energy efficiency goals. In this project, the Consortium for Building Energy Innovation (CBEI) helps participants by developing a set of written resources for partners, including a stakeholder checklist and three case studies on successful utility–city partnerships. CBEI has also conducted conference presentations, webinars, and meetings with EDA partners and other stakeholders. Thus far, 20 utility–city pairs have partnered with DOE's Accelerator and committed to providing whole-building data to at least 20% of commercial and/or multifamily building owners by the end of 2015.

Summary of Review Comments

Reviewers indicated that the project is quite valuable to Building Technologies Office objectives because increasing access to whole-building energy performance data is important for benchmarking and, consequently, market transformation. Reviewers commended the project's approach for partnering with cities, utilities, and others; demonstrating success in cities; and leading to the development of valuable deliverables, including roadmaps and three case studies. However, one reviewer expressed disappointment that only three case studies have been developed. Individual reviewers also voiced concern about the slow pace of the project and for the future of the partners-only website after the project's conclusion, which is scheduled for the end of 2015. Reviewers recommended (1) including additional stakeholders to assist utilities in the development of standards for data access and (2) conducting a second round of the EDA that involves cities and utilities that have limited access to funding or in-house expertise.



Project # CBI-78: CBEI: Transitioning Technology to the Market

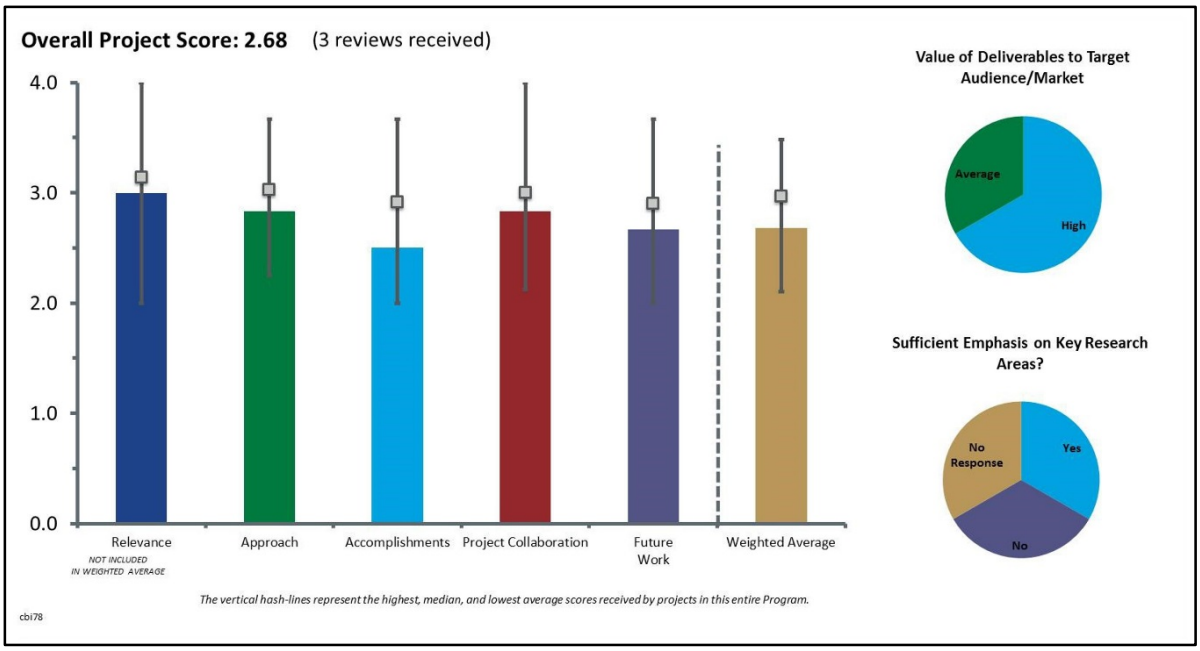
Presenter: Tim Wagner, United Technologies Research Center, wagnertc@utrc.utc.com
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

The Consortium for Building Energy Innovation (CBEI) is developing better approaches for commercializing technologies and deploying solutions to enable greater uptake of energy-efficient solutions in the market. The small and medium-sized commercial building market is highly fragmented, and project lead time often plays a significant role in the smaller overall returns typically found in the sector. To overcome these issues, the project team has engaged market partners that represent various stages throughout a technology commercialization life cycle to develop a tool to identify how incentives could be deployed to meet minimum payback periods. As a result of this effort, the project has obtained interest from 11 companies for two technologies developed by other CBEI projects.

Summary of Review Comments

According to reviewers, good progress has been made on the project to date; however, there is no clear plan for addressing future challenges and commercializing the technologies. Specific project strengths noted by reviewers include the project's extensive research to identify market-ready technologies and opportunities as well as efforts to identify potential market barriers. Reviewers identified a lack of plans for future work and a lack of measurable goals and success metrics as the main project weaknesses. Opinions varied in regards to the value of the deliverables; one reviewer indicated that the deliverables provide great summaries of compiled research data, while another stated that it is unclear what the project is delivering. Identifying additional external partners and determining a clear path forward for future implementation were recommended as ideal next steps. One reviewer also suggested that identifying a financing mechanism that enables a small company to pay for transitioning the technology to the market might help with the commercialization effort.



Project # CBI-79: CBEI: Using DOE Tools

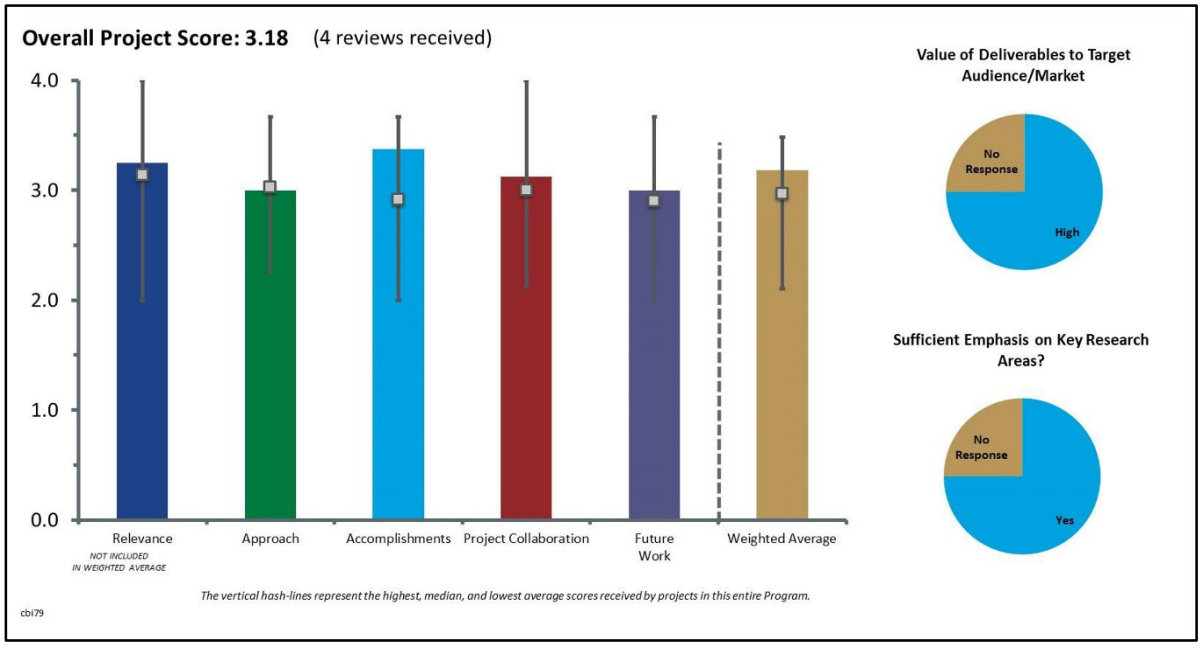
Presenter: Erica Cochran, Carnegie-Mellon University, ericadcochran@cmu.edu
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project is developing guides, collecting user feedback, and assisting with deployment to enhance market understanding and acceptance of U.S. Department of Energy (DOE) Building Technologies Office (BTO) tools and resources. The project is helping to inform potential users about BTO resources by (1) developing printed guides, webinars, and an online educational tutorial; (2) providing workshops to educate stakeholders about available DOE tools and resources; and (3) preparing two case studies to highlight the benefits of the Building Energy Asset Score(AS).

