

# 2013 Building Technologies Office Program Peer Review

November 2013

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

**2013  
Building Technologies Office  
Program Peer Review**

**April 2–4, 2013  
Washington, D.C.**

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## Letter from the Director

Dear Reader,

Thank you for your interest in the Building Technologies Office (BTO). This report summarizes the results of the *2013 Building Technologies Office Program Peer Review*, which was held in Washington, DC, on April 2–4, 2013, and was attended by more than 300 participants.

The Peer Review opened with a plenary session featuring overview presentations on the mission, goals, and activities of BTO and its four major programs: Emerging Technologies, Commercial Buildings Integration, Residential Buildings Integration, and Building Energy Codes. The plenary session concluded with an overview of a new analytical tool, the BTO Prioritization Tool, which provides quantitative insight into projected energy savings and input for BTO decision making. The remainder of the meeting was devoted to presentations on 59 BTO-funded projects, which were individually evaluated based on their relevance, approach, accomplishments/progress, collaboration and coordination, and proposed future work. All presentations are located at [buildings.energy.gov/2013\\_program\\_review.html](http://buildings.energy.gov/2013_program_review.html).

The projects reviewed illustrate BTO's efforts to develop high-impact, energy efficient building technologies, accelerate movement of building technologies and solutions to the market, and support a greater adoption of residential and commercial building energy codes. All of these efforts are aimed at reducing U.S. building energy use by 50 percent over the next two decades, compared to a 2010 baseline. A summary of reviewer comments and the final score for each project is provided in the report's Summary Table; the program chapters include the detailed comments and the average score for each evaluation criterion.

As we move into Fiscal Year 2014, BTO will use the information provided through this review process to enhance the management and effectiveness of existing efforts and inform the design of future programs and projects. We hope that this report will help our partners and stakeholders learn more about BTO projects and programs.

On behalf of the staff of the Buildings Technologies Office, I thank the reviewers who provided their time and expertise to make this review possible. We invite those interested in participating as a reviewer in future program reviews to send your resume and contact information to [btopeerreview@ee.doe.gov](mailto:btopeerreview@ee.doe.gov).

Sincerely,



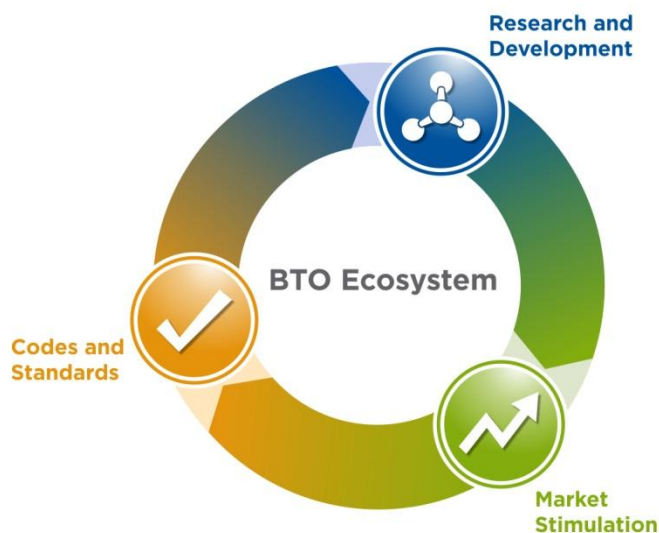
Roland Risser  
Director  
Building Technologies Office  
U.S. Department of Energy



## 1. Introduction

The mission of the Building Technologies Office (BTO) is to develop and promote efficient, environmentally friendly, and affordable technologies, systems, and practices for our nation's residential and commercial buildings. BTO follows a three-pronged approach, known as the BTO Ecosystem, to accomplish this mission (see Figure 1).

1. **Research and Development:** Develop high-impact technologies by supporting the research, development, demonstration, and deployment of technologies that have the potential to significantly improve building energy efficiency.
2. **Market Stimulation:** Accelerate technology-to-market by supporting market-priming measures that ensure building technologies overcome barriers to widespread adoption.
3. **Codes and Standards:** Lock-in energy and cost savings by supporting widespread adoption of building-efficiency technologies through voluntary efforts and regulatory activities.



*Figure 1. BTO Ecosystem*

The goal of BTO is to develop and promote the adoption of cost-effective technologies and practices that, when fully deployed, will reduce U.S. building-related energy use by 50% (from a 2010 *Annual Energy Outlook*<sup>1</sup> [AEO] baseline). These technologies and practices are expected to decrease annual energy use by approximately 20 quads, which is equivalent to approximately 1 billion metric tons of CO<sub>2</sub>, and save consumers \$200 billion in annual energy costs. BTO works toward this goal through five programs: (1) Emerging Technologies, (2) Commercial Buildings Integration, (3) Residential Buildings Integration, (4) Building Energy Codes, and (5) Appliance & Equipment Standards. Individual program goals and strategies are summarized later in this report.

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.

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<sup>1</sup> U.S. Energy Information Administration. *Annual Energy Outlook 2010 with Projections to 2035*. DOE/EIA-0383 (2010), April 2010.



## Program Peer Review

The BTO Peer Review was held on April 2–4, 2013, at the Renaissance Downtown Hotel in Washington, D.C. The review was attended by more than 300 participants and included presentations on 59 projects: 29 from the Emerging Technologies Program, 20 from the Commercial Buildings Integration Program, 6 from the Residential Buildings Integration Program, and 4 from the Building Energy Codes Program. This report summarizes the scores and comments provided by the independent reviewers for each project.

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 2013 BTO Program Peer Review*

	Emerging Tech (29 projects)	Commercial Bldgs (20 projects)	Residential Bldgs (6 projects)	Building Codes (4 projects)
<b>Average</b>	4.75	4.90	5.30	5.00
<b>Max</b>	6	6	6	5
<b>Min</b>	3	4	5	5

## Analysis Methodology

Reviewers evaluated projects by using five evaluation criteria and scoring them on a 1–4 scale, with four being the highest. In addition to numeric scores, reviewers were also asked to provide qualitative comments and feedback regarding the project’s strengths and weaknesses, and any suggestions relating to the scope of the work. For the full evaluation criteria document, please refer to Appendix B. Scores were based on the following criteria and weights:

- Score 1: **Relevance (standalone metric)** – Degree to which the project supports BTO goals and objectives.
- Score 2: **Approach (30%)** – Degree to which barriers are identified and addressed, and the quality of the project’s design, feasibility, and integration with other efforts.
- Score 3: **Accomplishments/Progress (40%)** – Degree to which progress has been made and measured against quantitative performance indicators, and the degree to which the project has demonstrated measurable progress toward BTO goals.
- Score 4: **Collaboration and Coordination (20%)** – Degree to which the project staff collaborates or coordinates with industry or other relevant stakeholders on accelerating the movement of technologies or practices into the market.
- 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 for each project using the equation shown in Figure 2, below.

$$\left[ \left( \frac{\sum_1^n \text{Score } 2}{n} \right) \times (0.3) \right] + \left[ \left( \frac{\sum_1^n \text{Score } 3}{n} \right) \times (0.4) \right] + \left[ \left( \frac{\sum_1^n \text{Score } 4}{n} \right) \times (0.2) \right] + \left[ \left( \frac{\sum_1^n \text{Score } 5}{n} \right) \times (0.1) \right]$$

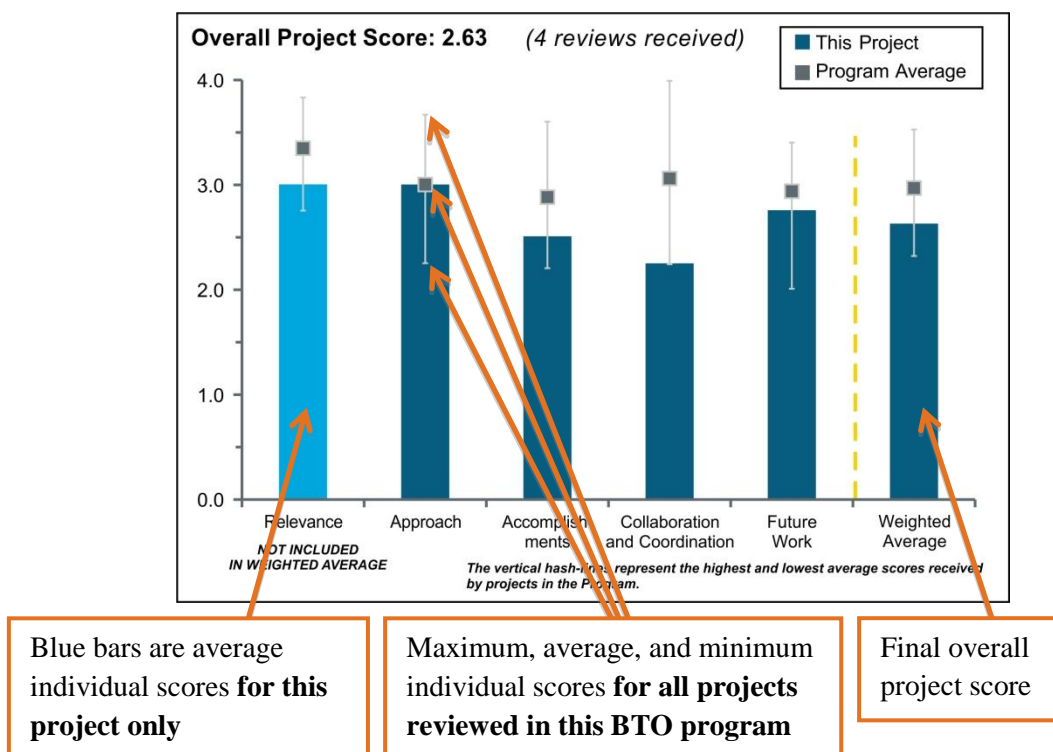
(n equals the number of reviewers per scoring metric)

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

## Organization of the Report

To align with BTO's organization, project comments and scores are grouped by program (Emerging Technologies, Commercial Buildings Integration, Residential Buildings Integration, and Building Energy Codes). The Summary Table in Chapter 2 provides an overview of reviewer comments and the final score for each project; the following chapters include the detailed comments and average score for each evaluation criterion.

Chapters 3–6 begin with a brief introduction of the program followed by project summaries and results from the peer review. For each project, a graph 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. Summary Table

### Emerging Technologies

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
ET-01	EnergyPlus (Building Energy Model) <i>Brent Griffith;</i> <i>National Renewable Energy Laboratory</i>	3.1	Reviewers recognized EnergyPlus as one of the foundational projects of the Building Technologies Office, praised recent additions to the model, and suggested more aggressive outreach to and more formal input from users. They cited the following as significant developments: California's adoption of Energy Plus into its Title 24 update, new products developed by Trane Corporation that reflect the influence of EnergyPlus, and recent model updates to handle low-energy systems such as variable refrigerant flow and chiller/heater systems. Reviewers suggested that users and industry have more input into planning and prioritizing new model features, and called for greater emphasis on outreach to increase the model's use. They also suggested increasing the focus on model validation and alignment with measured data, and making use of modern software development environments.
ET-02	Open Studio (Building Energy Model) <i>Larry Brackney;</i> <i>National Renewable Energy Laboratory</i>	3.2	Reviewers described OpenStudio as a project that complements EnergyPlus and multiplies the U.S. Department of Energy's (DOE's) investment in building energy modeling. Specific project strengths cited include the model's ease of use and rapid adoption, the success of multiple end-user applications that have been built on top of it, and the project's efforts to bring in external resources. Reviewers were concerned that the project may be competing with private sector efforts. They called for a clearer roadmap, focusing on EnergyPlus objectives versus "engine" development; a focus on small buildings, end-user piloting, and system interactions versus components; and a near-term focus on benchmarking existing buildings rather than improving building performance.
ET-03	Auto Tune (Building Energy Model Calibration) <i>Joshua New;</i> <i>Oak Ridge National Laboratory</i>	2.7	Reviewers identified AutoTune as a key technology for existing buildings. They praised the project for its early technical achievements and its intent to distribute the model through the OpenStudio platform. Some technical challenges with calibration were noted, including "getting the right answers for the wrong reasons" and a concern about AutoTune software licensing. Recommendations included focusing on the calibration issues in the short term, increasing emphasis on deployment, and including independent institutions in the validation process.

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
ET-04	Standard Method of Test for Integrated Heat Pumps <i>Wayne Reedy; Oak Ridge National Laboratory</i>	3.4	Reviewers commended the project for its development of an acceptable Method of Test Standard for integrated heat pump products. Specific project strengths cited included the diligence of the project team in reviewing existing standards, the engagement of all stakeholders, and the rapid development of the new standard through the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE). Reviewers observed that the project's energy descriptors, though mathematically correct, do not account for the cascaded energy used by the individual components. They praised the team for its proposed plan of action, but noted that the public review process could delay the project.
ET-05	Multi-Function Fuel-Fired Heat Pump <i>Edward Vineyard; Oak Ridge National Laboratory</i>	3.2	According to reviewers, this project's strengths included its development of a small-scale integrated system for air-conditioning, water heating, and power generation. Reviewers questioned the project's potential impact on BTO goals due to market barriers and costs versus benefits. They noted that the best aspect of the product is its use of natural gas. Reviewers suggested that cost and maintenance issues should be given careful consideration and heat pump manufacturers be engaged as the product develops. It was further recommended that market research be conducted to ensure that this costly system is marketed in the appropriate regions of the country.
ET-06	GATEWAY (Solid-State Lighting Demonstration) <i>Marc Ledbetter; Pacific Northwest National Laboratory</i>	3.4	Reviewers rated GATEWAY demonstrations as a highly relevant strategy to identify market acceptance issues and provide useful information to end users. They supported the project's approach, citing manufacturer interactions and objective information dissemination as key factors in widespread conversion to more efficient lighting technology. Reviewers noted an outstanding level of collaboration with the lighting industry and with users, and suggested greater collaboration in the area of controls. They praised the Solid-State Lighting (SSL) program and GATEWAY for providing facts to support user lighting decisions; identifying appropriate applications for SSL, such as municipal streetlighting; and focusing on product performance and quality to achieve energy savings goals. Reviewers suggested DOE improve promotion of the project results to the intended audiences.

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
ET-07	CALiPER (Commercially Available LED Product Evaluation and Reporting) <i>Marc Ledbetter;</i> <i>Pacific Northwest National Laboratory</i>	3.7	Reviewers rated CALiPER as highly relevant in providing objective product performance information and supporting industry standards. One reviewer said CALiPER reports have become the industry standard; others praised the independent testing of commercially available products, noting that CALiPER has moved the SSL market ahead. Reviewers commended the project for its collaboration with industry, communication of results, and impact on the market. They praised CALiPER's independent analysis and identification of market barriers and key issues faced by LED lighting. Reviewers encouraged even greater dissemination of results using existing and new channels, including the architectural and engineering communities.
ET-08	Advanced Variable Speed Air-Source Integrated Heat Pump <i>Van Baxter;</i> <i>Oak Ridge National Laboratory</i>	3.0	Reviewers commented favorably on the project for its success in designing an integrated heating, ventilation, and air conditioning (HVAC) system with a single-mode water heater and its encouraging preliminary energy savings results. They noted there was no specific cost goal and few engineering improvements. Reviewers suggested field testing to assess performance in other climates. They commented favorably that a manufacturer is onboard but suggested that a utility or municipality could be involved later.
ET-09	Absorption Heat Pump Water Heater <i>Kyle Gluesenkamp;</i> <i>Oak Ridge National Laboratory</i>	2.7	According to reviewers, the project has made good technical progress in developing an absorption heat pump water heater and the team has established excellent collaborations with several key partners. While the simulation results seem encouraging, laboratory tests have not achieved the energy factor goal and no cost goal was noted. Ionic liquid development has encountered challenges and it is unclear if a clear path forward has been identified. As the project is a mix of research and development, one reviewer questioned DOE's role and suggested that the project include research partners. Reviewers commented that this technology will benefit absorption technology more broadly and described it as a good technology for combined heat and power, solar water heating, and waste heat utilization applications.