Summary of Review Comments

While the reviewers agreed the project has exceeded its stated goals, they expressed a mix of views about some aspects of the project, namely its relevance to BTO goals and the value of its approach. Most reviewers felt the project: (1) supports BTO goals by disseminating crucial information, (2) has identified the critical barrier hindering DOE tool use (user awareness and understanding), (3) is well connected to key stakeholders (including those working in the target market), and (4) produces valuable deliverables that indicate high market penetration is feasible. However, one reviewer commented that the project does not directly support BTO's goal of a 50% energy reduction because it focuses only on providing information about energy-savings opportunities and has set project goals that are too low. In addition, a reviewer stated that little mention was made of work completed on other project aspects, such as documentation/supporting materials for BuildingSync. Reviewers suggested continuing to market the DOE tools as a suite, producing more deliverables to further dissemination of AS information, and expanding the project scope to include assisting building owners who have completed the asset scoring process to achieve energy savings.



Project # CBI-80: CBEI: Virtual Refrigerant Charge Sensing and Load Metering

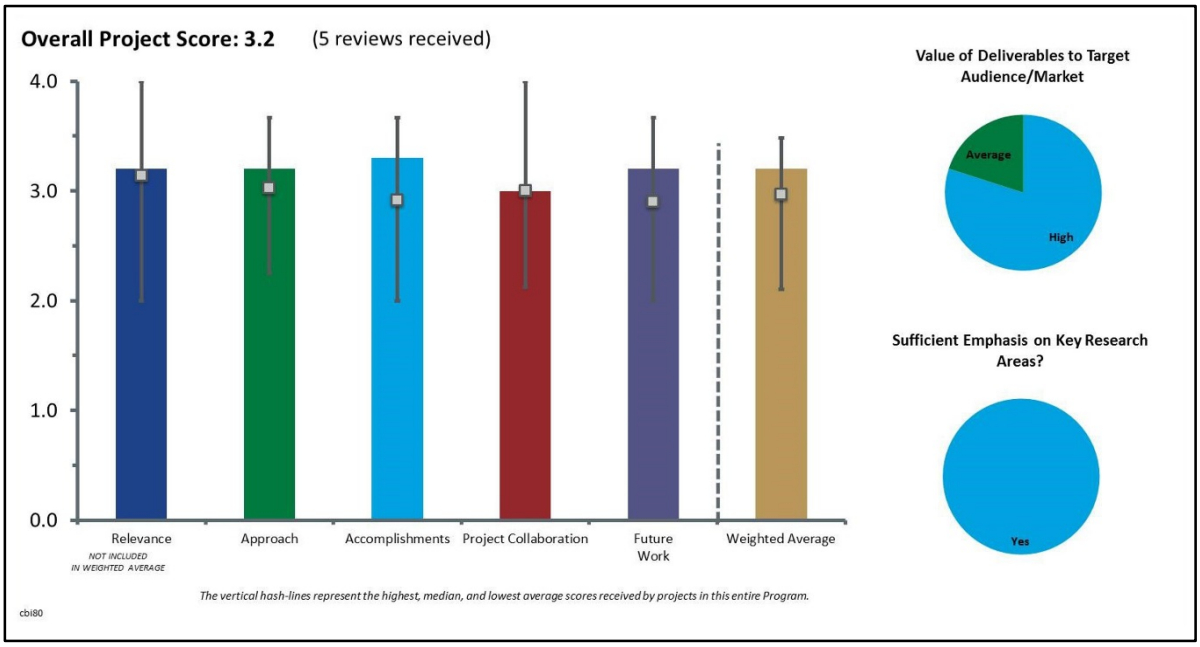
Presenter: James Braun, Purdue University, jbraun@purdue.edu
DOE Manager: Cody Taylor, cody.taylor@ee.doe.gov, 202-287-5842

Project Description

This project is developing an approach to use virtual sensors for rooftop air conditioning units (RTUs) and air handling units that will reduce costs by a factor of 10 compared to direct sensing methods, which are expensive and—consequently—not widely used. This project aims to commercialize these virtual sensors by extending their capacity to account for refrigerant charge, cooling capacity, and unit power for RTUs that have microchannel condensers, while ensuring the sensors provide accurate measurements. Virtual sensors could be brought to market as integrated sensors in manufactured products (e.g., RTUs) or as a stand-alone retrofit products for existing systems (e.g., chilled water systems). Commercial buildings use approximately 2.6 quads per year on primary cooling. Low-cost virtual sensors can enable the widespread adoption of monitoring, automated diagnostics, and advanced controls, which can reduce the energy used for cooling by 10%–20%.

Summary of Review Comments

Overall, reviewers expressed confidence regarding the future success of the project, noting that the technology has demonstrated strong results and reasonable accuracy with low-cost sensors and is focused on key research areas. Specific project strengths include (1) the identification of critical barriers (e.g., cost, sensor accuracy, operation in dynamic weather environments, and training), (2) a logical and appropriate future work plan, and (3) the potential to fulfill a market need by using inexpensive models to reduce the cost of advanced controls and diagnostics. Still, reviewers expressed concern about the technology's ability to handle missing, corrupt, or unreadable data. Concerned that the lack of a payback analysis would prevent market adoption of this technology, one reviewer strongly recommended incorporating one into the project. Another reviewer also expressed concern over a lack of measurable goals and stated that this makes it difficult to judge the success of the project. Reviewers recommended obtaining input from additional manufacturers, contractors, and building operators, as well as increasing the test environments and introducing some faults into the system.



Project # CBI-81: CBI - High Impact Technologies Review

Presenter: Amy Jiron, U.S. Department of Energy, Amy.Jiron@ee.doe.gov, 720-339-7475

Brief Summary of Project

The High Impact Technology (HIT) Catalyst was initiated by the U.S. Department of Energy's (DOE's) Commercial Buildings Integration (CBI) Program in 2014 to identify underutilized, cost-effective building technologies with large energy savings potential. The HIT Catalyst brings all of CBI's previously disparate technology-specific market transformation activities under a single strategic framework. On an annual cycle, DOE's Building Technologies Office (BTO) conducts a research, identification, and evaluation exercise to develop deployment strategies for those technologies that can make the most impact in achieving BTO's energy savings goals. These technologies are known as High Impact Technologies, or HITs. BTO researches the technology landscape for each HIT and identifies the HIT's most significant market adoption barriers. After this assessment, DOE designs a cohesive, step-by-step strategy to address particular types of barriers to full market adoption. The strategy can include a number of different deployment activities, including innovation challenges, real building demonstrations, performance specifications, application guides, and adoption campaigns.

Summary of Review Comments

General consensus was that the HIT Catalyst has carefully defined pathways and decision criteria, coupled with long-term goals and metrics. One reviewer felt that goals and metrics should be structured around technology adoption and its impact rather than proxy program hand-off elements. The market stimulation plan was, overall, considered a logical path to bring an innovative energy efficiency technology to broad market deployment, with market stimulation activities that respond to the most relevant market barriers. Although reviewers stressed the importance of keeping the program flexible (e.g., the effort for stimulation activities might vary between technologies), two reviewers were not clear about the method for weighting these activities or why some technologies take different paths from others.

It was generally agreed that the HIT Catalyst has a robust methodology for identifying and responding to critical barriers in the marketplace. However, one reviewer said there should be opportunities for course correction, especially to address new barriers. One reviewer felt that aligning challenges with adoption campaigns was "the most important thing the U.S. Department of Energy (DOE) can do" and that more resources should be devoted to challenges. Other reviewers noted that not all barriers to technology adoption are technical, identifying the need for a deeper understanding of buyers. Reviewers felt the HIT Catalyst should engage more vendors, customers, system integrators, equipment distributors, installation contractors, and utilities. It was suggested that the HIT Catalyst identify a technology's non-energy benefits and their impacts on market uptake. Similarly, reviewers stated that more stakeholders should have easy access to information, such as through the DOE website and trade shows.

The HIT Catalyst was described as offering effective and transparent opportunities for engagement with key stakeholders. Connecting DOE with similar programs (e.g., Green Proving Ground [GPG]) and the national laboratories was described as "very exciting." However, another reviewer saw greater opportunity to link HIT with more holistic solutions and align market simulation activities with other programs (e.g., GPG). Another reviewer was not clear how DOE is avoiding duplicity of efforts.

Most agreed the RCx campaign is a great first step. One reviewer felt an RCx campaign should focus on education, demonstration, and documentation. However, another felt the focus should be on conducting ongoing commissioning using a building automation system (BAS). A third said there should be a two-pronged approach: (1) RCx for smaller buildings without a BAS and (2) monitoring-based commissioning for larger buildings with a BAS. Reviewers varied as to campaign length, with some stating that three years is adequate to track quantifiable market transformation and others calling for four or five years to track the product through market adoption.