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
ET-10	Next Generation Rooftop Unit <i>Bo Shen; Oak Ridge National Laboratory</i>	2.7	Reviewers commented favorably on the project for developing highly efficient rooftop units. They cited the project's strengths as its solid approach, beginning with modeling, lab testing, and simulations, as well as it being very technical and results oriented. Reviewers observed that the approach could be characterized as "component optimization" and that the Oak Ridge National Laboratory (ORNL) heat pump model is the right tool initially. They recognized the project's progress, but noted that limited results were available for review at this time. Reviewers expect more specific results at the next peer review. They had a mixed view of the project's potential impact, from citing that it "could be a game changer" to noting that it is "not a good return on investment." Reviewers suggested having more than one major air conditioning manufacturer as an industrial partner and noted that a potential weakness of the project is the complexity of its multi-component design and control algorithms, which could reduce the effectiveness and life of the unit.
ET-11	Working Fluids Low Global Warming Potential Refrigerants <i>Edward Vineyard; Oak Ridge National Laboratory</i>	3.3	While some reviewers commented that this project is in line with BTO goals, others questioned its relevance to energy efficiency. The project's scientific approach was commended, though its likelihood of success was questioned. Reviewers noted that developing an open source model showed good use of national laboratory capabilities. The project's strengths included its use of a multi-institutional team and its partnerships with refrigerant manufacturers. Recommendations included cultivating partnerships with compressor manufacturers, investigating physical limitations/barriers, researching related private work being done, and stating what constitutes success. Reviewers suggested that the issue of leakage be more fully addressed, as it could change the rank order of refrigerants. They also commented that more results should have been presented considering the funds spent.
ET-12	Low Global Warming Potential Refrigerants <i>Mark McLinden; National Institute of Standards and Technology</i>	3.2	Reviewers commended this project for using computational modeling to down-select working fluids that have ideal properties for a particular thermodynamic cycle. They liked that these working fluids are readily available to manufacturers and suggested that the National Institute of Standards and Technology (NIST) expand its reporting. While few weaknesses were identified, reviewers did note the need for industry collaboration. Reviewers recommended that more criteria be included in the down-selection process, such as fluid viscosity, and that this methodology be extended to other thermodynamic cycles and fluid mixtures.

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
ET-13	Nanolubricants for Chillers <i>Mark Kedzierski; National Institute of Standards and Technology</i>	3.5	Reviewers commented that the project will reduce energy consumption in chillers, but its short- and long-term impacts were not quantified. They recommended that metrics for success be developed. Reviewers stated that the challenges were well identified and that the use of nanolubricants in R134a/Al2O3 is innovative for the boiling process in chillers. They noted that the result of the acoustically enhanced boiling was not presented and that it was not clear if the effect of viscosity and the shape of the particles had been included in the results. They also commended the project's collaboration with select partners; however, they expressed concern that there was no indication of technology transfer to a larger audience or reference to a commercialization timeline.
ET-14	Supercharger for Heat Pumps in Cold Climates <i>Thomas Walter; Mechanical Solutions, Inc.</i>	3.2	Reviewers commented favorably on the project for its development of a heat pump supercharger that maintains both capacity and coefficient of performance (COP) and for the project's relevance to BTO's goals and objectives. Specific project strengths cited include understanding the issues associated with the cold climate heat pump and the PI's in-depth knowledge of superchargers. The project was also commended for its applicability to the retrofit market and its potential to have an immediate market impact. Reviewers felt the extent of collaborations was limited as the project only mentioned "discussions" with potential collaborators. Reviewers suggested adding more collaborators to the project, particularly a compressor manufacturer. It was further recommended that the project needs to get to the prototype testing phase. Building the initial prototype and mapping its performance on a test loop will dictate adjustments of future steps.
ET-15	Ground Source Heat Pump (GSHP) Data Analysis <i>Xiaobing Liu; Oak Ridge National Laboratory</i>	2.4	According to the reviewers, collecting, analyzing, and documenting case studies on ground source heat pumps is both valuable and relevant to BTO goals. Since the project is new, data were limited; yet good effort was shown, especially while dealing with poor-quality data to date. Reviewers felt that insufficient detail was provided on the available options to extract useful case study data. They commented that the results of the project could have tremendous impact in identifying "best practices" and described the work as potentially having a good "bang for buck." Reviewers recommended documenting all challenges to collecting high-quality data. They also suggested including a comparison of maintenance cost, the cost effectiveness of heat exchangers and their performance based on the best available measured data or simulation, and the effect of measurement uncertainties and the quality control process on data quality. Reviewers also suggested that future similar projects better implement and enforce monitoring plans.



Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
ET-16	Low Cost Solar Water Heaters <i>Kate Hudon; National Renewable Energy Laboratory</i>	2.6	Reviewers commented that the project plan was well developed and relevant to BTO goals. There seemed to be an excellent relationship between the project team and the industrial partner, but there was concern that the collaboration was limited to a single manufacturer. Reviewers commented that the presentation lacked detailed analysis and description of the project's challenges. The project team documented good progress in testing the performance of the solar water heater prototype. Multiple reviewers commented that the technology of focus may present several challenges, especially in very extreme climates. Reviewers felt that additional testing, especially to evaluate the long-term performance of the system in extreme hot and cold climates, should be considered. In addition, it was suggested that other potential technology solutions be identified in the event the proposed technology fails. They also suggested that the performers provide clearer justification for the cost target and that they provide a discussion on lessons learned related to design, manufacturing, installation, and operation.
ET-17	Nanolens Window Coatings for Daylighting <i>Kyle Alvine; Pacific Northwest National Laboratory</i>	2.9	Reviewers commended this as an innovative daylighting technology, with the potential for greater market penetration due to reduced costs and improved aesthetic qualities relative to other daylighting technologies. They noted that while the technology is still in the early stage, the team has made good progress. The greatest areas of concern are the cost and durability of the film and the quality of the color mixing and view. Reviewers requested more performance data and they suggested that future work focus on manufacturing approaches that will limit infrastructure investments and non-gold materials, including an assessment of oxidation (which will also be an issue with silver), followed by detailed durability tests. Reviewers suggested combining nanolens coating with low-e coating to minimize costs. They were encouraged by the Cooperative Research and Development Agreement (CRADA) with PPG Industries and the openness of the team to work with other industry partners. They suggested BTO increase its investment in this project.

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
ET-18	Low-Cost Solutions for Dynamic Window Materials <i>Andre Anders; Lawrence Berkeley National Laboratory</i>	3.3	According to reviewers, the team is utilizing manufacturing solutions already used by industry to enable lower-cost electrochromic windows. They noted that the project does not address scale-up strategies, testing, or added sputtering costs and suggested this be done in future work. Reviewers noted that aluminum-doped zinc oxide (AZO) has a lower visible transmittance than tin-doped indium oxide (ITO), which may impact market penetration, and that the processing costs should be the same as incumbent technologies. They suggested that the team consider integrating with low-e coating to reduce costs. Reviewers noted that questions remain about the adoption of dynamic windows, including their applicability in retrofit markets, and the actual energy savings of dynamic windows relative to other energy-saving technologies. They also noted that the project team has been very active with invited talks, journal articles, and invention disclosures; however, it is difficult to assess commercialization potential.
ET-19	High-Performance Window Attachments <i>Charlie Curcija; Lawrence Berkeley National Laboratory</i>	3.0	Reviewers commented that this project has the potential for immediate and broad impact. They noted that the barriers have been well identified and solutions are impactful (such as the Web tool, database, and fact sheets). They noted the project's strengths include its modular approach to rating coverings/attachments that narrows the selection process; its Complex Glazing and Shading Product Database, which was described as invaluable; and its methodologies, which allow for flexibility in comparing systems with good analytical models. Reviewers cited the following weaknesses: the lack of a transparent method for determining which products are in the database; too much emphasis on cellular shades; no consideration of air leakage; lack of information for consumers about the rating/certification system; slow development of new tools; an incomplete whole building modeling approach; and insufficient industry collaboration. They also noted that the project is very costly and questioned the return on investment, specifically the facility upgrades. Reviewers suggested establishing a steering committee to monitor progress and suggest priorities.

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
ET-20	Advanced Facades, Daylighting, and Complex Fenestration Systems <i>Eleanor Lee;</i> <i>Lawrence Berkeley National Laboratory</i>	3.3	Reviewers commended this project as practical, well organized, and well executed; the presenter as highly knowledgeable; and the energy savings potential as good, but dependent on control strategies (like all daylighting technologies). One weakness cited is the focus on new construction—the impact on existing structures seems limited. While the project addresses some of the key barriers to daylighting (e.g., glare and visual comfort), it does not address others (e.g., aesthetics and functional performance of exterior systems). The reviewers noted good accomplishments in the areas of modeling daylight, discomfort glare, industry acceptance of the design, and industry evaluations for commercialization; however, they also stated that progress has been slow at times. They commended the COMFEN commercial building fenestration design tool as a great example of technology transfer and suggested it be expanded with more capabilities, and they agreed that adoption into OpenStudio is a good mechanism for getting tools into the hands of designers.
ET-21	Atmospheric Pressure Deposition of Electrochromic Windows <i>Robert Tenent;</i> <i>National Renewable Energy Laboratory</i>	3.1	Reviewers commended this project as a relevant technology for BTO, but they were split about whether this technology will ever have broad market impact. They noted that this project is in an early stage and needs data on broad wavelength transmittance, scalability, and cost to show that it can meet cost and performance goals. Reviewers felt that the project is focused on the right limitations of the technology, but may be limited by the technology itself. Descriptions of the progress have a lot of caveats. They noted the project's accomplishments, such as the high-performance transmittance of the mesoporous tungsten oxide; however, they commented that the lithium-doped nickel oxide (NiO) and NiO need improvement in optical performance; the low-cost processing requires spatial uniformity demonstration; and the electrolyte needs long-term stability demonstration. The project's strengths include good collaboration, but few companies are interested. Reviewers noted that the group has done a nice job communicating developments through peer reviewed journals and trade organizations but has not seen a market breakthrough.

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
ET-22	Advanced Surfaces and Accelerated Aging Technology Integration <i>Hugo Destaillats; Lawrence Berkeley National Laboratory</i>	3.7	<p>According to reviewers, this project has developed an accelerated aging test protocol that reduces the test period from three years to two weeks, is practical, and will push energy savings projects to market more quickly. They commented that the project will have a big impact on the industry by allowing more products to be manufactured and will increase competitiveness in the industry; however, the impact of aging on energy use is not clear. Reviewers had questions about the approach, asking how the results can be transferred to different roof tilts and how color variations are considered. They requested more detail on soiled surface analysis and conclusions and are unsure about how the approach can be adapted for future regional products or if freeze cycles should be included. They suggested analyzing the sensitivity of reflectance with each deposition component, working on soiling resistance. Reviewers were concerned that the team only works with one material and had not focused enough on surface chemistry, and that the project has been costly. They commended the fact that the test method can be patented and were encouraged that the ASTM and ISO standards were included for possible uptake by the standards community. Reviewers were split about interactions with industry. The workshop to get industry input is good, but reviewers would like more industry interaction other than receiving coupons, and would like to see more collaborations/updates with the EPA for ENERGY STAR.</p>
ET-23	New Cool Roof Coatings and Affordable Cool Color Asphalt Shingles <i>Meng-Dawn Cheng; Oak Ridge National Laboratory</i>	3.0	<p>According to reviewers, this project supports a mature technology and is driven by the need to meet the current strict performance definition of cool roofs. They noted that the test method could lead to higher-performing roof coatings, but the impact on energy is unclear. Project accomplishments include establishing factors that control change in solar reflectance and thermal emittance, identifying microbes by geographic region, and establishing an accelerated aging protocol. Reviewers expressed concern that the details of the coating development were not clear. Reviewers were encouraged that the team is actively involved with industry, which will make it easier to penetrate the market; however, they thought that the manufacturers would not be able to support a regional coating product by the end of the project and that the regional nature of the product would make it cost prohibitive. Reviewers commended the project for discontinuing the CRADA on cool roof shingles due to high costs.</p>

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
ET-24	Next Generation Attics and Roof Systems <i>William Miller; Oak Ridge National Laboratory</i>	2.8	<p>According to reviewers, it is unclear if the project is making progress in developing new roof/attic designs. They noted that the stated objective does not reflect the work being done, pointing out that the real project objective is to develop a sealed attic approach that is superior to conventional open cell foam, and expressing that a broader study would be more beneficial to DOE as this technology is focused on a niche market that is too small to make a significant contribution to BTO goals. While they noted that it is good the team is focused on attics as systems interacting with HVAC, the reviewers had many concerns about the approach, including whether the control and new sealed attic tests can be adequately compared, why the switch from cold to hot climate was done, and the accuracy of the equipment being used to measure greater than 100% relative humidity. The reviewers also questioned the claims made and expressed skepticism regarding the claims for reduced infiltration. Reviewers asked about the methodology used for the test setup in Charleston and the tracer gas test results. They expressed concern that poor installation is likely and will lead to systems that are not airtight and have poor thermal performance and moisture management. Reviewers stated that the project accomplishments are unclear and the project itself is costly. They also noted that the approach selected will have limited market impact because it is hard to install and will make the attic unusable. Reviewers were disappointed that other viable approaches were not mentioned. Reviewers also questioned the role of 3M and GAF, stating that the project seems like a proprietary testing opportunity for a few companies and not research into insulating attics. Reviewers suggested collaboration with building scientists and manufacturers, but felt that the project's next steps are unclear. Reviewers commended the team for tackling a hard problem and learning about issues with open cell approaches.</p>

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
ET-25	Air Barriers for Residential and Commercial Buildings <i>Diana Hun; Oak Ridge National Laboratory</i>	2.9	According to reviewers, this project is one of the few studies addressing air tightness, which is important for building energy performance. They noted that the impact the project will have on BTO goals is unclear as this is not technology development. Rather, the team is developing best practices and improving understanding, and similar work has been done internationally at higher air tightness requirements. Reviewers felt that the approach is well defined, but extension to state-of-the art solutions and aging would be beneficial. They suggested the principal investigator (PI) prioritize work to align with the greatest sources of infiltration in the building. The reviewers noted that the project findings are valuable to promoting adoption of new solutions and commended its partnership with the Air Barrier Association of America (ABAA). Challenges cited were the project's unclear impact on the market, uncertainty about how this knowledge will be implemented in practice (reviewers suggested code adoption), the need for more collaboration with building scientists, and the limited results produced to date. Reviewers suggested reviewing the project's methodology and developing a steering committee to review scope, approach, and progress.
ET-26	Aerogel Impregnated Polyurethane Piping and Duct Insulation <i>David Hess; InnoSense, LLC</i>	2.8	The reviewers noted that a higher-R insulating material is in line with BTO goals, but the team needs to provide cost data and information on the manufacturing approach. They commented that the presentation did not include enough data and was too high level. The following key challenges were identified: the potential impact for this technology has not been quantified; the project should have considered other materials besides aerogels, which are very costly; it is unclear whether cellulose insulation could adhere to a duct; the team has made only incremental improvements in R value; and interactions with industry are limited. Reviewers hoped for better results in Phase 2, but future plans do not address shortcomings of weak thermal performance. Reviewers noted that if the technology can improve R value and keep cellulose from settling, it will be an improvement. Reviewers suggested that BTO look at this project more closely to assess its value to DOE.

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
ET-27	Open Energy Information System <i>Jessica Granderson; Lawrence Berkeley National Laboratory</i>	2.9	Reviewers commented favorably on the project for developing open source software to analyze building operational data that will raise awareness of energy savings available in the building sector. They commended the project team for inviting the most appropriate key players to participate in the early stage formation of this platform; having a working model for pilot participants to try and generate feedback; focusing on a limited number of simple, cost-effective algorithms; using an open source database, which could stimulate use and interest in energy efficiency measures; and encouraging incorporation of other tools and databases, making the platform even more valuable as a forum for information exchange. They noted that the project has well-defined objectives and the PI is aware of the complexity of the problem, and that the approach could be better defined, including metrics for success and more information on end users and their needs.
ET-28	Small-Building Control Systems <i>Michael Brambley; Pacific Northwest National Laboratory</i>	2.6	Reviewers commented favorably on the project as a preliminary study on using automation and control systems for energy savings in small buildings and agreed that the project's objective is aligned with BTO goals. One reviewer commented that this is the first study within the DOE laboratories to focus on control of building energy, which can save large amounts of energy and is currently missing in smaller-to-intermediate-sized buildings. Several reviewers were concerned that the energy/cost savings projections were overstated. There was also a general concern from reviewers that many of the non-economic and non-technical factors influencing market penetration were not sufficiently addressed.



## SUMMARY TABLE

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
ET-29	Rooftop Unit Network <i>Michael Brambley; Pacific Northwest National Laboratory</i>	2.8	Reviewers commented favorably on the project as it relates to the demonstration of an open source software platform that is specifically designed to allow energy consuming or generating devices to plug in and communicate, similar to how devices can be plugged into personal computer networks. Specific project strengths cited include the concept of a platform that permits plug-and-play compatibility for all energy-associated systems in buildings, which is an important step toward managing those systems more effectively to coordinate with the grid, and the excellent flexibility of the project's implementation. Reviewers recommended that the project focus more on determining specifics around data needs, suggesting that improving building and grid efficiency requires the creation of a common blueprint for the specific internal and external building data needs. One reviewer commented that the project focus needs to be primarily on "finding commonality from device to device about the kind of information necessary, and how it is presented and exchanged to accomplish what is desired." Reviewers noted that the project is ambitious but will become a stepping stone toward integrating building components with the grid.

## Commercial Buildings Integration

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
CBI-01	Building Energy Modeling (BEM) Library <i>Ellen Franconi; Rocky Mountain Institute</i>	2.6	Reviewers saw the lack of standardized, documented best-practice procedures as a significant gap in the energy modeling world and applauded the project for its effort to directly address this gap in a way that is meaningful to both modelers and model users (e.g., building owners and operators). Reviewers noted that the project does not currently address what they see as the most significant gap in the modeling process—the lack of effective output to help building and system designers really understand the dynamics of a building’s operation in order to more effectively design equipment, especially control systems. They recommended that the project be refocused to address the issue of improving the output options of current modeling programs to make them more useful throughout the building design, implementation, and operation stages. Reviewers also suggested involving actual designers or owners as an advisory committee to increase the chances of adoption.
CBI-02	ISO50001: Conformant Management Systems <i>Aimee McKane; Lawrence Berkeley National Laboratory</i>	2.4	Reviewers commended the project for addressing a key issue of how to change corporate culture and integrate energy management into larger processes. They also applauded its effective collaborations among property holders, industry, and others. Reviewers doubted, however, whether the standard will be applicable to the commercial buildings market, questioned the extent to which the selected project approach will help achieve BTO goals, and expressed concerns regarding the project’s scalability. Reviewers recommended that the project spend the remaining pilot time quantifying accomplishments and determining cause/effect to ensure the success of future efforts.
CBI-03	Window Daylighting Demo <i>Stephen Selkowitz; Lawrence Berkeley National Laboratory</i>	3.1	The project received positive reviews for its applicability to BTO goals and its potential to significantly reduce cooling and lighting energy usage. Reviewers commended the project for its extensive collaboration among stakeholders, its outreach to a broader audience through conferences, and its potential to facilitate adoption of the technology. One reviewer questioned how the project will augment the product database to include components other than glass and how data quality will be ensured. While recommendations were few in number, one reviewer proposed incorporating more details on plans for additional field tests and the process to incorporate results from these studies.

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
CBI-04	Tech Portal <i>William Livingood; National Renewable Energy Laboratory</i>	3.0	Reviewers praised the project for its progress and potential to provide a convenient means to compare and evaluate energy efficiency technologies, but they raised concerns about the project's "if you build it, they will come" approach. Several reviewers commended the project for its simple approach to data collection, while also questioning how valid the data will be without explicit quality control mechanisms in place, and how this project relates to other BTO data collection efforts. Perhaps most critically, several reviewers questioned the reliance on building the infrastructure to provide data without a mechanism to ensure that the data will be submitted, and if it is, how quality will be controlled. One reviewer suggested that BTO initiate a concomitant project to assess and develop standards for measuring efficiency, quality assurance of measurement, etc.
CBI-05	Submeter Challenge <i>Jason Koman; U.S. Department of Energy</i>	2.8	The project's objective, approach, and progress to date received broad praise from reviewers. However, reviewers questioned the assertion that a lower-cost submeter will reduce building energy use by 2%. They also questioned whether development of a low-cost meter was plausible and if the industry would deploy the meter, and they repeatedly referred to the split incentive problem as a barrier. Reviewers stressed the importance of additional collaboration, particularly with utilities, to successfully transfer technology and disseminate information. Other suggestions included considering whether private industry (appliance or meter manufacturers) would be better suited to perform this project, and providing customers with an understanding of how to collect and analyze the data provided by the submeters. They questioned the project's focus on hardware only and whether software and installation costs should not also be considered.
CBI-06	Better Buildings Alliance <i>Kristen Taddonio; U.S. Department of Energy</i>	3.4	Reviewers praised the project for its sizable energy-savings potential, progress to date, and extensive collaboration among stakeholders. Conversely, concerns were raised regarding the lack of a holistic approach and the potential for dilution of the project's effectiveness due to its expansive scope. Reviewers suggested clarifying and enhancing the role of utilities in the project, reorganizing the project by sector-specific initiatives to improve efficiency, and increasing focus on promoting the project.

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
CBI-07	Lighting Energy Efficiency in Parking Campaign <i>Linda Sandahl; Pacific Northwest National Laboratory</i>	3.3	Reviewers commented that this project is well designed and impactful. They cited the project's potential for energy savings and its progress on square footage goals to date. The project also received high marks for its strong collaboration with large retailers and excellent tool selection. Reviewers identified project weaknesses in the absence of data for verification and site selection. They suggested additional coordination with financiers and utilities as well as awards and recognition as incentives.
CBI-08	Commercial Buildings Consortium <i>Sandy Fazeli; National Association of State Energy Officials</i>	2.8	Reviewers commended the project for its broad collaborations, but gave it mixed reviews on the clarity of its purpose and its ability to demonstrate how savings will be achieved. Some reviewers spoke highly of the project results, while others cited a lack of results to date and questioned the ability of the project plan to deliver results going forward. Identified weaknesses include a lack of tracking to demonstrate progress and a lack of marketing of analysis reports. Some reviewers felt that the project was duplicative of other efforts. Recommendations ranged from enhancing interactions with utilities to terminating the project.
CBI-09	Building Performance Database <i>Paul Mathew; Lawrence Berkeley National Laboratory</i>	3.3	This project generally received high marks, but reviewers were divided on the project's approach. Specific project strengths cited include its applicability to BTO goals and its role in the energy efficiency finance community. The project was also characterized as having excellent collaboration, given the number of active and pending stakeholders involved. Some reviewers described the project's approach as disorganized, overambitious, and somewhat inadequate, but others viewed the project as necessary and generally productive. However, reviewers also mentioned that other tools may obviate the need for such a project. Overall, recommendations were made to work closely with owners of key data sets to ensure project success.
CBI-10	SEED (Standard Energy Efficiency Data) <i>William Prindle; ICF International</i>	2.5	While some reviewers applauded the objective and overarching goals of the project, others questioned the need for the project given the existence of similar efforts. Reviewers noted that the project is behind schedule and the budget has doubled, and that despite budget and scope increases in the coming year, little detail was provided on future work. Reviewers acknowledged that BTO has experienced problems with the project, but they were divided on whether a satisfactory explanation was provided regarding resolution. The review team suggested conducting an assessment of whether the target market sees value in the product, and implementing stage gates along the project schedule to ensure its success.

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
CBI-11	Commercial Building Partnerships <i>Adam Hirsch; National Renewable Energy Laboratory</i>	3.2	Reviewers commented that the project has great potential and is a good source of lessons learned. Reviewers also applauded the project's design, extensive collaborations and stakeholder buy-in, and progress, noting that it was particularly well funded. Reviewers raised concerns regarding scalability from the pilot phase to the full project scope, the lack of quantitative metrics for evaluation purposes, and project wrap-up logistics. The review team suggested developing metrics for measuring project savings versus spending, energy efficiency measurement and verification, and to identify which project components are effective.
CBI-12	Advanced Energy Retrofit Guides and Advanced Energy Design Guides <i>Shanti Pless; National Renewable Energy Laboratory</i>	3.5	Reviewers applauded the project as being integral to accomplishing BTO goals and for its progress to date. Reviewers responded positively to the project's outreach to young engineers and the high level of collaboration among stakeholders. They remarked that one critical metric—the number of designs/retrofits implemented by individuals who received the information generated by the project—is distinctly absent. Moreover, reviewers noted that the project does not sufficiently provide solutions to demonstrate cost effectiveness, risks, and constraints. Reviewers made several suggestions, including improving the deployment approach and the analytical framework, increasing the focus of building owners on operations and maintenance, and expanding the tools to accommodate additional facility types.
CBI-13	Whole Building Energy Performance Training <i>Shanti Pless; National Renewable Energy Laboratory</i>	3.1	This project was praised as transformative and applicable to BTO goals. The review team felt that substantial progress has been made to date, including the number of training sessions held and development of supporting documentation, and that the effect of this work has been positive. Reviewers also looked favorably on the project's clear set of objectives. Reviewers questioned the project's training-based approach and whether the overall goals are too ambitious. They noted that the project lacks critical intermediate steps such as performance requirements in equipment specifications and actual energy performance review. Reviewers suggested that the project incorporate additional private-sector buildings to develop a better understanding of where private-sector barriers lie; focus on the best means to creating value; and include other stakeholders, such as the American Institute of Architects (AIA), American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), and U.S. Green Building Council (USGBC), in future work.

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
CBI-14	Transforming the Commercial Building Operations <i>Ron Underhill;</i> <i>Pacific Northwest National Laboratory</i>	2.9	Overall, reviewers agreed that the project is critical to reducing existing building energy consumption and noted that it can have an immediate impact. However, they suggested that some work may be needed to refocus the project on tool development and automated techniques that maximize project effectiveness. Reviewers were concerned that sufficient performance targets to measure success were not identified. Additionally, the review team remarked that training trainers may not be the most effective approach, as the characteristics of both building energy management tools and building operations and maintenance staff are changing quickly. Reviewers offered a variety of recommendations for project improvement, including transmitting regular energy management reports to staff to inform decision making; improving project marketing; creating a troubleshooting process for when documentation does not exist; engaging building managers and expanding partnerships; and most critically, focusing on additional tool development.
CBI-15	Financing Turnkey Efficiency Solutions for Small Buildings and Small Portfolios <i>Rois Langer;</i> <i>National Renewable Energy Laboratory</i>	2.3	Reviewers commended the project's focus, but they also raised concerns that it does not address the full problem statement and they questioned the project's potential for duplication as well as its schedule. Reviewers also questioned whether the strategy of using pre-packaged energy efficiency measures to forecast costs and savings for "typical" small buildings would lower the risk for the financial community. Several reviewers noted a weakness in the lack of engagement to date with the financial community and utilities. Some also questioned the role of DOE and national laboratories in working in this space.
CBI-16	Small Building Energy Management System <i>Jessica Granderson;</i> <i>Lawrence Berkeley National Laboratory</i>	2.6	Reviewers viewed the project as relevant to achieving BTO goals and potentially of great benefit to the small business community. However, the reviewers challenged the selection of project delivery through small commercial HVAC contractors due to a potential conflict of interest in terms of overstating energy savings based on maintenance activities that are difficult to verify. One reviewer questioned whether the project would be scalable to 5% of buildings in a few years. One reviewer remarked that the project is not very well defined and its outcome is uncertain. Reviewers suggested a broader outreach to other areas of the country; alternative approaches that eliminate the need for on-site labor; and reaching out to additional stakeholders, particularly to assess performance benchmarks and identify energy use targets.

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
CBI-17	Rooftop Unit Suite <i>Michael Brambley; Pacific Northwest National Laboratory</i>	3.2	Reviewers noted that the project is integral to achieving BTO goals and commended the project for delivering good results. Reviewers also applauded the project's logical structure and focus on low-cost improvements. However, reviewers also highlighted several weaknesses, including a lack of clarity regarding the project's long-term plan, confusion around collaborations, and a lack of clarity on cost-effectiveness criteria for product rollout. They raised concerns about a lack of market pull to commercialize the advanced controller or the smart monitoring and diagnostic system. Reviewers suggested that DOE do more to ensure adoption by the rooftop unit market, as well as develop training, guides, and additional information for owners, HVAC technicians, and utility programs.
CBI-18	Rooftop Unit Campaign <i>Michael Deru and Andres Potes; National Renewable Energy Laboratory and Waypoint Building Group</i>	2.9	Reviewers commended the project's goals but raised some concerns about the ability to achieve them. They noted that the multipronged, multi-partner approach is well thought out and appropriate for this type of project. However, they cited several concerns, including confusion regarding the project's focus; its lack of inclusion of contractors to accelerate market adoption; and its inability to address particular market barriers, especially customer segmentation. Reviewers recommended that the project clarify its focus, expand into a national initiative, and leverage utility rebates.
CBI-19	Retrofitting Doors on Open Refrigerated Cases <i>William Goetzler; Navigant Consulting, Inc.</i>	3.5	Reviewers commended this project for its relevance to BTO goals and its potential for energy savings in a highly mature market. They described the project's approach, collaborations, tools, and guide as helpful and well thought out. They applauded the project's marketing and communication tools—which were coupled with strong data support to demonstrate progress and accomplishments—as streamlined and effective. The review team mentioned several weaknesses, including that industry will need to overcome some barriers for wide-scale implementation, that the scope of retrofits is too narrow, and that the minimal collaboration with contractors and technicians will inhibit the project's impact. Reviewers suggested that a website be constructed for utility use. Some reviewers questioned DOE's role in this project in lieu of the private sector.



# SUMMARY TABLE

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
CBI-20	Technology Specification Deployment <i>William Goetzler; Navigant Consulting, Inc.</i>	3.2	Reviewers noted several project strengths, including the strategy of identifying key energy efficiency technologies that remain unclassified, definition of baseline use, and effective alignment with utility savings. However, they felt that the measures for energy and cost savings potential were unclear. Reviewers suggested that benchmarks be used to identify some fairly specific product investment numbers, the required modifications to existing equipment, and the reductions in energy use as a result of the conversions. They also expressed concern about the lack of clarity regarding the technical details and robustness of the case studies. Reviewers recommended holding a webinar with utilities to inform them of the project resources available to them, modeling the impact of the conversions, and creating two distinct types of case studies that include best practices and lessons learned.

## Residential Buildings Integration

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
RBI-01	Building America <i>Eric Werling and Ren Anderson; U.S. Department of Energy and National Renewable Energy Laboratory</i>	3.0	Reviewers praised the Building America program for its effectiveness in advancing energy efficiency and its importance to the building industry. Specific strengths cited included Building America's steady and substantial progress in advancing high-performance buildings through its unique, integrated whole house approach; taking the residential sector "from research to product development to market transformation"; and being "an unparalleled source of research and development in the field." One reviewer summarized: "The project provides for a strategic partnership that drives innovation that otherwise would not happen or at best take many more years to evolve." Several reviewers were concerned that Building America was not effective at reaching some critical audiences, most notably building code officials. It was suggested that Building America solutions be more aggressively promoted and that Building America should be part of every conversation about code development, adoption, and implementation. (However, one reviewer disagreed with this). Reviewers also suggested that Building America expand its focus to more effectively reach audiences beyond Building America partners (i.e., mainstream builders, contractors, trade associations, and code officials).
RBI-02	Challenge Home <i>Sam Rashkin; U.S. Department of Energy</i>	3.4	Reviewers commended the project for its relevance to BTO goals and its role as a bridge between above-code and zero net energy homes. They identified three specific strengths of the project: a well-thought-out strategy based on analysis of barriers to introducing new technologies to the market; a highly developed marketing and outreach plan; and a clear, strong value proposition for the Challenge Home brand. Several reviewers were concerned about the addition of another labeling program to the overcrowded energy efficiency market and the lack of emphasis on consumer use and understanding. Reviewers suggested that the project address risks associated with new technology adoption for investors, contractors, and homeowners, and incorporate consumer use and training into its strategy.

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
RBI-03	Better Buildings Neighborhood Program <i>Danielle Byrnett and David Roberts; U.S. Department of Energy and National Renewable Energy Laboratory</i>	2.9	Reviewers commented that the project's objectives were well aligned with BTO goals and made good use of the opportunity offered by the American Recovery and Reinvestment Act. However, they noted that the goals were disparate and aggressive given the three-year funding period. Reviewers were impressed with the amount of information sharing and agreed that capturing and sharing lessons learned was a good objective. They noted that data collection requirements were not made clear to the grantees from the start of the program, and that grantees were not equipped with sufficient data collection tools. Reviewers also commented that the proposed statistical analysis lacked sufficient detail to evaluate it completely; for example, justifications for the assumptions used in the net present value calculations were lacking. Reviewers suggested that DOE perform a sensitivity analysis for the assumptions. They also suggested that future efforts focus on specific, well-documented barriers and provide well-defined data collection requirements from the start.
RBI-04	Solar Decathlon <i>Sara Farrar-Nagy; National Renewable Energy Laboratory</i>	3.8	Reviewers gave high ratings to this project, pointing out that its popularity with schools indicates that participants find the event to be well designed and executed. They noted the project's effectiveness in educating university students and homeowners, and in showcasing innovation, and they cited its success in receiving awards and recognition. The reviewers agreed that the Solar Decathlon is mostly a stakeholder outreach initiative that is hard to rate for market impact. They were unanimous in stating that the core strengths reside in the competition's ability to motivate creative and intelligent students to focus on building highly efficient houses that intrigue themselves, the industry, and the public at large. This hands-on learning encourages students to be drawn into the clean-energy workforce and become strong voices for clean energy solutions. Reviewers suggested reaching out more to K–12 students, and doing more in the off-year to remain in the public eye.