The reviewers collectively identified RCx campaign metrics to track, including square feet; number, types, and total area of buildings; energy costs/Btu per square foot, before and after, per building and per building type; operations and maintenance costs; cost of implementation and return on investment; number of control systems changed; comfort; code compliance; end-user acceptance; and persistence (year-over-year degradation).

4. Residential Buildings Integration

4.1 Program Overview

BTO's Residential Buildings Integration (RBI) Program collaborates with home builders, contractors, energy professionals, state and local governments, utilities, product manufacturers, universities, national laboratories, and other researchers to improve energy performance in new and existing homes. To identify cost-effective solutions that reduce energy consumption beyond current minimum codes (for new construction) and common practice (for home retrofits), the Program focuses on research, development, and demonstration activities, as well as innovative approaches to accelerate the adoption of energy-efficient technologies.

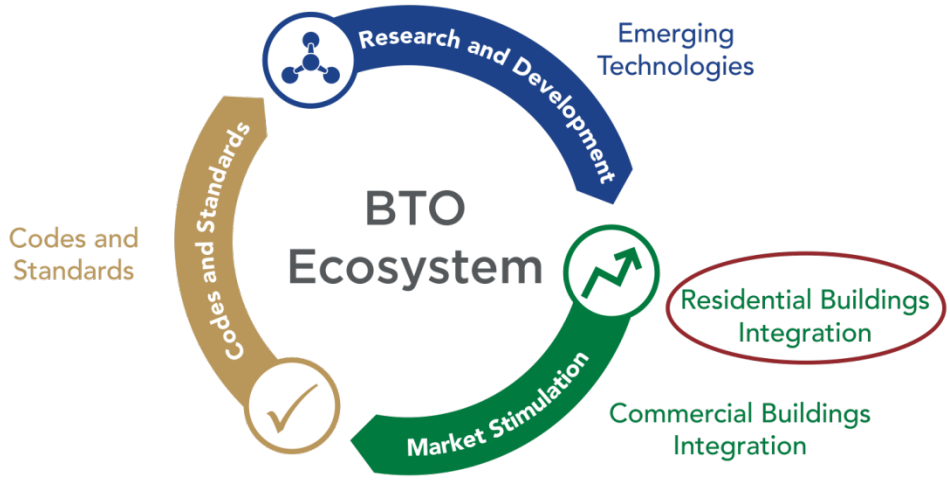


Figure 6. The role of the Residential Buildings Integration Program in the BTO Ecosystem

The Program's *mission* is to accelerate energy performance improvements in existing and new residential buildings using an integrated building systems approach to achieve peak energy performance. The Program's goal is to reduce the energy used for space conditioning and water heating in single-family homes by 40% from 2010 levels by 2025. This market outcome goal comprises two 2025 goals for the existing and new homes market:

- A 35% energy use intensity (EUI) reduction in the heating, cooling, and water heating end uses in existing single-family homes.
- Cost-effective design and construction of new single-family homes that will consume 50% less energy per square foot for heating, cooling, and water heating relative to typical homes in 2010.

The Program achieves these goals through the following strategies:

- Demonstrate and integrate cost-effective, energy-efficient technologies and practices in representative homes, which significantly reduce EUI and optimize home performance.
- Prove energy-savings solutions in new and existing buildings with market partners that can greatly reduce the EUI of homes through demonstrating the market viability of energy efficiency and service models that stakeholders can use to engage customers.
- Accelerate market-wide adoption of energy-saving solutions and the resulting benefits by addressing market barriers and expanding a skilled workforce to successfully increase energy efficiency in homes.

To track its progress toward achieving these goals, the Program analyzes and evaluates the impacts of Program-funded activities on building energy codes and standards and on the residential buildings market.

4.2 Summary of Peer Review Feedback

Project # RBI-19: NREL: Energy Efficiency Potential Mapping (Analysis & Tools for Building America and Industry)

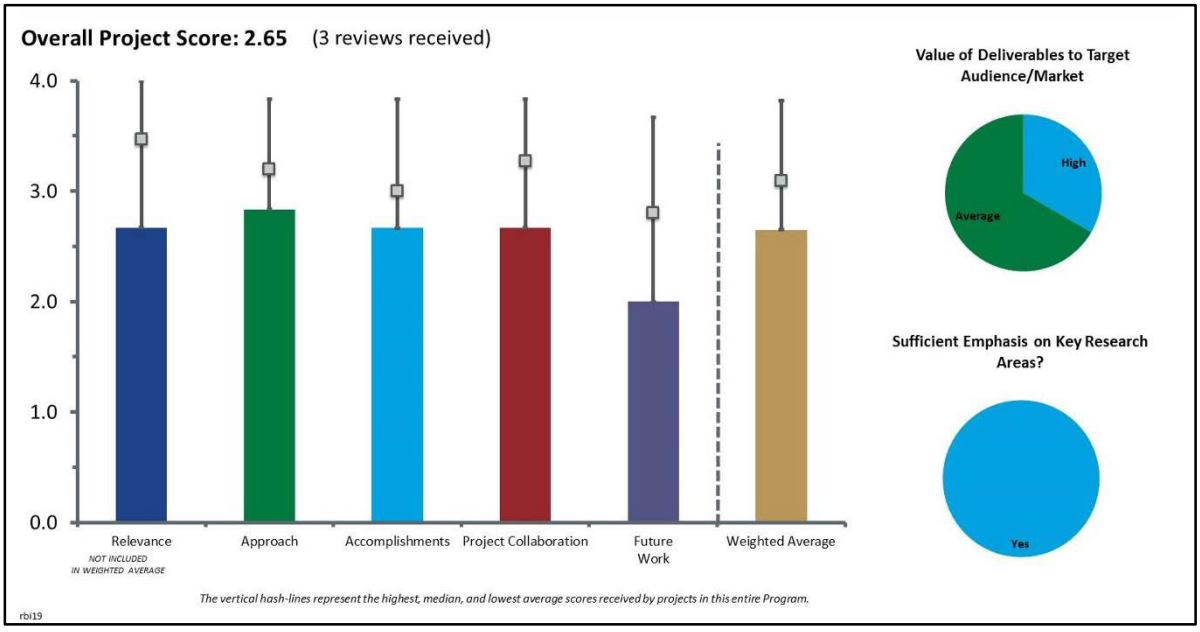
Presenter: Scott Horowitz, National Renewable Energy Laboratory, scott.horowitz@nrel.gov
DOE Manager: Eric Werling, eric.werling@ee.doe.gov, 202-586-0410

Project Description

This project seeks to produce actionable national-scale analysis and visualizations that assess the technical and economic potential of residential energy efficiency technologies by using high-resolution data on building characteristics and weather as well as building energy simulations. Researchers and the market need these tools and foundational analysis to cost-effectively research, develop, and deploy energy efficiency solutions in new and existing homes, including estimating the potential impact of specific energy efficiency technologies or in particular areas, states, or regions. National-scale analysis can estimate technical and economic impact, for a given home energy upgrade scenario, across a diverse range of baseline conditions that have an impact on energy savings. The project provides benefits for a range of stakeholders, including Building America teams, homebuilders, home performance practitioners, manufacturers, utilities, researchers, and local/state governments.

Summary of Review Comments

Reviewers did not achieve consensus about the potential energy savings impact of the project or its utility in helping stakeholders determine the value of energy efficiency measures. One reviewer felt the project provides a tremendous amount of data and visual information that policymakers can apply to particular situations (e.g., climate, house types) to determine the effectiveness of efficiency measures. Others questioned whether users would have confidence in the accuracy of the results, and to what degree the results would actually be used by those building and selling homes. Reviewers suggested a stronger focus on presenting local, state and regional results, citing a higher likelihood of implementation by policymakers, code officials, and others at this level. Two reviewers praised the project for being technically strong and statistically sound, and for coupling analysis that includes numerous performance simulations with improved visualization. Regarding the proposed future work, reviewers felt the project should focus more on verifying the accuracy of results and on developing ways to increase implementation of the results. Two reviewers also questioned whether the current and potential impacts of the project justify the planned future activities and budget. Reviewers suggested (1) including state-by-state policies in the analysis, (2) incorporating estimates of the effectiveness of particular energy efficiency measures, (3) expanding the list of participants to entities in a better position to initiate or benefit from energy efficiency measures (i.e., state governments, Consortium for Energy Efficiency, code officials, and the American Council for an Energy-Efficient Economy), and (4) incorporating OpenStudio and Home Performance Extensible Markup Language (HPXML) to make the tool more usable by others.