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
RBI-05	Home Performance with ENERGY STAR <i>Ely Jacobsohn; U.S. Department of Energy</i>	3.0	Reviewers believed that the Home Performance with ENERGY STAR (HPwES) project has the potential to substantially improve existing homes. A major strength is its utilization of the ENERGY STAR brand to provide a common platform for program sponsors and participating contractors to market the whole-house approach to consumers. The reviewers agreed that the HPwES methodology, which is based on a public-private partnership, is the right approach to support both the national platform and local implementation. One reviewer noted that DOE's calculation that its investment is leveraged by state, local, and private funding at a ratio of 86:1 is impressive. Several reviewers commented that the HPwES team's major challenge moving forward is developing a strategy that impacts the different segments of the market with limited resources. They also felt that the project's approach may be overlooking those who would benefit the most—existing homeowners. While housing starts do seem to be making a recovery, the renovation market should also be a significant target, as it could help homeowners decide where to focus their efforts for the “biggest bang for the buck.” Looking ahead, the reviewers were pleased with the team's development of incremental improvements to HPwES via the V1.5 Sponsor Guide and appreciated the judicious approach the team is taking in designing and developing improvements to increase participation and market penetration.
RBI-06	Home Energy Score <i>Joan Glickman and Norm Bourassa; U.S. Department of Energy and Lawrence Berkeley National Laboratory</i>	3.0	Reviewers saw a lot of potential for Home Energy Score in the market, felt that its approach is technically sound, and observed that there has been good opportunity for stakeholder input. One reviewer expressed concern that the intended use of the tool in the market is unclear with regard to providing an absolute or relative score, and cautioned that the real estate market could limit the utility of the tool. Specific project strengths cited were the technical approach, which was very well researched and documented; the robustness of the tool and its user-friendly nature; and an application program interface (API) that was well thought out to enable broader adoption. Reviewers noted that the tool's impact on motivating investment in energy efficiency improvements is yet to be determined, and that quality control and replicability will be critical to its success. A reviewer also suggested that behavioral aspects could be added to the tool's capability to better motivate current homeowners to invest in energy efficiency improvements. One reviewer strongly recommended that the program closely align with the Home Performance with ENERGY STAR program to enable greater market impact.

## Building Energy Codes

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
COD-01	Building Codes Technical Assistance <i>Christopher Wagner;</i> <i>National Association of State Energy Officials (NASEO)</i>	3.0	Reviewers commented with mostly positive feedback regarding NASEO's involvement in energy code adoption and implementation. They cited NASEO's ability to engage state energy offices and utilities as a key strength, and they recommended working with more utilities in the future. Some reviewers felt that the scope of the project is too broadly focused and, in some ways, duplicative of other BTO-funded activities. Some also questioned the role of NASEO in building energy codes and suggested that NASEO better define their role.
COD-02	Midwest Building Codes Technical Assistance and Commercial Projects <i>Stacey Paradis;</i> <i>Midwest Energy Efficiency Alliance (MEEA)</i>	3.9	The reviewers commented favorably on MEEA's project activities and the organization's role in facilitating code adoption and compliance in the Midwest. They identified the project's strengths in engaging necessary stakeholders at the state and local levels, addressing the relevant political issues at the local level, and serving as a technical resource for policy makers on adoption, implementation, and compliance issues. The reviewers did not identify any weaknesses. The reviewers also supported MEEA's future plans, particularly the plans to promote adoption of the 2012 IECC in additional Midwest states and to increase its focus on benchmarking programs. Overall, the reviewers felt that MEEA's project has made significant progress toward BTO goals and its funding has a high return on investment.
COD-03	National Building Codes Collaborative and Technical Assistance <i>Maureen Guttman;</i> <i>Alliance to Save Energy</i>	3.6	Reviewers commented favorably on this project's success in providing leadership and information to the building energy codes community. They cited the project's strengths in identifying critical barriers common to code adoption and compliance and producing information products to address them; developing objective, impartial fact sheets on key metrics for decision makers such as construction costs; sharing best practices; building and maintaining an informative website; and focusing on collaboration, outreach, and communication with key stakeholders. Reviewers also commended its success in forming state compliance collaboratives and for leveraging DOE project funding in a 2:1 ratio. They suggested building evaluation into future plans to determine the impact of compliance efforts. Reviewers also suggested further evaluating the needs of states and Regional Environmental & Energy Offices (REEOs) to develop specialized solutions.

## SUMMARY TABLE

Project Number	Project Title <i>Presenter Name &amp; Organization</i>	Final Score	Summary/Results
COD-04	Southeast Adoption and Compliance Technical Assistance <i>Jenah Zweig; Southeast Energy Efficiency Alliance</i>	3.6	Reviewers commended this project for convening stakeholders and providing technical support in the Southeast. They identified the project's strengths in identifying opportunities for energy code advancement in the region, maintaining strong relationships with stakeholders on the ground, and providing the resources and training necessary to achieve BTO goals. One reviewer suggested that the project develop a more diverse approach to stakeholder engagement in different states and localities throughout the region. Reviewers also suggested that the project take an even larger leadership role in leveraging groups and crafting strategies for states and municipalities based on best practices and lessons learned in the Southeast.

### 3. Emerging Technologies Program Summary

The Emerging Technologies Program supports research and development of cost-effective, high-impact, energy-efficient building technologies and accelerates their commercialization into the market place (see Figure 4). Key technology focus areas include the following:

- Lighting
- Heating, ventilation, and air conditioning
- Building envelope
- Water heating
- Appliances
- Sensors and controls
- Building energy modeling and design/decision support tools



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

By 2020, the Emerging Technologies Program aims to bring a minimum of 20 energy-efficient innovations to the market. The Program's long-term goal is to introduce technologies to the market that can achieve significant energy savings by 2030. Specific energy saving goals include: 65% energy savings in lighting, 37% savings in water heating, 24% savings in HVAC, 34% savings in building envelope & windows, 18% savings due to sensors & controls, and 29% savings in appliances (compared to a 2010 AEO baseline). These goals are based on the maximum-adoption potential, which assumes that all units up for replacement are changed to the energy efficient stock. To track its progress, the Program will monitor technology cost and performance improvements and determine how much it has influenced the overall change in energy-efficiency trends by analyzing and evaluating the market penetration of program-funded technologies.



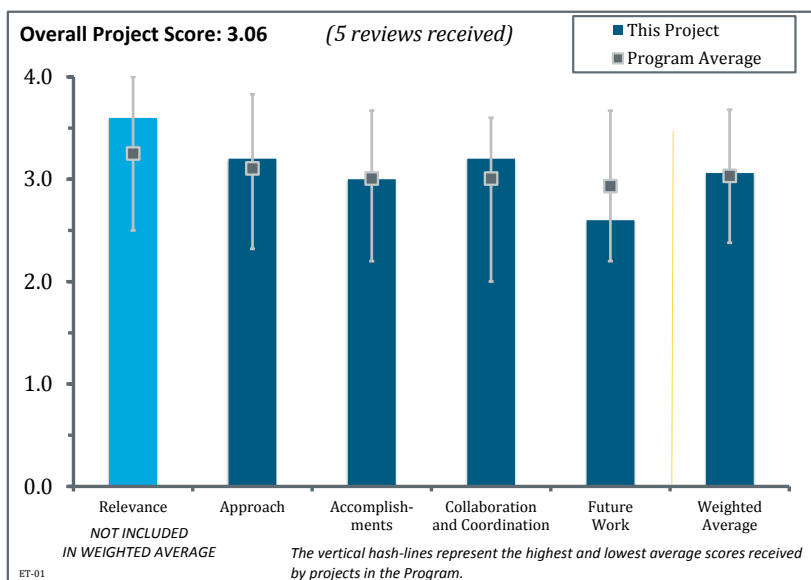
## Project # ET-01: EnergyPlus (Building Energy Model)

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### Brief Summary of Project

EnergyPlus is the U.S. Department of Energy's (DOE's) whole-building energy modeling engine, an industry-leading product that supports not only design of new buildings and retrofits, but underpins the development of energy efficiency codes and standards, labels, and incentive programs, as well as the compliance, certification, and qualification processes for these programs. DOE will continue to deliver updates of EnergyPlus that enhance modeling flexibility, incorporate models for high-priority new systems (such as high-performance "challenge" rooftop units), and improve execution speed. DOE will continue to support both modelers and third-party vendors in their use of EnergyPlus.



### A. Relevance

This project was rated **3.6** for its relevance to Building Technologies Office (BTO) goals and objectives.

- The building industry, including state and regional energy policy makers, depends on DOE to develop, maintain, and enhance building energy simulation tools. The California Energy Commission (CEC) has partnered with DOE over the last 30 years in this area, as the Building Energy Efficiency Standards depend on building energy simulation tools for both periodic updates and ongoing code compliance. Four years ago, the CEC made a commitment to use EnergyPlus as the reference method for determining energy savings in new building construction projects as well building additions and alterations. BTO has been very responsive to the CEC's needs for particular EnergyPlus updates to support its use in California's Standards development and compliance processes. Other energy agencies and utility programs have also recently adopted EnergyPlus as their core computational program for building energy efficiency evaluations. It is very important that DOE continue to support the building industry in this regard.
- EnergyPlus may be one of the most important efforts of BTO. The effort has transitioned from just developing the core/engine, to focusing on a system architecture that allows applications to be readily completed; this is key to getting it actually used. It is an important sign that Trane/Trace 800 and others are embracing the model as a validated engine that can complement their interface efforts and make them and their users more productive.
- This project is a core and important part of the building energy modeling program area.
- An accurate load model is very important in efficient design.
- The presentation did not capture the full relevance of the proposed project and its alignment with BTO goals and objectives. This may be in part because the work is foundational and the impact will be delivered by others enabled by the tool.

## B. Approach

This project was rated **3.2** for its approach.

- EnergyPlus updates are effective and the tentative plans for a major update of the software using modern software development languages and environments is both appropriate and promising.
- The shift to a three-layer stack is very important for defining responsibilities and for facilitating cooperation and accelerating smart adoption and adaptation. The external collaborators as well as the focus of the group are impressive.
- The approach seems to be very thorough.
- It is unclear how the needs were collected or solicited from users and developers. This was shown as a single bullet. It was not clear whether it was formal or informal, where the information was collected, and how it was prioritized.
- The proposed project is large and a continuation of earlier work so the scope is broad, but that is what is required to achieve a working energy modeling platform. However, there is reason to be concerned that the priority areas were selected from requests. This suggests a lack of rigorous and significant opportunity to depart from the BTO goals and objectives. It is surprising that the areas are not aligned with the priority technical areas identified by the (soon-to-be-released by BTO) priority tool.

## C. Accomplishments/Progress

This project was rated **3.0** for its accomplishments and progress.

- EnergyPlus development is very well planned and executed, with new releases scheduled every six months. The priority of the EnergyPlus updates are well-matched to building industry needs.
- The tool has a wide usage, which attests to the value it brings to researchers and some practitioners.
- This project should keep adding features, such as central chiller/heaters (April 2013 release).
- There was not enough information in the presentation to do a solid evaluation of the progress to date; there was nothing to compare it to.
- This program area is split into a lot of sections for the level of funding the program received. It is difficult to tell, but it appears that fewer than a third of the projects were presented for review.

## D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.2** for its collaboration and coordination with relevant stakeholders.

- The acceptance by equipment manufacturers, such as Trane, speaks volumes about the industry's acceptance.
- It appears the project has many of the right people involved, and that they understand the need to make this much more than a DOE effort.
- The EnergyPlus update process includes building industry input; EnergyPlus users have opportunities to contribute to the list of desired features that are then prioritized and implemented over time.
- There has been limited involvement of key players from the various segments of the industry. It appeared that Trane was the only one that contributed. It is important to ensure that the components and systems included in the model are generic and do not favor one manufacturer over another. Having only one industrial contributor may not send the right message.
- There was little on technology transfer or collaborations. It was not clear if the project is aggressively pushing for more adoption. Most of the areas described have been under development for multiple years.

## E. Proposed Future Work

This project was rated **2.6** for its proposed future work.

- The reviewer missed the in-person presentation of this project and is unclear on the details of the plans to overhaul EnergyPlus by making use of modern software development environments and adding more

capabilities to modularize the software, which will enable more innovation both in its development and use. It is uncertain whether BTO has allocated sufficient development funds for this new effort.

- While a Gantt chart was shown there was no discussion about stage gates and decision points. The presenters reported on time delivery of outputs in the previous cycle. It seems like there are no exit points to this project, in that it would continue forever. Better project management would include asking and answering: when is it good enough. DOE is not a software house, but this tool has a huge number of lines of code. The reviewer questioned if code development (not the science and technology) would be best performed outside DOE to maximize value and return on investment.
- There should be even more emphasis on validation and calibration against “as-builts” (real buildings as they are being used). That feedback loop is critical for influencing design practices. The details of system design—not just heating, ventilation, and air conditioning system choice—really matter. For example, it needs to get easier for a system designer to show linkages between pipe size, system head loss, pump energy, and chiller work. This will enable designers to easily do “what-ifs” on system design and installation quality. The reviewer questions how the project will perform optimizations when it means comparing better window installation to higher window R-value. The reviewer wants to know where the marginal dollars should be spent.
- It is difficult to comment on future work as little was presented.
- The project should keep evaluating more technologies and configurations.

#### Project Strengths:

- This is a foundation project for BTO and is very important. The reviewer feels very good about the direction it is taking and the methodical approach to prioritization. The resources required seem modest, but the project may be underfunded compared to the potential value.
- This is a core technology development area supporting the building energy simulation community.
- This project is relevant to DOE’s objectives; it includes broadly used technical leadership, and the quality assurance seems to be good.
- Two reviewers did not enter a response.

#### Project Weaknesses:

- There was little content in the presentation with which to evaluate the project.
- There seems to be some potential that this will become too ponderous to use.
- This is a never-ending project without exit points, there is limited external support from industry, and the selection of technical areas seems loose.
- There is feedback at every level. It is unclear what the designers really want and what the research community wants. It is unclear how to interactively calibrate against real buildings, both to understand simulation needs and to begin understanding the gaps among as-designed, as-built, and as-operated.
- One reviewer did not enter a response.

#### Recommendations:

- EnergyPlus and OpenStudio seem to need much more outreach to get better feedback. The reviewer wondered if there was enough engagement with ASHRAE, and who is working on showing the U.S. Green Building Council (and others) how good (and bad) simulation affects divergences between design and actual performance. The reviewer also wondered how downstream developers build interfaces (applications stack) that people really want to use to solve their problems.
- This is a very important tool for the research community, but the presentation was poorly delivered.
- Three reviewers did not enter a response.

## Project # ET-02: Open Studio (Building Energy Model)

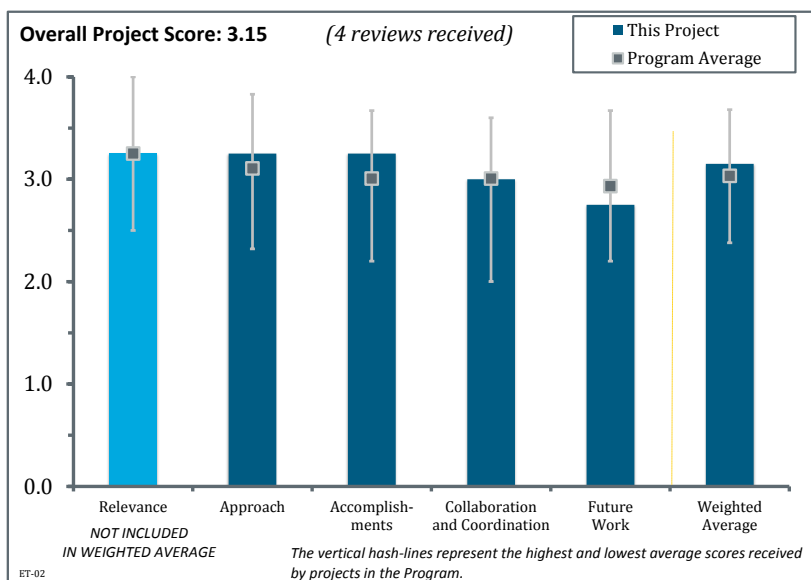
Larry Brackney, National Renewable Energy Laboratory, larry.brackney@nrel.gov

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### Brief Summary of Project

OpenStudio is the U.S. Department of Energy's (DOE's) whole-building energy modeling "operating system," an open-source software development kit for rapid development of applications that use energy analysis using EnergyPlus. OpenStudio supports a number of applications including DOE's Commercial Asset Score, California's Title 24 Code Compliance Tool, Concept3D's Simuwatt mobile audit application, design assistance and incentive programs at utilities such as Xcel Energy and National Grid, and a number of projects at DOE's Energy-Efficient Buildings Hub. Going forward, DOE will increase

OpenStudio's coverage of EnergyPlus features, improve its support for standard data exchanges, expand its utilities for model quality assurance, and continue to support its growing list of users and third-party software vendors.



### A. Relevance

This project was rated **3.3** for its relevance to Building Technologies Office (BTO) goals and objectives.

- At last, there is a system information architecture that just might multiply the effectiveness of the investment in developing EnergyPlus. The efforts to bring in external resources, from both laboratories (Dakota) and others, and the efforts to facilitate rapid prototyping, are impressive. If the two barriers to greater use of modeling are (a) the difficulty of learning and of feeding the beast, and (b) poor feedback (comparison of model and design to actual performance), this effort is making progress.
- The development of a simulation platform is crucial for understanding the complex dynamics of the building energy flow and implementing control and automation systems. It is also a crucial educational tool. It is not clear if and how much the platform is/will be supported by DOE and at what level.
- Being able to reasonably and accurately apportion the energy use in existing buildings with abbreviated inputs so that the retrofit focus can be applied to those components and systems that will yield the most benefit is very useful. Also, bringing standardization to the format of typical building energy audits is a helpful step forward in improving the energy efficiency of existing buildings.
- The Open Studio software development kit (SDK) is a great idea, but some of the OpenStudio work competes with the private sector.