Project # RBI-20: NREL: Building America Technical Quality Management

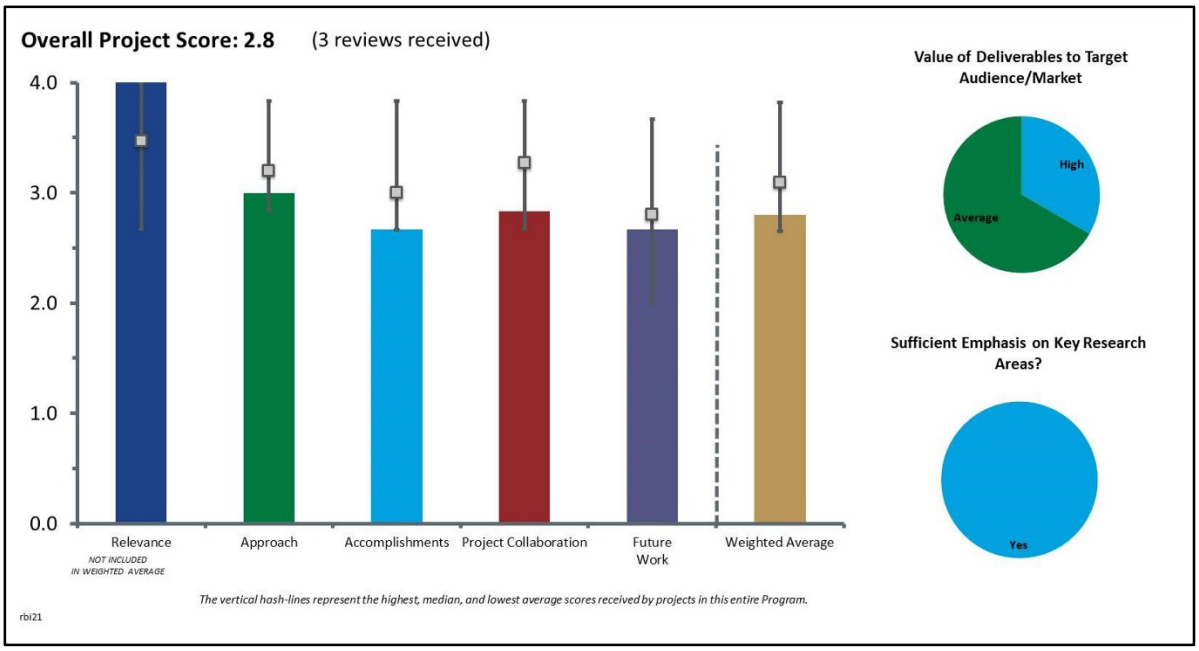
Presenter: Stacey Rothgeb, National Renewable Energy Laboratory, stacey.rothgeb@nrel.gov
DOE Manager: Eric Werling, eric.werling@ee.doe.gov, 202-586-0410

Project Description

This project integrates technical planning and management between Building America teams and other related systems integration research at the National Renewable Energy Laboratory (NREL), Residential Buildings Integration projects at other DOE national laboratories, and the Building Technologies Office at large. The primary focus of this project is to support Building America teams by ensuring the credibility of their research results, improving the market transformation impact of their work, and enhancing overall Building America program effectiveness. Specific activities include supporting the DOE in managing programs and projects, field test support, peer review and publication management, funding opportunity announcement support, communications and outreach, and assistance to the DOE Race to Zero Student Design Competition. The output of NREL's Technical Quality Management of the Building America Teams is a well-coordinated research product portfolio that addresses the most pressing technical gaps and barriers while effectively utilizing federal funding. Building America research products include market-proven innovations documented through technical reports, best practice guidelines, case studies, and content for the Building America Solution Center. Successful Building America projects lead to voluntary changes in practices among the nation's leading builders, ultimately resulting in broad market adoption of Building America innovations.

Summary of Review Comments

This project's management support role in Building America was seen as a necessity for this "flagship" residential program, as are the project's outreach efforts and its role in technology transfer. The project received high marks for providing quality control and for its well-coordinated collaborations, which integrate all Building America teams/researchers and set up arrangements with industry partners to ensure technology transfer. Reviewers noted that, as the project is semi-managerial in nature, it is difficult to determine tangible objectives or quantifiable results. Nonetheless, most reviewers felt that metrics such as the number of peer-reviewed reports, report downloads, and website hits indicate fruitful activity, although one reviewer suggested that changes in Residential Energy Consumption Survey data or shifts in Home Energy Rating System scores would be better indications of market penetration. One reviewer questioned how much stringency is used in deciding whether Building America projects continue. Suggestions from individual reviewers include (1) assisting the Race to Zero in finding partners that could help build contestant designs; (2) developing a matrix of specifications by climate zone that can be used to determine when the goal for each of the three core technical challenges has been reached in each climate zone; and (3) changing the project name to better convey the importance of outreach and stakeholder engagement.



Project # RBI-21: ORNL: HVAC Lab Research

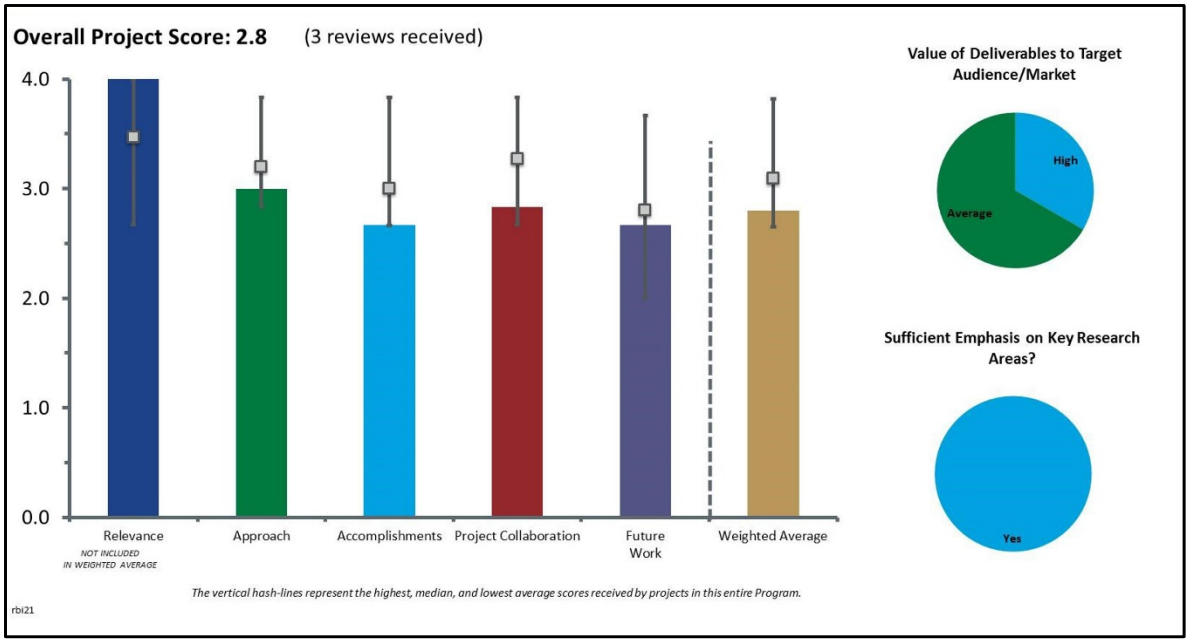
Presenter: Jeffrey Munk, Oak Ridge National Laboratory, munkjd@ornl.gov
DOE Manager: Eric Werling, eric.werling@ee.doe.gov, 202-586-0410

Project Description

This project seeks to reduce building energy use by making heating, ventilating, and air conditioning (HVAC) services more efficient. The project has three major focus areas in support of this goal: (1) advanced HVAC/water heater product development and market facilitation, (2) international collaborative research and development, and (3) detailed evaluation of the ground source heat pump demonstrations funded by the American Recovery and Reinvestment Act of 2009.

Summary of Review Comments

Reviewers largely agreed that the project is relevant to Building Technologies Office objectives and has made good progress on a key challenge for heat pumps by generating data for sizing guidance of variable-speed heat pumps (VSHPs). Two reviewers felt that doing the work necessary to change Manual S (the Air Conditioning Contractors of America [ACCA] guidance document for selecting and sizing residential heating and cooling equipment) is a good objective and that using experimental efforts combined with modeling is a sound approach. However, reviewers were confused about the decision to use a test house with two interacting variable speed units, which would complicate determination of the performance curves. Collaborations were described as sufficient, although one reviewer thought the sizing guidance issue could be addressed more widely, moving beyond just VSHPs, and another noted that ACCA's engagement—critical to project success—was assumed by the reviewers rather than stated by the presenter. Accomplishments (changes to Manual S) were seen as significant for a small project, although reviewers indicated that more work is needed to determine why there are some mismatches between experimental and modeled data. One reviewer suggested comparing performance with a two-speed heat pump and potentially a single-speed one. Another reviewer noted that the U.S. Department of Energy and others may already have test results (e.g., from seasonal energy efficiency ratio test procedures) that could provide relevant information, suggesting that the project could assess these results. However, the project is complete, so no future work is planned.



Project # RBI-22: BSC: Building America, Building Science Consortium, Unvented Roofs—Air Permeable Insulation

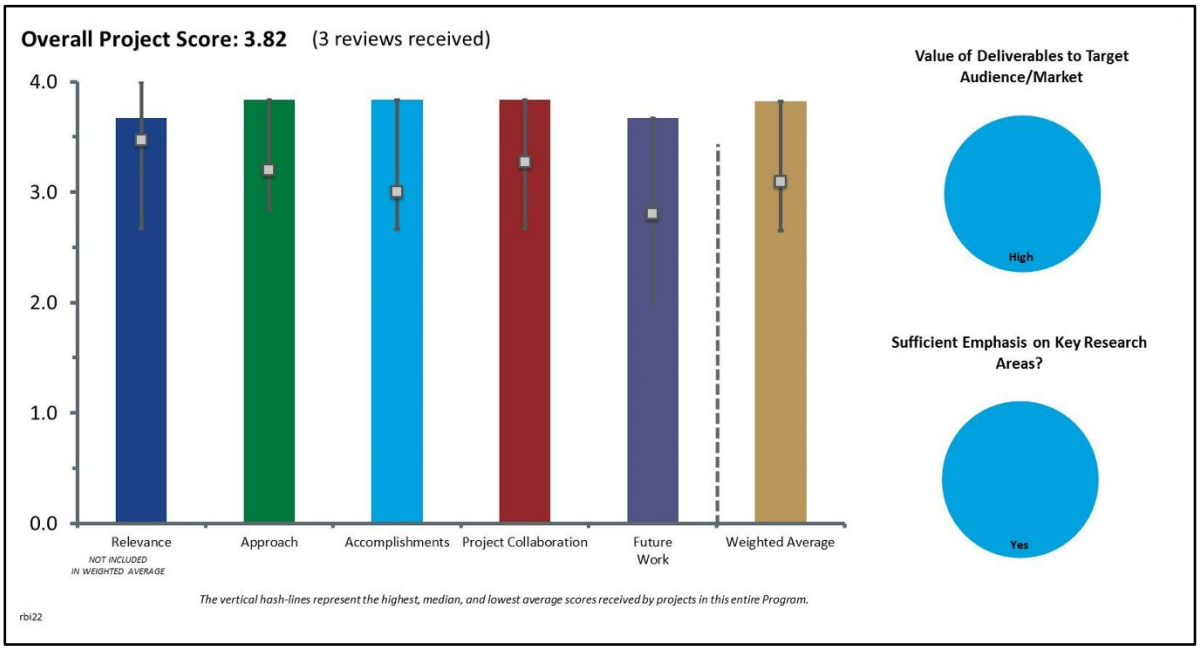
Presenter: Joe Lstiburek, Building Science Corp., joe@buildingscience.com
DOE Manager: Eric Werling, eric.werling@ee.doe.gov, 202-586-0410

Project Description

This project seeks to develop methods of constructing unvented conditioned attics using air permeable insulation materials such as fiberglass and cellulose. These methods can be used in both new house construction and in the weatherization of existing houses. Among current options, spray polyurethane foam is expensive and involves environmental concerns, and dense pack cellulose is risky in the weatherization of existing house rafter assemblies. The solutions developed by this project can reduce the construction of unvented roofs by more than 50% and allow the use of dense pack cellulose in retrofit applications without risk. The private sector is prepared to take these solutions to market immediately.

Summary of Review Comments

Reviewers praised virtually every aspect of this project, noting that it offers clear recommendations and a low-cost solution for constructing unvented attics with air permeable insulation that builders would embrace. They characterized the project as being sharply focused and fast paced, noting that the research was completed in just one year. They also highlighted the project's usefulness in both retrofitting existing homes and creating more efficient new manufactured homes. In addition, one reviewer praised the researcher for his extensive knowledge of moisture migration in buildings and his keen observation skills. Reviewers expressed concern that even though the research to support a code change has been completed and the follow-up code change proposal has been submitted, implementing a code change might still take several years, partly because manufacturers of spray foam might try to delay code approval because this technique would cut into their market. Individual reviewers recommended (1) documenting the researcher's approach and encouraging others to replicate it, (2) monitoring the installations to gather more data on the effectiveness of the solution, and (3) asking the Building Energy Codes Program to assist in achieving a code change supported by this research.



Project # RBI-23: ARIES: Building America, High Performance Factory Built Housing

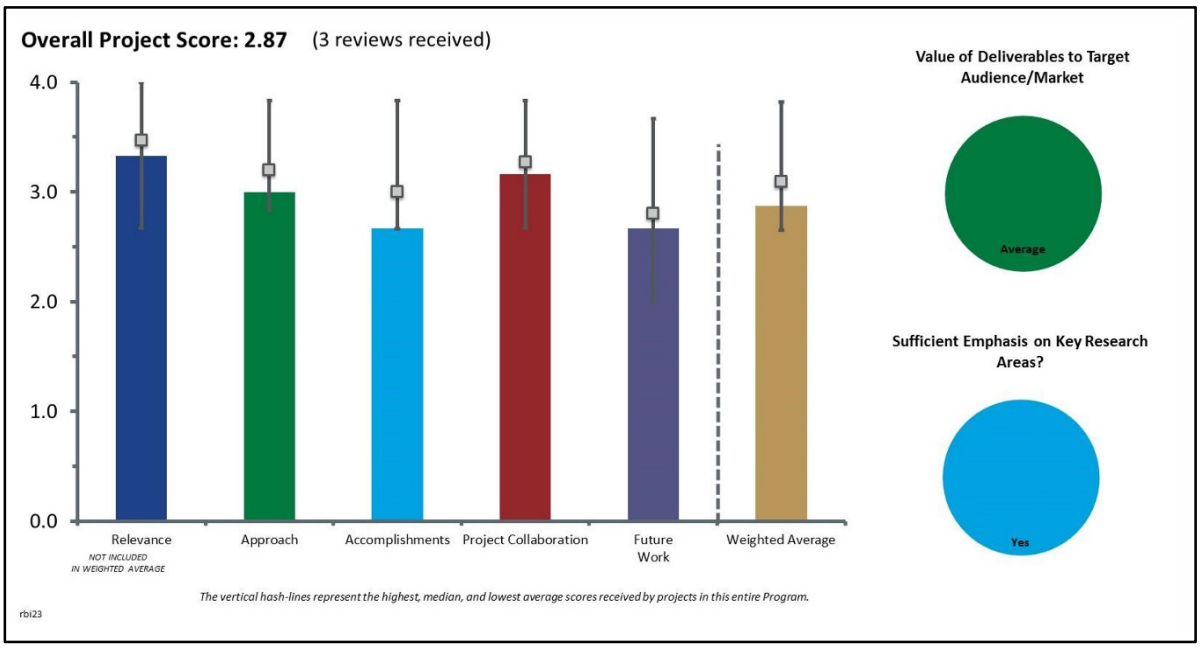
Presenter: Jordan Dentz, Levy Partnership, jdentz@levypartnership.com
DOE Manager: Eric Werling, eric.werling@ee.doe.gov, 202-586-0410

Project Description

This project's goal is to provide manufactured home builders with high-performance, cost-effective alternative envelope designs as a comprehensive solution for reaching net zero energy use. The project is (1) developing and testing technologies to reduce new manufactured home energy use by 50%, (2) collaborating with manufacturers that build more than 80% of new manufactured homes, and (3) participating in the ongoing manufactured home standards development process. In addition to developing and demonstrating solutions, the project will generate clear guidelines for manufacturing plants and installers.