### B. Approach

This project was rated **3.3** for its approach.

- The software development strategy is sound, open, flexible, and collaborative.
- As with other projects reviewed, the reviewer missed the emphasis on up-front and continuing involvement with the anticipated end users. It is unclear if the project is developing tools that designers will want to use. If so, it is also unclear how much time is necessary for adoption.

- It is not clear that the required accuracy can be achieved with the simplicity of inputs that are desired, but it is encouraging that the project appears to be following users to determine how effectively it is in correctly assessing energy use in the various categories. Working with practitioners in the early releases will be critical to the success of this project.
- Lots of little pieces are being pulled together. It is difficult to understand what the overall plan for OpenStudio is. Supporting only 30% of EnergyPlus objects limits the usefulness for users.

### C. Accomplishments/Progress

This project was rated **3.3** for its accomplishments and progress.

- It looks like the project is tracking well toward well-established goals.
- Initial versions of this project have been released and all milestones were met.
- It is not entirely clear from presentation where this project is. This is always an issue with software development projects such as this.
- This project is still in beta after more than five years of work. It is unclear when version 1.0 will be released (version 0.11 was just announced). There are lots of cool and useful features, but the vision for the overall product and when the project will be complete is not clear.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.0** for its collaboration and coordination with relevant stakeholders.

- The software is already recognized as state of the art and used by thousands around the country and abroad and is the result of collaborations with government and private partners.
- There is lots of obvious interest in the SDK; this is a great step forward. However, the limited support (30%) of EnergyPlus objects limits the potential market impact. It is unclear as to why there is a push to new engines before getting to 50% of EnergyPlus.
- This project would be outstanding except that there is no clear feedback from the actual end users in the market. It is great to be working with manufacturers who can use the system (e.g., Trane), but the project might not develop a system that (for example) would make Leadership in Energy and Environmental Design, building energy quotient (bEQ), Portfolio Manager, and other tools more capable, less user-hostile, and more influential in the industry.
- More collaboration with actual practitioners and more focus on working with auditors on ease-of-use and accuracy issues in actual applications would be helpful. Any feedback should be incorporated into the development process. The goal should be to enable this to be an accurate and cost-effective tool for modeling and categorizing energy use, even in very small buildings, without the need for substantial special training. To be successful, this program will have to be used directly by those who conduct audits, not a specialized modeler.

### E. Proposed Future Work

This project was rated **2.8** for its proposed future work.

- The outline is reasonable, including collaboration and support of early version users and expansion of the product to a wider variety of building types. A big focus for this product should be on smaller buildings. This is not clear in the presentation.
- The release schedule will continue. It is not clear if new funding will be proposed to continue the software development and support.
- There is little information on future work; for example, the other 70% of EnergyPlus objects.
- This is inherently a multi-year effort.

**Project Strengths:**

- Producing an automated (easy-to-use) tool that can quickly and accurately categorize the energy use of existing buildings would be very helpful in assisting the improvement of the energy performance of existing buildings. This can also be used to help standardize the format of building energy audit reports.
- This project is outstandingly important, complex, and ambitious. It is useful for academia and industry.
- Open Studio SDK is obvious gaining interest in the private sector.

**Project Weaknesses:**

- To date, computer modeling has not been very helpful in improving building energy efficiency. Truly effective design practitioners increasingly see the modeling as a code or program requirement only, and not an important part of the actual design or auditing process. A big part of the problem is how modeling is configured and used. Computer modeling could be very helpful in the analysis of heating and cooling loads for buildings, but to be helpful in this area a much more in-depth picture of how loads vary dynamically is needed. Some practitioners now import the 8760 load data into spreadsheets that can be manipulated to help them better understand the characteristics and dynamics of everyday loads in order to more effectively configure heating, ventilation, and air conditioning (HVAC) zones and systems. Current modeling procedures typically employ specialists who often do not understand the finer points of building operation, equipment, systems, and especially controls. These programs also incorporate algorithms that are not widely understood to operate the various mechanical systems. As a result, the exercise often does not enlighten the engineer about the dynamics of the building's operation and the transfer of information about what should, could, or has been modeled. The engineering and implementation process almost always fails and most buildings operate far less efficiently than possible or as expected. As potentially important as modeling could be to developing more efficient buildings, it is probably the most overvalued and poorly configured element in the building design and construction process. New approaches must be considered and applied to change this. This project seems to be building on, rather than departing from, the existing structure of modeling programs.
- This project has incomplete implementation of EnergyPlus objects (30%) and seemingly scattered feature development.
- This project needs to provide some details on the accuracy of the simulation results.

**Recommendations:**

- The reviewer worries that this is a component-dominated model that seems to slight system interactions. It is not just about the details of the windows selected, but about the details of how they are installed. Comparing HVAC system types requires being able to look at estimates of system-level performance at different levels. It would be good to, for example, compare chilled beam with variable air volume (VAV) approaches early in the design and development phase. But, there is not a single answer since a lot will depend on water-side and air-side efficiencies (pipe and duct sizing and layout, for example, can have huge effects). There is an enormous need for designers to look easily at the energy and economics of optimizing such things.
- The short-term goals for this program should be focused on benchmarking energy use only for existing buildings. It is recommended that the project avoid implementing features aimed at simulating strategies to improve building energy performance. Features, such as advanced controls, should not be allowed to drain resources from the primary task of this project in order to provide an easy-to-use and accurate benchmarking tool for existing buildings into various categories, such as lighting, heating, cooling, and plug load. And, it should provide as much detail as possible so it can be readily determined by others what approaches would be most effective in improving the energy performance of the building modeled.
- It is unclear how the project deals with the poor quality for more green building extensible markup language (gbXML) and industry foundation classes (IFC) models. It is unclear if the user has to deal with that. It is unclear what the split between development and support is and how quality control is dealt with in the business capability lifecycle (BCL). "We have a process" was all that was covered by the presenter.
- One reviewer did not enter a response.



## Project # ET-03: AutoTune (Building Energy Model Calibration)

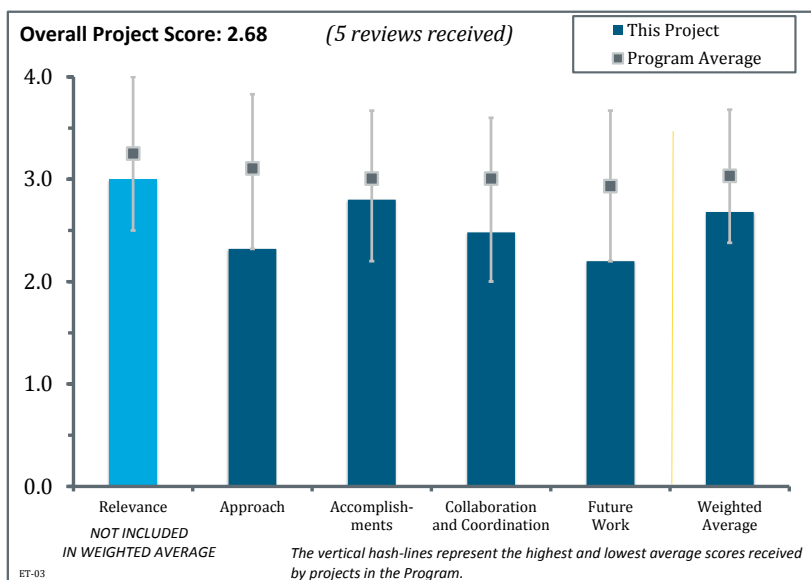
Joshua New, Oak Ridge National Laboratory, [newjr@ornl.gov](mailto:newjr@ornl.gov)

Amir Roth, U.S. Department of Energy, [amir.roth@ee.doe.gov](mailto:amir.roth@ee.doe.gov)

### Brief Summary of Project

The AutoTune project is using machine learning techniques to develop an automated process for calibrating (or “tuning”) unknown or uncertain energy model inputs (e.g., infiltration rates and equipment efficiencies) using measured data, such as utility bills, interval meter data, and Building Management System (BMS) data. Calibrated energy models are used for retrofit analysis, building commissioning, and dynamic building operation. Now completing its second year, the AutoTune project has demonstrated the ability to tune residential and office building models with certain HVAC system types to within

ASHRAE calibration guidelines. Current work is focusing on expanding the range of building types covered by AutoTune as well as improving tuning accuracy and the speed of the tuning process.



### A. Relevance

This project was rated **3.0** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This project provides indirect benefits for achieving BTO’s goals of a 50% energy consumption reduction. This project is grounded on a well-based hypothesis that the accuracy of energy modeling tools depends on input data. It improves the accuracy of energy modeling tools, considering absolute values of results, and in this way it extends the applicability of these tools. It enables energy analyses and design decisions for technologies whose performance depend on unreliable stochastic data, such as occupancy, infiltration, etc. However, even with current modeling methods that are based on not-so-well-tuned energy simulation models, decision makers (engineers, architects, owners, etc.) can make relevant decisions. Therefore, this project is not as much relevant for new buildings as for existing buildings.
- This tool could be an important part of the OpenStudio suite. It aims to address an important issue, which is whole-building energy model calibration. An uncalibrated model can be dangerous, but a model that appears to give the right answer for the wrong reason is perhaps even worse. Calibration of the model is very time consuming and is one factor preventing widespread uptake of modeling as a tool for new and retrofit design.
- Autotuning building energy models is an excellent topic for the U.S. Department of Energy (DOE) and BTO to invest in. This project is tackling a much-needed issue that is currently keeping model-based estimates of energy efficiency potential from wide acceptance and use in the marketplace.
- This is a great project with the potential to be very useful across a broad range of building types.
- The problem statement on slide two is exactly correct.



## B. Approach

This project was rated **2.3** for its approach.

- If the project can in fact reach the goals on slide three, then the approach works.
- The important barriers are clearly identified. What is not clear is if the methodology proposed will be sophisticated enough that AutoTune will not arrive at the right answer for the wrong reason. The approach needs to be able to check for errors in the model, which may be in the form of omissions or errors in input data. Additionally, there is the case where the model is physically correct, but one or more of the building energy systems is not functioning properly due to a malfunction. In this case, the impact of the malfunction is attributed to the complete building, and while this may give the correct estimate of total energy consumption, it may lead to incorrect retrofit actions being taken. This is a very complex problem that was not dealt with thoroughly in the presentation.
- Without getting more details about the project, such as a detailed proposal, it is difficult to rate the overall approach. However, based on the presentation it seems that the project research team is handling the project very well. The project has very well-characterized research questions and a well defined scope. It seems that researchers investigated various aspects of the project. The research team is aware of the type of problems that may appear. The presenters handled all the questions about the possible barriers and weaknesses of the project very well, which indicates detailed analysis and high-quality research.
- It is unclear from the presentation materials if the AutoTune technology will be available under an open source license or if it is proprietary. If the latter, that is unfortunate as the reviewer believes that all DOE BTO investments in software-related technology should result in open source products.
- It is not clear what the deployment plan is. The examples shown were based on houses an order of magnitude less complex than commercial buildings. It is unclear how well this works with commercial buildings.

## C. Accomplishments/Progress

This project was rated **2.8** for its accomplishments and progress.

- This is a good validation approach. The project uses systematic selection of detailed validation data ranging from Oak Ridge National Laboratory's houses with very detailed monitoring to energy audit data from weatherization with only a few data points. The presenters could show more validation data in this presentation, but this would probably require more than 20 minutes for the presentation.
- This project is difficult to assess, given that the tool has not been released and the data presented, while very impressive, lacked sufficient detail. The project management seems to be on track.
- This project is on track and budget.
- It is unclear how far this autotuning project has come in terms of the entire scope of building energy modeling. It is unclear if its current use is limited to autotuning the building envelope parameters, or if it also includes tuning lighting and HVAC system parameters.
- One reviewer did not enter a response.

## D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **2.5** for its collaboration and coordination with relevant stakeholders.

- This project has excellent potential market impact. The funding chart shows significant collaboration from cost-sharing partners.
- This project has a large potential for collaboration with entities such as universities, utility companies that have smart metering data, and other DOE laboratories. However, it seems that current collaboration is only between different divisions in the National Renewable Energy Laboratory.
- It is unclear if there are any autotuning products coming out of this work that are not proprietary. If this is true, then the technology transfer and market impact will be more limited than is necessary.
- It is unclear what the deployment plan is, how the private sector will be able to use and deploy this, and what will happen with future technology changes. It appears that it uses pre-calculated results to determine

where to start with the optimization (i.e., changing thermal characteristics of windows by 25% affects energy use by 5%, while decreasing infiltration by 10% equals 10% energy change, the focus should be on the infiltration as the driver). It is also unclear if the starting points are even realistic across a broad range of building types where process loads (refrigeration, cooking, etc.) are the majority of energy use.

- This project's collaborations and contributions are dominated by in-kind computing, mostly supercomputing. The need for such computing power calls into question the viability of calibrating complex models on desktop machines.

## E. Proposed Future Work

This project was rated **2.2** for its proposed future work.

- The presentation provides some aspects of future work.
- An audience question revealed that air infiltration is not dealt with effectively and is an important factor that needs to be addressed going forward. It is not clear if retrofits will be treated in the same way as new builds and how inherent performance degradation with age of the building will be dealt with. This ties back to the air leakage and other parameters that vary with building age.
- The next steps look to be very limited and it is unclear if there will be any more development. It is unclear if this project is really completely finished.
- The future work is not described in detail.
- The future work is not well documented on the slides.

## Project Strengths:

- There is an urgent need for this tool. The preliminary reports are promising. This project is connected to OpenStudio.
- This is useful research and application for dealing with huge multidiscipline-optimization projects.
- This project has well-defined goals and high-quality research work.
- Two reviewers did not enter a response

## Project Weaknesses:

- This is a great idea and approach. The reviewer would need to actually try using the tool in order to comment more.
- There are some questions around the methodology. There is a potential to get the right answer for the wrong reason and for users to place more credence in the results than they ought to.
- There was little thought (presented) as to how to deploy and how the private sector can use this tool.
- The collaboration could be improved.
- One reviewer did not enter a response.

## Recommendations:

- This project should add independent entities/institutions in the validation process of the AutoTune algorithms.
- It is unclear if this tool will be open source.
- Two reviewers did not enter a response.

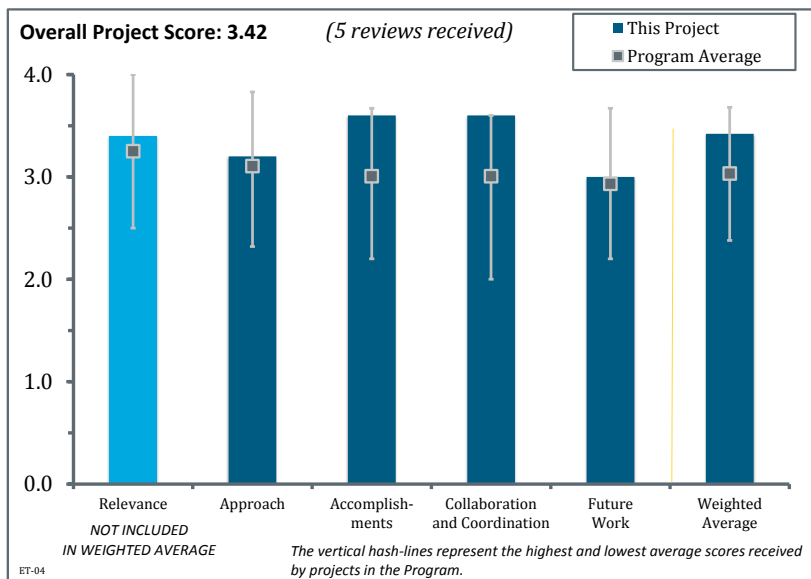
## Project # ET-04: Standard Method-of-Test for Integrated Heat Pumps

Wayne Reedy, Oak Ridge National Laboratory, wreeedy2@comcast.net

Antonio Bouza, U.S. Department of Energy, antonio.bouza@ee.doe.gov

### Brief Summary of Project

The primary goal of this project is to develop an acceptable method-of-test (MOT) standard for integrated heat pump (IHP) products. Specific objectives include the following: (1) development of a uniform MOT along with performance descriptors understandable by the consumer and (2) establishment of a rating standard to facilitate market penetration of these energy-saving appliances. The endpoint of the project will be a rating standard that will allow consumers to make informed comparisons of the energy performance of integrated appliances to that of a suite of separate-function appliances. Because the IHP can reduce energy use by  $\geq 50\%$ , it can make a significant contribution to meeting the Building Technologies Office (BTO) goal of reducing building energy use by 50% by 2030.



### A. Relevance

This project was rated **3.4** for its relevance to BTO goals and objectives.