Summary of Review Comments

Reviewers indicated the project addresses an important sector of the housing industry—manufactured housing—but they had differing views on the project's level of accomplishments and pace of progress. Some reviewers noted the project has (1) yielded a number of specific recommendations for improving the envelope, (2) developed three houses to serve as valuable testbeds, and (3) produced impressive outputs in various publication formats. However, another reviewer expressed disappointment that it took the project 5 years to produce test results from the three testbeds. Reviewers generally praised the project for having a solid team of collaborators and noted the strong industry participation, although one reviewer felt the team appears to lack members with good heating, ventilation, and air conditioning (HVAC) engineering skills and practical field experience. Regarding the planned future work, one reviewer found it to be meritorious and achievable but questioned whether the emphasis on air flow and the use of CONTAM/TRNSYS, a building energy analysis tool, might be too sophisticated for this project. Another was skeptical that the proposed work to solve HVAC problems in the testbeds (CONTAM/TRNSYS analysis and use of transfer fans) will be helpful. Reviewers recommended the project team review related Building America work (e.g., research conducted in project RBI-22: BSC: Building America, Building Science Consortium, Unvented Roofs—Air Permeable Insulation) and past efforts documented in the Building America Solution Center on this topic, noting that the successes and failures of past projects might be enlightening. Individual reviewers also recommended addressing (1) the issue of the venting of water vapor in unvented attics that use dense packed fiber insulation, and (2) the U.S. Department of Energy's (DOE's) statutory role in this area more directly (e.g., by providing technical support for performance levels that might be offered under DOE's statutory authority).



5. Building Energy Codes

5.1 Program Overview

BTO's Building Energy Codes Program supports efforts to increase the energy efficiency of buildings by improving model codes and standards. Building energy codes and standards are designed to set minimum efficiency requirements for new and renovated buildings that reduce energy use and emissions over the life of the building. The Building Energy Codes Program, together with the Appliance and Equipment Standards Program, leads BTO efforts to "lock in the savings" of building efficiency technologies through regulatory activities (see Figure 7).

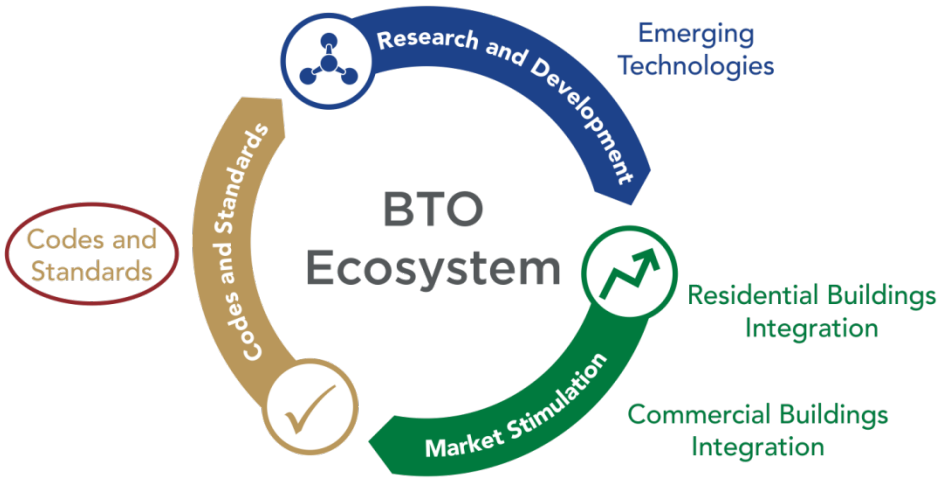


Figure 7. The role of the Building Energy Codes Program in the BTO Ecosystem

The Program's *mission* is to support building energy codes and standards development, adoption, implementation, and enforcement processes to achieve the maximum practicable, cost-effective improvements in energy efficiency, while providing safe, healthy buildings for occupants.

The Program's goal is to see that by 2025, typical design and construction practices lead to new buildings that use 40% less energy per square foot than comparable buildings built in 2010.

The Program achieves this goal through the following strategies:

- Participate in industry processes through which energy codes are developed, discussed, or approved and provide information of benefit to others in advancing energy codes.
- Establish the Program in a leadership position by convening forums for discussing and sharing information on all aspects of codes.
- Empower those who seek to improve energy codes by providing research, analysis, tools, and resources; developing code change proposals; establishing the value of energy codes to all stakeholders; and ensuring coordination with other building codes.
- Ensure intended energy savings by supporting education and outreach activities aimed at increasing energy savings and developing methodologies to measure changes in code-related energy use.

To track its progress toward achieving this goal, the Program monitors state- and local-level building energy code adoption and compliance efforts.

5.2 Summary of Peer Review Feedback

Project # COD-05: PNNL: Codes Portfolio

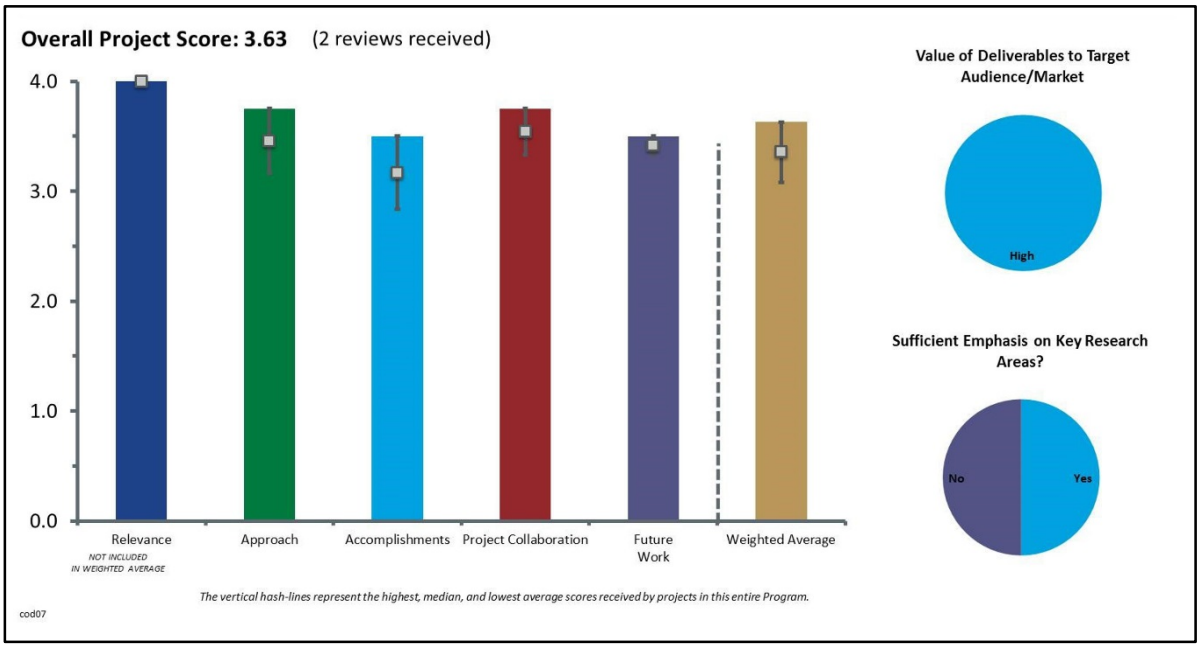
Presenter: Bing Liu, Pacific Northwest National Laboratory, bing.liu@pnnl.gov
DOE Manager: David Cohan, david.cohan@ee.doe.gov, 202-287-1983

Project Description

The mission of the U.S. Department of Energy (DOE) Codes and Standards Program is to support energy efficiency in buildings through national model codes and standards, and to provide technical assistance to states and localities as they implement energy codes. The Program supports code and standard development, adoption, and compliance efforts by providing regulatory, technical, and program planning and evaluation assistance to stakeholders. By 2020, the Program seeks to achieve annual primary energy savings of 1.3 quads and cumulative savings of 11.6 quads since its inception in 1992.

Summary of Review Comments

According to reviewers, this project is successfully pursuing and supporting essential efforts to reduce energy consumption in U.S. buildings through support of the Building Energy Codes Program (BECP). Reviewers agreed on the importance of creating, disseminating, and promoting cost-effective building codes, commending the project for its high value to the target audience and for its demonstrated achievements in driving energy savings throughout the country. The reviewers also praised the project's integration and collaboration, but one reviewer noted that additional letters of support from other organizations might be valuable. A reviewer wondered whether removing legacy codes from the RES*check*/COM*check* software would encourage cities/states to upgrade or "graduate" to the newer versions. In addition, a reviewer wondered whether the use of RES*check*/COM*check* gives code officials too much assistance during reviews and prevents them from needing to closely review new construction projects' compliance. One reviewer recommended that the project team and DOE communicate the benefits of BECP to designers, owners, Congress, and the general public, including going beyond statistics and telling stories related to quality of life. This reviewer also recommended that the project receive additional funding.