- There has not been a generally acceptable MOT standard for IHP available in the market for industry use. This project worked with ASHRAE to form SPC206 and developed an MOT for IHP. To be able to test the performance of the IHP, a standard was needed. The outcome of this project is important and relevant to meeting BOT's goal of reducing energy use.
- This is not a direct energy savings project so it does not have a direct relevance to the BTO energy savings goal. However, DOE is statutorily required to consider the industry consensus process in establishing test procedures. This project is a great example of this statutory requirement.
- IHP testing method has a moderate impact on market penetration.
- Two reviewers did not enter a response.

### B. Approach

This project was rated **3.2** for its approach.

- The project team worked diligently to review existing standards, engaged all stakeholders, and developed this new standard through ASHRAE in record time. All available measurement equipment and techniques are being employed to minimize burden on industry users. The draft standard is available for public review. Upon responding to public comments, it will likely be adopted as a new industry standard.
- The six new "combined appliance" metrics that were established recommend developing one stand-alone metric that will allow the efficiency of air- and ground-source IHPs to be compared against one another, respectively.
- This is the best way to develop a consensus on this much-needed test procedure.

- This project integrates a heat pump test method and compares energy performance of integrated appliance with separate function appliances. Though such an approach can be better understood by consumers, it is confusing and misleading. Though mathematically correct, it compares the component output and added energy used by this component with the output and input of the corresponding separate function appliance. It does not account for the cascaded energy used by the component. It would be more accurate to compare the input energy of the IHP and multiple outputs with the sums of inputs and outputs of separate function appliances.
- One reviewer did not enter a response.

### C. Accomplishments/Progress

This project was rated **3.6** for its accomplishments and progress.

- Developing a new MOT standard is time consuming and requires a delicate inclusion of all stakeholder input. The presenter and collaborators have made excellent progress thus far.
- A public review draft is under review. This has been developed in a relatively short time as compared to other efforts.
- Three reviewers did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.6** for its collaboration and coordination with relevant stakeholders.

- This project has excellent teamwork. All major heat pump manufacturers are involved in developing this standard.
- This project results in direct contact with all parties interested in this topic (i.e., manufacturers, utilities, users, and academia).
- Three reviewers did not enter a response.

### E. Proposed Future Work

This project was rated **3.0** for its proposed future work.

- The reviewer has been involved with the development of two ASHRAE MOT standards and is familiar with the process. Waiting for public review comments regarding this IHP MOT standard and resolving issues are the last steps before adoption of the standard. The proposed plan of action is appropriate.
- This project cannot stop now. The effort is only half done. The comments received in response to the public review could be substantive and difficult to resolve.
- It looks like almost all of the work is done.
- Two reviewers did not enter a response.

### Project Strengths:

- It appears the committee is well balanced. Accordingly, all perspectives were addressed during the development of the current draft. The presenter indicated that the committee vote for the current draft was unanimous.
- This is a good project and is done well; congratulations to the project team.
- This MOT for IHP was needed.
- Two reviewer did not enter a response.

### Project Weaknesses:

- The project is at risk of being delayed if considerable objections are raised in the public comments.
- Four reviewers did not enter a response.

Recommendations:

- DOE needs to assess the delays that might develop as a result of objections to the standard. At some point, it may be necessary to act on its own authority (i.e., issue a proposed test procedure).
- Four reviewers did not enter a response.

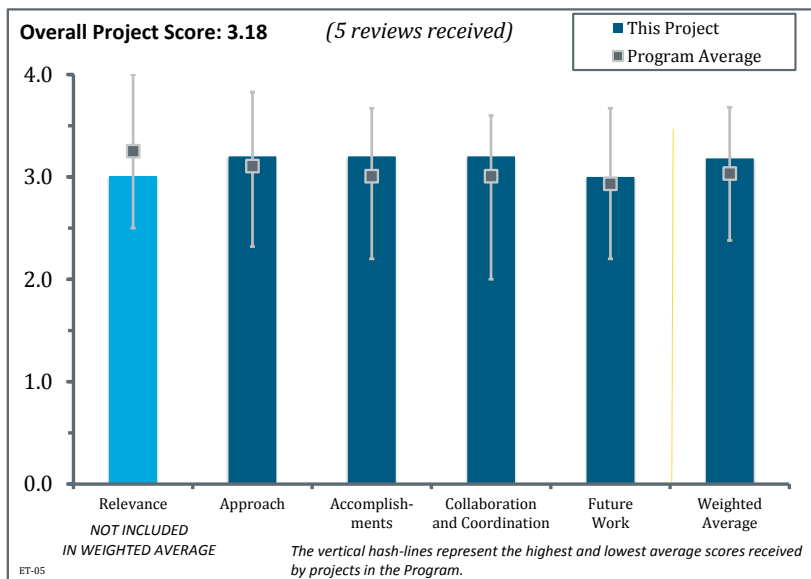
## Project # ET-05: Multi-Function Fuel-Fired Heat Pump

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### Brief Summary of Project

The primary goal of this project is to develop and promote the market introduction of a residential, fuel-fired, multifunction heat pump that can achieve the 20% heating, ventilation, and air conditioning and 60% water heating energy savings required to meet the Building Technologies Office (BTO) goal of 50% reduction in building energy use by 2030. Specific objectives include (1) reducing primary energy consumption by 30%, with a cooling source coefficient of performance (COP) of 1.3 and a heating source COP of 1.5; (2) reducing water heating energy consumption by 80%; (3) improving the reliability of the electric grid by reducing peak power demand by 85%; (4) using natural gas, an abundant U.S. energy resource, as a fuel; and (5) protecting the environment by reducing carbon emissions by 30%, nitrogen oxide by 30%, and sulfur dioxide by 95%.



### A. Relevance

This project was rated **3.0** for its relevance to BTO goals and objectives.

- This project has good BTO goal relevance in terms of the magnitude of the portion of the end use energy addressed, also residential heating, cooling, and water heating. The best aspect is the fuel switching to natural gas, which may not be a specific stated goal of BTO.
- This project seeks to build upon the success of commercial heat pumps and develop a residential heat pump using a natural-gas-engine-driven compressor. It uses waste heat recovery for space heating as well as water heating and takes advantage of new controllers for optimized performance. It appears that the proposed system offers energy saving in support of BTO goals.
- Development of small-scale integrated systems for air-conditioning, water heating, and power generation is very important for efficient utilization of fuel energy and reducing the grid load.
- It is doubtful that a fuel-fired heat pump will be able to have the market penetration to have a significant impact on BTO goals.
- One reviewer did not enter a response.

### B. Approach

This project was rated **3.2** for its approach.

- The overall system integration and use of available open source control board and off-the-shelf heat exchangers are providing confidence in achieving the project goals while keeping the cost at a reasonable target level. The use of computational fluid dynamics (CFD) for identifying flow and heat transfer issues is OK, but care must be taken when using the simulation results. The outcome of the simulations are highly dependent on boundary conditions, grid generation, and use of appropriate user-defined functions (UDF).

Using the results as an initial aid in system evaluation is OK, but they should not be used as the only source. It is not clear if the flow control issues are identified and resolved. While the initial results are promising, the cost and maintenance issues should be given careful consideration.

- It appears that the performers are focused on critical aspects of the project, such as cost reduction and enhancing the system reliability and longevity. These two parameters (i.e., critical barriers) ultimately determine the success and market penetration level of the technology. Close communication/collaboration/partnership with heat exchanger and fan manufacturers, as well as electronics manufacturers, is important. A two-year maintenance schedule is reasonable.
- There are many barriers to address. The approach is appropriate for developing a prototype and evaluating the performance. But, the overall barriers of cost and market acceptance may be more difficult for the current team.
- The project needs to include an analysis of typical building load profiles for heating and power to determine the size of the equipment and the use of produced heat. A comparative analysis of maintenance requirements is also needed.
- Although this system is capable of greatly reducing building energy use, its up-front costs will be a major barrier to market acceptance.

### C. Accomplishments/Progress

This project was rated **3.2** for its accomplishments and progress.

- A stage-gate process is being employed to monitor progress and reduce risk. So far, the progress has been in line with the project plans. COP results for the alpha prototype are promising, but total system integration will impact the final performance results.
- The achieved performance metrics are close to the objective.
- This project's progress is difficult to judge. There is a long way to go at this point. The addition of the power generation part is a major extension of scope of the project. That part of the project is scheduled for next year.
- Two reviewers did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.2** for its collaboration and coordination with relevant stakeholders.

- The team has done a good job of recruiting and involving natural gas service providers and internal combustion engine manufacturers. It is unclear if any heat pump manufacturers are involved.
- It was stated that in order for this system to operate efficiently, its oil would need to be changed every couple of years. In order for the market to accept this new technology, the effort needed to maintain the system must be thoroughly thought out.
- There are some collaborators, but there is a need to establish a collaboration that can address the market penetration barriers.
- Two reviewers did not enter a response.

### E. Proposed Future Work

This project was rated **3.0** for its proposed future work.

- The reviewer is curious to know what the overall cost/benefit will be upon incorporating a power generation feature. A resident's ability to sell electricity back to the grid as well as financial incentives varies considerably throughout the country. A sufficient amount of market research must be conducted to ensure that this system is marketed in the appropriate regions of the country, both from the weather and sell-back perspectives.
- The proposed future plans and schedule are appropriate. Some steps seem to be generic in nature and do not include specificity.
- This project should continue working on cost reduction and required maintenance.



- The addition of the power generation aspect should be attempted. There may be more technical issues to address as the power generation aspect is evaluated. Without a clear view of the market acceptance, this project may not make the cut. This is a very costly and sophisticated system for residential application.
- One reviewer did not enter a response.

### Project Strengths:

- This is a good project and is making good progress. Reaching the beta unit, completing additional development work, performing careful testing, and eventually marketing is far away and requires the attention of the entire team.
- The project is very well aligned with the BTO goals. The approach is reasonable, but similar efforts in the past have failed. The fate of this technology hinges on cost and reliability.
- This team will deliver a prototype for evaluation. If that is all that is expected, the project team will deliver. The presenters have identified a couple of technologies to improve the product and one to reduce the cost of controls.
- Two reviewers did not enter a response.

### Project Weaknesses:

- The project needs to address market acceptance. Perhaps some expertise can be added.
- Four reviewers did not enter a response.

### Recommendations:

- It would have been helpful if a better explanation was provided of the system diagram. It was not clear how the water freezing issue was addressed. System performance should be analyzed over an entire year to better quantify annual energy savings. The impact of engine vibrations on the compressor, increased leakage rate, etc. were not discussed.
- Sometime down the road, DOE needs to assess this project and determine whether there is a market for this costly and different technology. If DOE/BTO starts to aggressively pursue the fuel switching aspect of this technology, then this project could become more of a priority.
- Three reviewers did not enter a response.

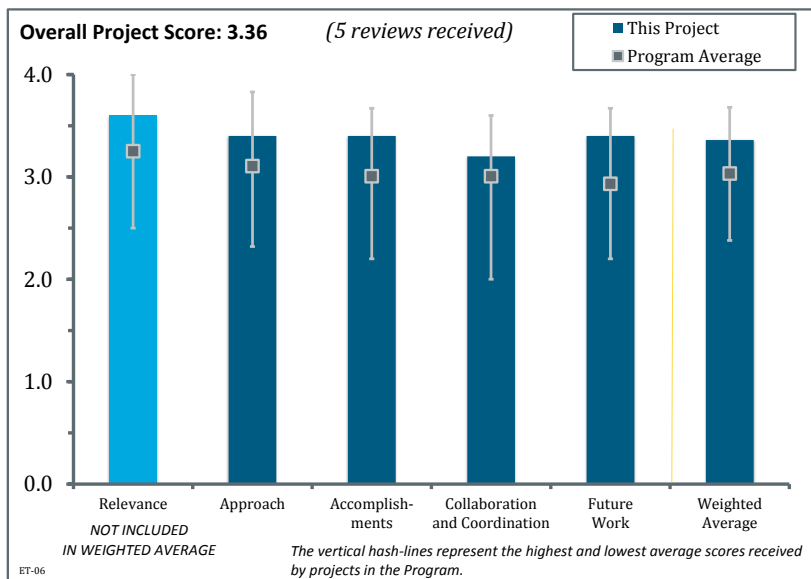
## Project # ET-06: GATEWAY (Solid-State Lighting Demonstration)

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### Brief Summary of Project

GATEWAY is one of the U.S. Department of Energy's (DOE's) integrated set of market development support activities for high-performance solid-state lighting (SSL). These market development support activities are intended to affect the types of SSL general illumination products adopted by the market, to accelerate commercial adoption of those products, and to speed appropriate application of those products to maximize energy savings. GATEWAY addresses the SSL users' need for information and their high transaction costs by providing well-documented case studies of SSL in real-world installations; information about how SSL products compare to traditional lighting technologies; and objective, widely available technical information from a credible source.



### A. Relevance

This project was rated **3.6** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This appears to be a very well-thought-out and well-directed project. Implementation of efficient and effective light-emitting diode (LED) lighting is a strong element in meeting BTO energy reduction goals.
- Demonstrating new technologies to specifically identify market acceptance issues is an excellent area for DOE/BTO resource investments.
- The need for demonstration is sometimes a challenge to defend. It is difficult to measure the impact of these efforts. Products change so quickly that relevance is an issue. The cost and timeline of GATEWAY studies seem inadequate to the challenge. It also seems burdensome to partner with DOE.
- This project seems to be focused on purchasers or designers who would specify relevant information for end users or companies.
- One reviewer did not enter a response.

### B. Approach

This project was rated **3.4** for its approach.

- The project has been a shining light in terms of interaction with industry, doing what industry could not do on its own, reaching goals, and publicizing the accomplishments of its allies. It is a distillate of the best of ENERGY STAR.
- The project appears to be soundly directed with a good understanding of issues and barriers. Frequent meetings and discussions with manufacturers and users are very useful.
- The method for identifying and prioritizing opportunities needs better explanation. Obviously this project should tie in with a larger market development plan, but that was not made explicit. The research team needs to increase focus on the foundational components or elements of the technology, like the proposed

shift of CALiPER efforts from products to more issue-based analysis. It was unclear why the presenters showed equivalent potential for residential and commercial applications, yet focus GATEWAY entirely on commercial buildings.

- The goal to double efficiency may be audacious enough, but it is not clear if it is practical. It is unclear how long it will take to produce and what the benefit is in reduction of energy compared to present technology.
- One reviewer did not enter a response.

### C. Accomplishments/Progress

This project was rated **3.4** for its accomplishments and progress.

- The release of information regarding product weakness with outside input in a salesman-free environment is a great resource for purchasers.
- This seems to be right on track for converting the outdoor lighting industry to more efficient LED lighting.
- It is unclear what laid the groundwork for saving so much energy by getting to scale so quickly.
- It is unclear how the impact of demonstration projects will be measured. Time and cost do not seem well suited to the actual barriers in the market.
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.2** for its collaboration and coordination with relevant stakeholders.

- As presented, the level of collaboration with both industry and potential users is outstanding.
- Collaboration, technology transfer, and market impact are the DNA of the DOE SSL program.
- It is unclear if the project is partnering closely with manufacturers. It would make sense in order to share the cost of early deployment with them and tighten the feedback loop through close collaboration. The presenter stated they screen out “bad applications.” It is unclear if findings and lessons learned should be communicated from that process.
- Greater collaboration with designers and controls experts would increase the value of technology transfer.
- One reviewer did not enter a response.

### E. Proposed Future Work

This project was rated **3.4** for its proposed future work.

- Great progress in virtually all areas has been achieved, with the exception of the controls issue that needs to be addressed and how fluorescents may play a role in the future of lighting.
- As the project is near completion, it is extremely important that the results of employing these more efficient lighting systems be well publicized to those industries and groups that are prospective users. Papers and articles in those trade journals should be undertaken and strongly encouraged by others.
- The plan was not explicit by application or product category, despite the existence of a multi-year plan that should identify a reasonable sequence of industrial development.
- Two reviewers did not enter a response.

### Project Strengths:

- The DOE SSL program is absolutely exemplary. It is marked by very tight collaboration with industry to set and refine performance goals and metrics, and to keep the playing field level. There is great emphasis on the “scorekeeping” and “referee” functions that let the players focus on building and marketing ever-better products. This project is flexible and adaptable, such as its ability to recognize and embrace the role of fixtures/luminaries in addition to the raw lumens/watt of the LED itself. This project has the uncanny ability to see the application areas with great early promise, such as municipal street lighting, stimulated by American Recovery and Reinvestment Act (ARRA) funding.

- LED lighting has the opportunity to transform the lighting industry into a new era of efficiency. This project is certainly aiding that transformation.
- The presentation had good detail. The study design seems well considered.
- Generally, lighting has been a no-brainer in the industry for retrofitting in buildings, but discrepancies regarding information and no outside objective reviews has created concern in the industry. This project continues to support the adoption of new lighting programs based on fact, not fiction.
- One reviewer did not enter a response.

### Project Weaknesses:

- The reviewer has always supported procurement-oriented goals, but the L Prize was fantastic. The only concern is that the prize approach, which works so well for “widgets,” might have more difficulty with replication in areas that require systems integration and whole-building thinking. It would be better to see a “pay-for-performance” approach to acquiring buildings, for example.
- It is unclear why no attention was given to residential applications. The reviewer also questioned how one can defend the value of demonstration in this industry versus support of a regime for quality assurance. The market naturally demonstrates products and weeds out the bad ones. DOE could invest in the infrastructure for accelerating that feedback cycle across all applications instead of funding a small number of trials. It is unclear whether these funds should be spent in another manner.
- The project needs to be certain the momentum it is developing has the ability to continue on its own. It needs to end with the right resources in place. This issue is not well addressed.
- Controls and marketing of the information seem to be the major weaknesses of the project.
- One reviewer did not enter a response.

### Recommendations:

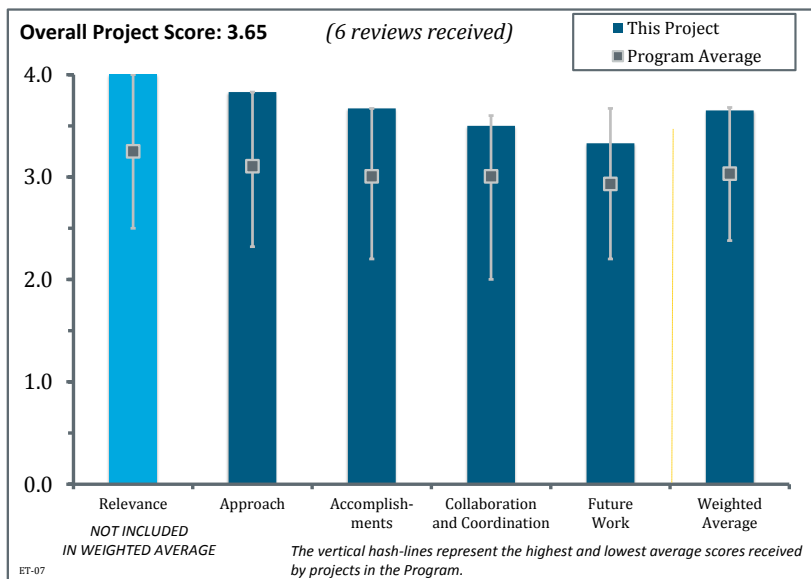
- The reviewer is an admirer of what Brodrick and his team have accomplished, and the postings they frequently do to show what is happening and where they are headed.
- The project should deeply consider whether this is the right model for investment for this particular barrier to market development. The reviewer is concerned with the analysis provided by Navigant in the January 2012 report, Energy Savings Potential of Solid-State Lighting in General Illumination Applications. Navigant’s assumptions and analysis do not seem to have the sophistication demanded for guiding efforts that may be used in planning a large program such as the SSL initiative. For example, Navigant assumes that demand for artificial lighting (essentially, lumens per square foot) will not change, even though the cost of light is expected to decrease and new technology will open up new applications.
- This project is very well funded, so it may not be quite fair to compare it to other DOE/BTO projects that do not have ample or even sufficient resources.
- It is time to focus on what is required to keep the industry moving after this project ends.
- One reviewer did not enter a response.

## Project # ET-07: CALiPER (Commercially Available LED Product Evaluation and Reporting)

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### Brief Summary of Project

CALiPER is one of the U.S. Department of Energy's (DOE's) integrated set of market development support activities for high-performance solid-state lighting (SSL). These market development support activities are intended to affect the types of SSL general illumination products adopted by the market, to accelerate commercial adoption of those products, and to speed appropriate application of those products to maximize energy savings. CALiPER addresses the market need for credible, third-party product information by providing independent performance test results, benchmark testing, and data for conventional lighting technologies; supporting development of industry standards and test procedures; and conducting independent investigations of key SSL technical challenges and issues.



### A. Relevance

This project was rated **4.0** for its relevance to Building Technologies Office (BTO) goals and objectives.

- CALiPER seems to focus correctly on lamps and other categories where the buyer may bear more risk due to a lack of information, replacement lamps, wall packs, and so on. This is a positive step toward issues that cross categories. Product testing is a valuable function in the marketplace, but it may be better addressed by ENERGY STAR, Lighting Facts, and other off-the-shelf quality assurance. It may be appropriate to conduct category-level testing as originally designed, where a category may have an unusual variability in quality, for example, to elicit factors and solutions.
- With the evolution of light-emitting diodes (LED) as a low-energy and low-maintenance alternative to mainstream lighting technologies, this could have a very important part in all three aspects of the BTO ecosystem, by driving code adoption, research and development, and comparisons within the marketplace.
- Like GATEWAY, this appears to be a very well-thought-out and well-directed project. Implementation of LED lighting is a strong element in meeting BTO energy reduction goals.
- Objective and relevant performance standards for new technologies is an excellent use of DOE/BTO resources.
- This project challenges the industry to meet minimum requirements and standards.
- One reviewer did not enter a response.

## B. Approach

This project was rated **3.8** for its approach.

- This project appears to be soundly directed with a good understanding of issues and barriers. Frequent meetings and discussions with manufacturers and users are very useful. Looking for and addressing potential problems is extremely important to the success of the LED lighting transformation effort.
- Key market barriers were well addressed and the focus on commercially available products appears to have things headed in the right direction. The key LED issues identified, such as flicker and dimming problems, are definitely real-world problems that need to be addressed.
- CALiPER product performance reports have become the industry standard; this project is well funded and the numerous work products are effectively supporting the marketplace.
- The program has been a shining light in interaction with industry, doing what industry could not do on its own, reaching goals, and publicizing the accomplishments of its allies. It is a distillate of the best of ENERGY STAR.
- This project provides information, quality of performance, and independent testing, as well as reduces initial costs. It hits the industry mark for owners and managers.
- This project needs improvement, but it is also showing improvement.

## C. Accomplishments/Progress

This project was rated **3.7** for its accomplishments and progress.

- The LED Lighting Facts project and website are a good resource. Additionally, the report from August 2012 is a good document. Industry recognition and respect pushed this from a rating of “good” to “outstanding.”
- This project appears to have helped move the trend of more efficient LED lighting ahead nicely with its accomplishments to date.
- It is unclear what laid the groundwork for saving so much energy by getting to scale so quickly.
- Five reports were released, 200 products were tested, and educational seminar/webinars/roundtables achieved their goals.
- It is unclear if there is a quicker way to release findings than a paper report. There should be better integration into the Lighting Facts database.
- One reviewer did not enter a response.

## D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.5** for its collaboration and coordination with relevant stakeholders.

- As presented, the level of collaboration and transfer of knowledge/technology seems to be very good.
- There have been good market collaborations and good communication of the results with this project.
- Collaboration, technology transfer, and market impact are the DNA of the DOE SSL program.
- Interaction with end users, manufacturers, and R&D and design firms created a huge impact on the market.
- The project has excellent collaboration with the SSL industry.
- It is unclear why manufacturers should not pay a fee to support quality assurance. It is also not clear why DOE is funding this project out of its normal budget. DOE should take advantage of this effort to creating a neutral, industry-supported organization to provide quality assurance functions.

## E. Proposed Future Work

This project was rated **3.3** for its proposed future work.

- As the industry evolves and the up-front cost for lighting comes down, continuation of this effort will only become more important.

- Working with industry organizations, such as in the Lighting Energy Efficiency in Parking (LEEP) Campaign, will create greater deployment at the end-user level. Multiple deployment avenues are needed to create the maximum market adoption.
- The proposed work toward fiscal year 2016 goals appears appropriate and the goals are exceptional.
- It is good to adapt the project to opportunities with greater overall value.
- Two reviewers did not enter a response.

#### Project Strengths:

- The DOE SSL program is absolutely exemplary. It has been marked by very tight collaboration with industry to set and refine performance goals and metrics, and to keep the playing field level. There is good emphasis on the “scorekeeping” and “referee” functions that let the players focus on building and marketing ever-better products. The project is flexible and adaptable, such as its ability to recognize and embrace the role of fixtures/luminaries in addition to the raw lumens/watt of the LED itself. The DOE SSL program has the uncanny ability to see the application areas with great early promise, such as municipal street lighting, stimulated by American Recovery and Reinvestment Act funding.
- This is an important project that could help standardize a facet of the industry that is quickly evolving (and at times evolving in divergent directions). The independent analysis and identification of key market barriers and key issues with LED lighting are strengths of the project. Additionally, some of the deliverables (LED Lighting Facts) are already valuable resources. The project appears to already have considerable recognition within the industry. There is a definite need for this project to continue.
- Transformation to LED lighting is the next big thing in improving building energy efficiency. This project appears to be a very substantial aid in that process.
- SSL seems to be a model for end users to put their toe in the water on energy efficiency programs and create successful outcomes.
- Contrary to GATEWAY, there is evidence to support the value of off-the-shelf product testing. CALiPER has done a reasonable job updating by category to keep up with the pace of market development.
- One reviewer did not enter a response.

#### Project Weaknesses:

- There are no major weaknesses in this project.
- The reviewer has always supported procurement-oriented goals, but the L Prize was fantastic. The only concern is that the prize approach, which works so well for “widgets,” might have more difficulty with replication in areas that require systems integration and whole-building thinking. The reviewer would rather see a “pay-for-performance” approach to acquiring buildings, for example.
- Developments should be publicized throughout the architectural and engineering communities.
- Some important measures of performance are not addressed. Efficacy is not all that important to the targeted market barrier. Buyers are going to be more interested in information related to the quality of the light, the quality of the product, health, safety, false advertising, and so on. It is unclear if CALiPER caught the flaws in the now-recalled Lighting Science Group (LSG) products. This project could evaluate the program’s effectiveness from that perspective.
- Mass marketing this information, such as with the ENERGY STAR label and producing case studies of successful outcomes, will create greater deployment of this project.
- One reviewer did not enter a response.

#### Recommendations:

- The reviewer is an admirer of what Brodrick and his team have accomplished, and the postings they frequently do to show what is happening and where they are headed.
- Some of these SSL projects seem to be built around out-dated models for removing market barriers. It is unclear how effective the conference call and webinar model used by Technical Information Network is for Solid-State Lighting. There are tremendous new tools for sharing information and knowledge—these should be used. Information should be shared immediately, rather than waiting for a scientific paper to be produced and uploaded to the DOE SSL website. Share findings immediately with manufacturers and

buyers, then report to the public on the success of those efforts. This reviewer is concerned with the analysis provided by Navigant in the January 2012 report, *Energy Savings Potential of Solid-State Lighting in General Illumination Applications*. Navigant's assumptions and analysis do not seem to have the sophistication demanded for guiding efforts that may be used in planning a large program such as the SSL initiative. For example, Navigant assumes that demand for artificial lighting (essentially, lumens per square foot) will not change, even though the cost of light is expected to decrease and new technology will open up new applications.

- This project is very well funded, so it may not be quite fair to compare it to other DOE/BTO projects that do not have ample or sometimes even sufficient resources.
- This project should try to develop paths to introduce exceptionally efficient LED lighting to high-profile projects and see that the results are well publicized.
- Two reviewers did not enter a response.



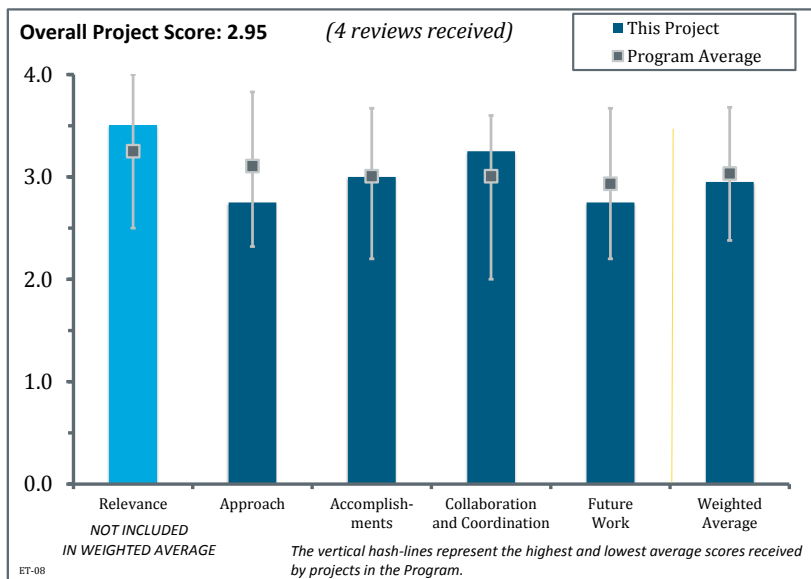
## Project # ET-08: Advanced Variable Speed Air-Source Integrated Heat Pump

Van Baxter, Oak Ridge National Laboratory, vdb@ornl.gov

Antonio Bouza, U.S. Department of Energy, antonio.bouza@ee.doe.gov

### Brief Summary of Project

The primary goal of this project is to develop and promote the market introduction of an advanced, variable speed, air-source integrated heat pump (AS-IHP) with  $\geq 50\%$  energy savings versus minimum efficiency systems. The ultimate outcome will be development of a fully variable speed version of an AS-IHP product intended to be introduced to the U.S. market by the cooperative research and development agreement (CRADA) partner (Nordyne). Because the IHP can reduce energy use by  $\geq 50\%$ , it can make a significant contribution to meeting the Building Technologies Office (BTO) goal of reducing building energy use by 50% by 2030.



### A. Relevance

This project was rated **3.5** for its relevance to BTO goals and objectives.

- The technology has good potential for not only residential and small commercial buildings, but for larger dining facilities, laundries, and other facilities with more stable heat loads throughout the year. This project needs examples and analysis of load profiles and heat generation capacity. The objective of this project is to develop advanced HVAC systems with water heating capability for residential or small commercial buildings. The proposed technology development may be used in new construction or retrofits. The expected energy efficiency for space conditioning and water heating services is relevant to the goals of BTO.
- This project has good relevance because of the scope of the end use addressed: residential heating, cooling, and water heating. The limited market may reduce the potential impact.
- One reviewer did not enter a response.

### B. Approach

This project was rated **2.8** for its approach.

- Based on the review of the written materials presented and the oral presentation, the team has done a good job of designing an integrated system. The addition of a single mode water heater is a very good option. Overall, this is a promising system and preliminary results are encouraging.
- This approach will deliver a prototype for evaluation; it is basically linking up existing technologies.
- Two reviewers did not enter a response.

### C. Accomplishments/Progress

This project was rated **3.0** for its accomplishments and progress.

- This project has made excellent progress thus far. The development of the prototype and laboratory testing are completed. The first-generation package system has been fabricated and is undergoing testing. The results show energy savings exceeding the target of 50% in one region.
- It is unclear what the status of the product is. The presentation showed some assemblies. A successful field test will be a critical accomplishment. The plan indicates that a field test is in the immediate future.
- Two reviewers did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.3** for its collaboration and coordination with relevant stakeholders.

- So far, only a single manufacturer is on board. That is probably OK for now. It would be good if a utility or municipality is involved later. The presentation did not indicate any expansion of collaboration.
- The team has identified a good industry partner and progress made thus far confirms close collaboration and the keen interest of the collaborating industry.
- Two reviewers did not enter a response.

### E. Proposed Future Work

This project was rated **2.8** for its proposed future work.

- Even though the project will require additional time to complete, the proposed plan seems to focus on positive end results and success instead of just completion.
- The proposed field test is more than justified at this point, it is essential. This project needs the results of the field tests to further assess the technology.
- Modeling results for different climates that predominately use electricity are desirable.
- Two reviewers did not enter a response.

#### Project Strengths:

- Oak Ridge National Laboratory provides the necessary credibility for such a project. The manufacturer alone would be challenged to provide objective performance data, or at least the objectivity would be challenged by others.
- This project has excellent collaboration with an industry partner.
- Two reviewers did not enter a response.

#### Project Weaknesses:

- There are few engineering improvements being developed in this project. This project is just putting existing technologies together and evaluating.
- Three reviewers did not enter a response.

#### Recommendations:

- It appears a specific cost goal was not part of the project. That may be OK, but not considering cost improvements might mean that efficiency improvements are overlooked. Hopefully, the field testing will allow for further analysis to assess performance in other climates.
- Three reviewers did not enter a response.