Project # COD-13: DOE Codes Program Overview

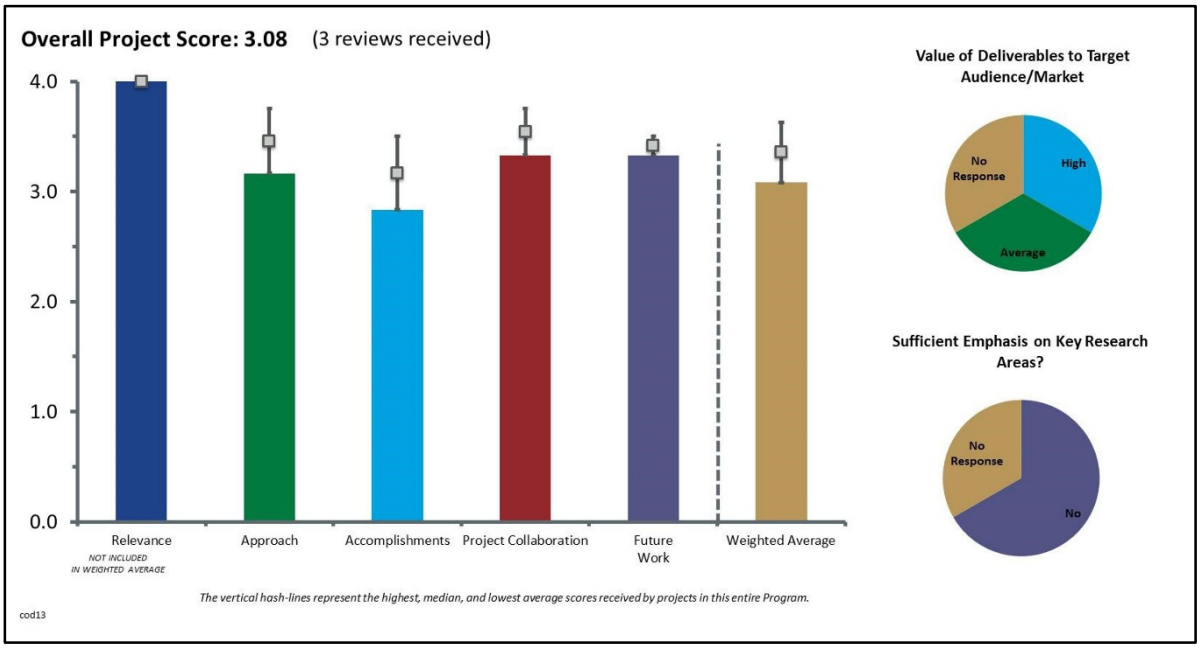
Presenter: David Cohan, U.S. Department of Energy, david.cohan@ee.doe.gov

Project Description

The U.S. Department of Energy (DOE) is explicitly directed by statute to participate in all phases of building energy codes. The DOE Building Energy Codes Program (BECP) spearheads these efforts and drives energy savings by working with codes and standards organizations to increase building energy code stringency and compliance rates. Specifically, BECP supports building energy code and standard development, adoption, implementation, and enforcement processes to achieve the maximum practicable, cost-effective improvements in energy efficiency while providing safe, healthy buildings for occupants. BECP's long-term goal, through enhanced building energy codes, is to achieve cumulative energy savings of 14 quads, reduce energy bills by $125 billion, and avoid 1 billion metric tons of carbon emissions by 2030.

Summary of Review Comments

Reviewers indicated that this program is highly relevant to Building Technologies Office goals, and stressed that increased funding is necessary to meet congressionally mandated requirements. One reviewer called building code-related efforts "fundamental to reducing energy consumption, driving innovation, and reaching true sustainability in the built environment." The approach was generally considered good—reviewers found the proposed tools and training very promising—although one reviewer would like to see more aggressive movement toward integrating those tools into automated building information modeling tool integration and interoperability. The collaborations were called excellent, but one reviewer suggested bringing additional resources/team members aboard to speed progress and increases the program's responsiveness to changing conditions. One reviewer felt strongly that some of the budget should be put toward code adoption through outreach, not relying on statistics but instead implementing aggressive marketing using success stories from states that stay current on building energy codes. The same reviewer recommended developing training and promotional materials with a "TED Talk" quality, as well as shorter training segments (3 to 5 minutes) on very specific portions of the codes.



Appendix A: Final List of Reviewers

Adams, Coleman
Hitachi Consulting

Adifon, Leandre
Ingersoll Rand

Alvarado, Jorge
Texas A&M University

Balbach, Chris
Performance Systems Development of New York, LLC

Barooah, Prabir
University of Florida

Blissard, Laureen
Green Builder Coalition

Chang, Chih-hung (Alex)
Oregon State University

Chiu, Wilson
University of Connecticut

Cioc, Sorin
The University of Toledo

Coulter, Jonathan
Advanced Energy

Cremaschi, Lorenzo
Oklahoma State University

Duren, Steve
The Adhesive and Sealant Council

Elling, Jennifer
Xcel Energy

Ellis, Michael
Virginia Polytechnic Institute and State University

Elzarka, Hazem
University of Cincinnati

Fehrenbach, Dan
Elevate Energy

Gayeski, Nick
KGS Buildings LLC

Ge, Hua
Concordia University

Gerner, Frank
University of Cincinnati

Gilligan, Donald
National Association of Energy Service Companies

Gu, Lixing
University of Central Florida, Florida Solar Energy Center

Healy, William
National Institute of Standards and Technology

Hinge, Adam
Sustainable Energy Partnerships

Horsey, Mary
ESource

Hostler, Steve
Echogen Power Systems

Inanici, Mehlika
University of Washington

Jungclaus, Matt
Rocky Mountain Institute

Kim, Jong-Jin
University of Michigan

Kismohr, Steve
Midwest Energy Efficiency Alliance (MEEA)

Knight, Dennis
Whole Building Systems, LLC

Kumar, Ashok
U.S. Army Engineer Research and Development Center

Larson, Samara
LincHousing

Lee, Hohyun
Santa Clara University

Lilya, Dustin
DC Engineering

Lord, John
Loudoun County Public Schools

Majersik, Cliff
Institute for Market Transformation

Marston, Annie
Baumann

McCurdy, Rick
McCurdy and Associates LLC

Novoselac, Atila
The University of Texas at Austin

Orosz, Michael
Information Systems Institute

Passe, Ulrike
Iowa State University

Penafiel, Karen
Buidling Owners and Managers Association International

Petze, John
Sky Foundry

Pollock, Ed
Pollock Etc, LLC

Powell, Kevin
U.S. General Services Administration

Radermacher, K. Reinhard
University of Maryland

Rainey, Teresa
Skidmore, Owings & Merrill LLP

Sailor, David
Portland State University

Sherif, S. A.
University of Florida

Smyth, Ed
DNV KEMA Energy & Sustainability

Spencer, Michael G.
Cornell University

Syal, Matt
Michigan State University

Talbott, John
Consultant

Treado, Stephen
Pennsylvania State University

Vowles, Mira
Bonneville Power Administration

Watson, Tom
Daikin Applied

Wen, Jin
Drexel University

Williams, Scott
Williams Building Systems Engineering PC

Zhai, John
University of Colorado at Boulder

Appendix B: Project Evaluation Forms

Main Project Evaluation Form

This evaluation form was used by reviewers to provide project ratings and comments for the majority of projects (i.e., for all projects but the High Impact Technology Catalyst Program) during the 2015 Building Technologies Office Peer Review.

Evaluation Criteria: Building Technologies Office (BTO) Program Peer Review 2015

A. Relevance (Stand Alone Metric)—Degree to which the project supports BTO goals and objectives.

1 – Poor: Project provides little or no support to BTO objectives.
2 – Fair: Project provides some support to BTO objectives.
3 – Good: Most project aspects align with BTO objectives.
4 – Outstanding: Project is critical to the BTO and fully supports BTO objectives.

- ☐ Poor
- ☐ Fair
- ☐ Good
- ☐ Outstanding

Comments on Relevance:

B. Approach (30%):

1. Degree to which the project is focused on the critical barriers. **(15%)**

1 – Poor: Project has identified few, if any relevant barriers.
2 – Fair: Project has identified some of the relevant barriers; no critical barriers identified.
3 – Good: Most of the critical barriers are identified, but a few relevant barriers were omitted.
4 – Outstanding: All critical barriers are identified; difficult to identify missed barriers.

- ☐ Poor
- ☐ Fair
- ☐ Good
- ☐ Outstanding

2. Degree to which the project's design addresses the barriers identified. **(15%)**

1 – Poor: Project is unlikely to contribute to overcoming the barriers.
2 – Fair: Has significant weaknesses; but may have some impact on overcoming barriers.
3 – Good: Generally effective but could be improved; contributes to overcoming most barriers.
4 – Outstanding: Sharply focused on overcoming critical barriers; difficult to improve the project approach.

- ☐ Poor
- ☐ Fair
- ☐ Good
- ☐ Outstanding

Comments on Approach:

C. Accomplishments/Progress/Impact (40%):

1. Degree to which the project ***has*** made progress towards achieving the stated ***project*** goals. **(20%)** (Note: New projects should be scored in relation to the length of time the project has been active.)

1 – Poor: Little or no demonstrated progress towards project goals.
2 – Fair: Modest progress toward meeting project goals.
3 – Good: Significant demonstrated progress toward project goals.
4 – Outstanding: Excellent, measurable progress toward project goals.

- ☐ Poor
- ☐ Fair
- ☐ Good
- ☐ Outstanding

2. Degree to which the project ***will*** significantly contribute to the achievement of its ***program's*** goal. **(20%)**

1 – Poor: Weak evidence presented, contribution to program's goal is unlikely.
2 – Fair: Some evidence presented, contribution to program's goal will likely be small.
3 – Good: Substantial evidence presented, meaningful contribution to program's goal is likely.
4 – Outstanding: Strong evidence presented, transformative contribution to program's goal is likely.

- ☐ Poor
- ☐ Fair
- ☐ Good
- ☐ Outstanding

Comments on Accomplishments/Progress/Impact:

D. Project Integration and Collaborations (20%):

1. Degree to which the presenter has demonstrated an understanding of the key stakeholders necessary to accelerate movement of technologies or practices into the market. **(10%)**

1 – Poor: The presenter has demonstrated a rudimentary familiarity with the key stakeholders, many stakeholders were omitted.
2 – Fair: The presenter has demonstrated a basic understanding of the key stakeholders, a few stakeholders were omitted.
3 – Good: The presenter has demonstrated a deep understanding of the key stakeholders, no key stakeholders were omitted from the presentation.
4 – Outstanding: The presenter has demonstrated an exceptional level of understanding of the key stakeholders, no key stakeholders were omitted from the presentation.

- ☐ Poor
- ☐ Fair
- ☐ Good
- ☐ Outstanding

2. Degree to which the project staff collaborates or coordinates with industry or other relevant stakeholders. **(10%)**

1 – Poor: Most work is done at the sponsoring organization with little outside collaboration or coordination.
2 – Fair: Collaboration and coordination exist, but could be significantly improved.
3 – Good: Good collaboration exists; partners are fairly well coordinated.
4 – Outstanding: Close, appropriate collaboration with industry and/or other institutions; partners are full participants and are well coordinated.

- ☐ Poor
- ☐ Fair
- ☐ Good
- ☐ Outstanding

Comments on Project Integration and Collaborations:

E. Proposed Future Work (10%)—Degree to which the project has effectively planned its future in a logical manner by incorporating appropriate decision points, considering impediments to its goals, and, when sensible, mitigating risk by providing alternate pathways. (Note: Ending projects will not be evaluated on this criterion; leave blank if project is ending.)

1 – Poor: Current plans are unrelated to past work, have little likelihood of eliminating barriers or meeting project or BTO objectives.
2 – Fair: Plans build on past work and may lead to improvements, but need better focus on overcoming barriers; many risks are not addressed in future plans that threaten the achievement of project or BTO objectives.
3 – Good: Plans build on past progress and focus on overcoming barriers, some risks exist that could prevent the achievement of project or BTO objectives.
4 – Outstanding: Plans clearly build on past progress and are sharply focused on barriers; risks that could prevent the achievement of project or BTO objectives are appropriately addressed.

- ☐ Poor
- ☐ Fair
- ☐ Good
- ☐ Outstanding

Comments on Proposed Future Work:

Please substantiate your score with comments about the project's strengths:

Please substantiate your score with comments about the project's weaknesses:

Please offer any additional recommendations you have for the project:

How would you rate the value of the deliverables produced by the project to its target audience/market?

- ☐ High
- ☐ Average
- ☐ Low

Explain:

Are the key research areas/deployment activities relevant to the project scope receiving sufficient emphasis?

- ☐ Yes
- ☐ No

Explain:

High Impact Technology Catalyst Program Evaluation Form

This evaluation form was used by reviewers to provide comments for the High Impact Technology Catalyst Program during the 2015 Building Technologies Office Peer Review.

Evaluation Criteria: Building Technologies Office (BTO) High Impact Technology Catalyst Program Review

Thank you for agreeing to review the High Impact Technology Catalyst Program. Through the High Impact Technology Catalyst Program, initiated in 2014, the U.S. Department of Energy (DOE) identifies and guides high impact technologies (cost-effective, underutilized energy-efficient commercial building technologies) through their early market introduction phases, ultimately leading them to the broader market through partnerships with the commercial buildings industry via the Better Buildings Alliance, federal leaders, regional non-profits, utilities, and efficiency organizations.

Your candid responses to the following questions will provide instrumental feedback regarding the High Impact Technology Catalyst Program. In an effort to collect robust data, please avoid one-word answers and provide as much detail as you can in your answers.

Multi-year Strategy

1. Does the High Impact Technology (HIT) Catalyst demonstrate pre-identified pathways and pre-defined decision criteria coupled with long-term goals and metrics to quantify success?

2. From your experience, do you believe that the HIT Catalyst addresses unmet needs or gaps in current energy efficiency programmatic offerings?

3. Are there ways in which the HIT Catalyst could provide better assistance than what we have planned for technology deployment?

4. Are there other unanswered needs in the technology pipeline which the HIT Catalyst, as described to date, would not address?

5. Does the HIT Catalyst multi-year plan provide a robust methodology to identify and respond to critical barriers in the marketplace?

6. Does the HIT Catalyst multi-year plan present open, effective, and transparent opportunities for engagement with key stakeholders?

7. What other types of program models might the DOE consider to aid in achieving its objectives?

8. What steps could the HIT Catalyst take to drive demand in addition to disseminating information on technology performance?

Market Stimulation Activities

9. Do the market stimulation activities outlined (Innovation Challenges, Real Building Demonstrations, Technical Resource Development, and Adoption Campaigns) respond to the most relevant market barriers?

10. Does the planning process incorporate key issues for analysis and directed decision making?

11. Do the market stimulation activities form an effectively balanced portfolio of activities that will contribute to achieving HIT Catalyst goals and objectives?

12. Are market stimulation activities properly ordered so as to accelerate technology market adoption? For example, we might issue an Innovation Challenge to drive the development of technologies that meet unmet market demands and then conduct a real building demonstration of products that meet the Challenge to remedy apprehension about performance of the new products.

13. Does HIT Catalyst planning for market stimulation activities effectively allow for the integration of complementary market programs and opportunities to leverage work by others and other available resources?

14. What other factors should be considered in planning market transformation activities?

Retro-Commissioning Campaign

15. Is a Campaign the correct market stimulation activity to drive cost-effective national building energy performance improvements?

16. Could a retro-commissioning (RCx) campaign help overcome technical and non-technical barriers and enable DOE to track quantifiable energy savings metrics (metrics that count, market adoption rates)?

17. In your opinion, what are realistic and achievable RCx campaign metrics to track; i.e., cost, square feet commissioned, number of buildings?

18. Is three years long enough to track quantifiable market transformation through an RCx Campaign?

19. Please help us identify the following for an RCx Campaign:

- Targeted audiences and sectors; i.e., early adopters;
- Key stakeholders to engage in planning efforts;
- Partners to assist with information dissemination and recruitment of Campaign participants;
- Exemplary existing RCx programs with replicable best practices (which sector or market?);
- Other related resources, studies, papers, or projects to consider and leverage.

2015 PROGRAM PEER REVIEW

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