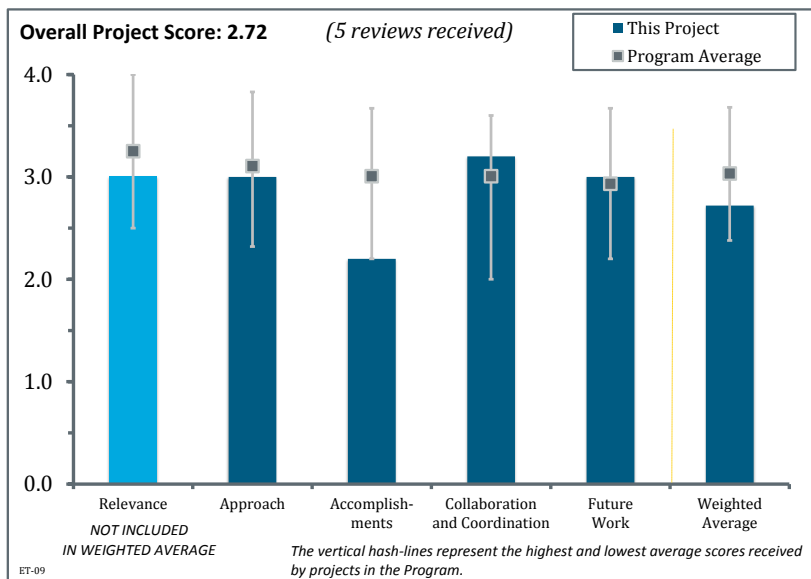
## Project # ET-09: Absorption Heat Pump Water Heater

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Antonio Bouza, U.S. Department of Energy, [antonio.bouza@ee.doe.gov](mailto:antonio.bouza@ee.doe.gov)

### Brief Summary of Project

The primary goal of this project is to develop and promote the market introduction of an absorption heat pump water heater. Absorption technology has the potential to greatly boost water heater efficiency, but it faces the barriers of high first cost and working fluid challenges. The principal metric for this project is annual energy savings of 40% for residential water heating compared to that of a baseline minimum efficiency unit. Absorption technology has the promise to achieve an energy factor exceeding 1.0 for naturally ventilated gas-fired water heaters. This project supports the market introduction of an absorption heat pump water heater that can achieve the 60% water heating energy savings required to meet the Building Technologies Office (BTO) goal of reducing building energy use by 50% by 2030.



### A. Relevance

This project was rated **3.0** for its relevance to BTO goals and objectives.

- The project studies a relatively easy product to take to market and, assuming the outcomes of the study are positive, it could make a great impact with minimal investment. Oak Ridge National Laboratory has done an excellent job of bringing in a multitude of partners.
- The use of absorption technology to enhance water heater efficiency is relevant to the goal of the BTO. This is a high-risk project with major challenges to overcome.
- Good technology for combined heat and power (CHP), solar water heating, and waste heat utilization applications.
- Because this project only addresses residential water heating and has an expected low market acceptance, it does not have the potential to make a large contribution to BTO goals. A large market share is also not likely.
- One reviewer did not enter a response.

### B. Approach

This project was rated **3.0** for its approach.

- There are no faults with the current approach.
- The simulations are used to estimate the energy factor. While the simulation results seem to be encouraging, the laboratory tests have not achieved the energy factor goal. It appears that many questions remain and it was unclear if a systemic approach is being used to resolve the outstanding technical issues. More of a trial-and-error approach is being employed to identify lithium bromide water additives.

- This project is a mix of basic and applied research. It is unclear if this is appropriate for DOE's applied research dollars. For example, a case needs to be made as to why it is appropriate to support the basic research in ionic liquids. It is unclear if there are other research entities in the topic of absorption technology on ionic liquids. It is also unclear why a small residential water heating project should lead the way in this field. It appears there is some cross pollination, but it is unclear how it all fits together. If DOE is OK with this arrangement, then it should look for basic research partners.
- Two reviewers did not enter a response.

### C. Accomplishments/Progress

This project was rated **2.2** for its accomplishments and progress.

- The rate of progress has not necessarily been slow, as represented in the "fair" rating, but the project is in the early stages of deployment and much progress is needed to better determine the feasibility of success.
- Progress has been made in developing the overall system. However, ionic liquid development has encountered challenges and it is unclear if a clear path forward has been identified.
- The most effective approach to advancing this system would be to first determine the most practical working fluid. With more than 1,010 possible solutions, it appears that the adoption of this technology may be many more years into the future.
- The presentation did not show specific progress on performance indicators. Also, a price point was not mentioned. Price could be a significant barrier.
- This project has solid results with a clear presentation.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.2** for its collaboration and coordination with relevant stakeholders.

- The team has reached out to identify collaborators. Collaboration on membrane-based technology development seems to be progressing well. There are many good collaborators involved in this project.
- The list of partners was robust and relevant.
- There are a wide variety of partners participating.
- An estimated cost must be predicted. The up-front costs of many of today's high-efficiency systems is the primary barrier for effective market penetration. Until an appropriate price premium for this system is calculated, this system will not be as beneficial as anticipated.
- One reviewer did not enter a response.

### E. Proposed Future Work

This project was rated **3.0** for its proposed future work.

- The future of the project is being well addressed.
- The proposed future plans and schedule are OK. Steps seem to be generic in nature and do not include specifics indicating the level of uncertainty.
- Hopefully a reasonably representative prototype can be developed by the time this phase of the project ends. It is likely there will be considerable future research suggested.
- Two reviewers did not enter a response.

### Project Strengths:

- This is practical technology with a high likelihood of implementation, assuming the outcomes are positive. The scientific methodology seems strong.
- There is a considerable amount of multidisciplinary expertise on the team.
- Three reviewers did not enter a response.

### Project Weaknesses:

- This is a challenging project; future obstacles and technical difficulties are yet to be identified and overcome.
- The reviewer is uncertain that the team is focused on delivering a commercially viable product in the near term.
- If feasible, the focus should be expanded to include polyvinyl chloride vented water heaters.
- Two reviewers did not enter a response.

### Recommendations:

- This project is a mix of basic and applied research, which makes it different from the competing projects in BTO's Emerging Technologies portfolio. Much of the research would benefit absorption technology in general and not just the residential water heating efficiency arena. Accordingly, a decision point to go further with this project should consider the overall DOE interest in absorption technology and not just the residential water heating aspect.
- Four reviewers did not enter a response.

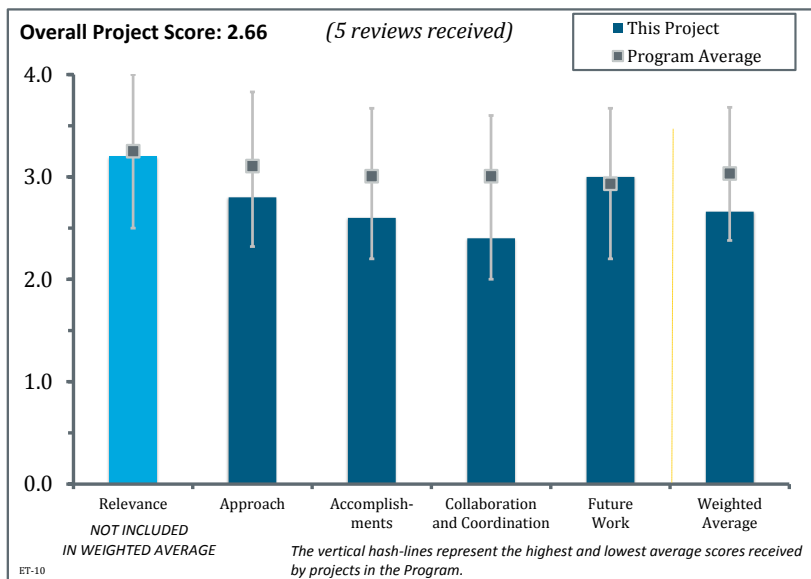
## Project # ET-10: Next Generation Rooftop Unit

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### Brief Summary of Project

The primary goal of this project is to develop a highly efficient rooftop unit (RTU). Meeting the U.S. Department of Energy goal to reduce heating, ventilation, and air conditioning (HVAC) energy use by 20% will require development and market implementation of advanced, highly efficient building HVAC equipment options by 2020. Today's RTUs are inefficient for a host of reasons. The main objective of this project is to successfully develop a system and component modeling library to facilitate the market introduction of a high-efficiency RTU at 10 tons and 20 tons (the biggest technical challenge) capable of achieving an integrated energy efficiency ratio (IEER) greater than 20.



### A. Relevance

This project was rated **3.2** for its relevance to Building Technologies Office (BTO) goals and objectives.

- With half of all United States commercial floor space being cooled by RTUs, a small improvement can make a significant impact to savings. A major improvement in technology can have a tremendous impact.
- This project supports BTO goals. However, the expected impact is rather limited. The evaluated best case scenario is \$50 million a year in energy savings. The most likely scenario is that 10%–20% of units will be replaced because of this project. It is barely sufficient to justify over \$1 million in funding for the project.
- A large number of RTUs supports this project's relevance. However, there are other programs addressing this segment of commercial building energy consumption.
- This project entails significant retrofit and purchase of RTUs in this country and validates the need for new technology in this arena.
- This is a very good project and the development of highly efficient RTUs supports the goals of the BTO.

### B. Approach

This project was rated **2.8** for its approach.

- This is a solid approach beginning with modeling, laboratory testing, and simulations. This project is very technical and results-oriented in order to break the barriers and try to discover a breakthrough solution.
- It appears that considerable simulations have been performed. The team is competent and works hard. However, limited results were available for evaluation. It is expected that more results will be available during the next review cycle.
- The approach is adequate to accomplish the project goals.

- The approach can be characterized as component optimization. The barrier is the extreme complication of analyzing a mix of options. The Oak Ridge National Laboratory (ORNL) heat pump model is the right tool to sort things out, at least initially.
- There did not seem to be any empirical evidence proving the necessity of creating a 20 IEER system with a dual compressor. The part load is not in question, but the use of a small compressor and a large compressor presents multiple failure points.

### C. Accomplishments/Progress

This project was rated **2.6** for its accomplishments and progress.

- Progress is being made, but limited results were available for review at this time, making it difficult to assess the progress against quantitative performance indicators. It is anticipated that much more specific results will be available for the assessment of progress at the next review cycle.
- The preliminary result showing IEER improvement from 11.2 to 18 is very good. This result needs to be verified.
- Testing and modeling data needs to be made available prior to making a decision on whether or not to continue this project. Product reliability reports regarding this configuration would also be helpful.
- It did not seem like progress was moving quickly or that other manufacturers were interested in jumping into the solution mix.
- The selected architecture of the RTU with variable-speed control of the smallest of three compressors working in tandem will result in a complicated control algorithm and frequent on-off operation of other tandem compressors, which will reduce the unit's expected effectiveness.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **2.4** for its collaboration and coordination with relevant stakeholders.

- The project has done good work with Trane/Ingersoll Rand and with trying to get out a few publications.
- Trane was brought on as a partner, but having more than one partner would be beneficial. There are no outcomes to review and comment on.
- It appears that good collaboration with industry partners is taking place.
- The single manufacturing partner could be considered a limitation in terms of technology transfer and market impact. Specifically, it needs to be determined if this project will only benefit the participant or the industry as a whole.
- The outcome of this project would be improved if it was conducted in cooperation with a major air conditioning manufacturer as an industrial partner.

### E. Proposed Future Work

This project was rated **3.0** for its proposed future work.

- It does not appear that there is too much more to do. The project should proceed to the planned final results.
- This project has very tangible goals.
- The proposed future plans and schedule are OK.
- The future plan as listed is a typical plan for a design project.
- The testing of a prototype needs to be completed in order to make a go or no-go decision.

### Project Strengths:

- The ORNL Heat Pump demand model is well recognized in the industry as a means to assess various arrangements of heat pump technologies. Accordingly, the resulting assessment would be credible.
- The technology could be a game changer if the project meets its goals and objectives.

- Something needs to be done to provide a breakthrough for these high-energy-wasting RTUs. The challenge is real, but difficult. Working with industry manufacturers will be key, as is (ultimately) working with utility companies to offer incentives to improve the payback economics.
- The project is based on an extensive ORNL computational tool and a library of the components that should result in the development of an RTU with an IEER of 20.
- One reviewer did not enter a response.

### Project Weaknesses:

- This project is limited because it is working with a single manufacturer. The project needs to pull in and develop competition to spur innovation and speed up the market process. The project is stuck with what one firm will provide with few options.
- It is not clear what impact selected RTU components will have on the unit efficiency. The selected architecture will have complex control algorithms with repeated on-off operation of tandem compressors that may affect its efficiency.
- The project is somewhat limited in the scope of arrangements to investigate. During the Peer Review question and answer session, the audience mentioned some more options (e.g., different tandem capacities and more variable speeds).
- The project is led by competent researchers, but limited results were presented for assessment during this peer review cycle.
- There is uncertainty about system components and reliability under load conditions.

### Recommendations:

- It appears there is one industry partner for now. The topic of optimizing components is generally applicable to all manufacturers. Care should be taken to allow the widespread dissemination of results.
- This project should conduct comparative evaluation of alternative architectures of the RTU and the effect of component selection on the potential IEER of the unit.
- Three reviewers did not enter a response.



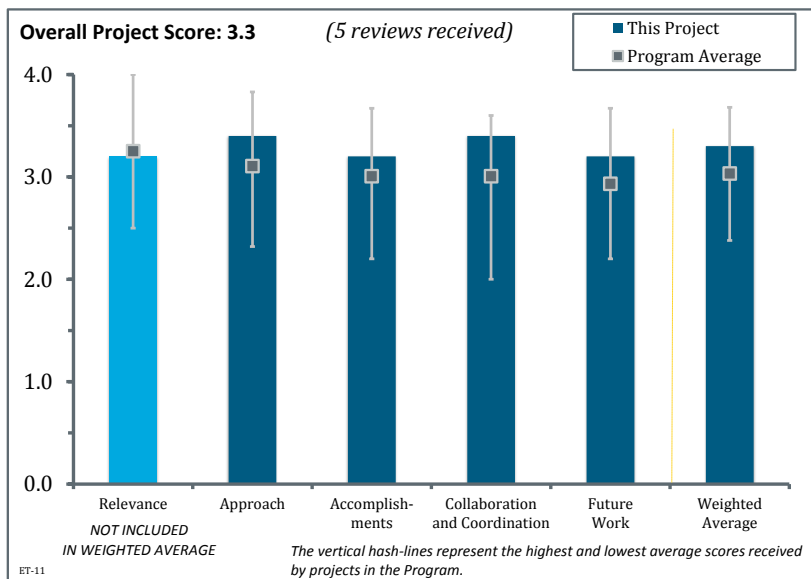
## Project # ET-11: Working Fluids Low Global Warming Potential Refrigerants

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### Brief Summary of Project

The overall goal of this project is to aid in the development of alternative refrigerants with low global warming potential (GWP). Meeting the U.S. Department of Energy goal to reduce heating, ventilation, and air conditioning (HVAC) energy use by 20% will require the development and market implementation of new refrigerants. Current low GWP alternatives may increase energy consumption, introduce safety risks, and require significant modifications to equipment at higher costs. Specific objectives of this project include providing guidance to the HVAC and refrigeration community on selecting alternative, energy-efficient, low GWP refrigerants. This includes the development of an open-source life cycle climate performance (LCCP) design tool with industry input (through the Air-Conditioning, Heating, and Refrigeration Institute) and determining and testing low GWP refrigerants.



### A. Relevance

This project was rated **3.2** for its relevance to Building Technologies Office (BTO) goals and objectives.

- Working fluids are very important components of building heating and cooling. Working fluids affect energy consumption and have significant environmental impact. The selection of the most efficient fluid within the regulations is completely in line with BTO goals.
- There is no question about the relevance of the project, but its relevance to BTO objectives is not clearly stated in the presentation.
- Development of low GWP refrigerants with little or no impact on system efficiency is important to the BTO's 50% energy saving objective.
- The project does not directly relate to the goals of BTO. But, it is an important issue to address. The project is more a "let's not make a bad situation worse" scenario rather than a direct energy savings scenario.
- One reviewer did not enter a response.

### B. Approach

This project was rated **3.4** for its approach.

- The approach is very thorough and scientifically sound. The limitations are related to the number of elements and the complexity of the molecules under study, but the methodology can be used to extend the study in the future. The estimation of the properties of a new molecule (such as flammability and GWP) are not shown, but can be found in literature.
- The testing of alternative refrigerants and a summary of the results in the open source LCCP tool is a very effective way to have an effect on the market penetration of new refrigerants.

- The open source model development is a good utilization of the expertise available at the national laboratories.
- The presentation was mainly focused on obvious things and did not provide any information on critical barriers to the development of better refrigerants, feasibility of the approach, etc. There was little new information in this presentation, other than a few alternative refrigerants that have been tested and were fine. A few graphs about the impact on components or system performance would have been helpful.
- One reviewer did not enter a response.

### C. Accomplishments/Progress

This project was rated **3.2** for its accomplishments and progress.

- This is exceptional work, especially considering that the scope of the original project has been extended.
- The project's accomplishment is completely on target.
- Although on schedule, it is not apparent the project will meet the global need to offer new refrigerants. It is unclear if enough will be done to actually influence the new offerings.
- The compressor calorimeter evaluation is in progress, but no results were presented. Testing in supermarket systems is in progress, but nothing was presented. More results should have been presented considering that \$4 million has already been spent on this project.
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.4** for its collaboration and coordination with relevant stakeholders.

- The partnership with the refrigerant manufacturers is an indication that this is an important project to them. It is also an indication that there is concern for energy performance in this macro-environmental discussion.
- This project is conducted with the cooperation of industrial partners and academic institutions.
- This project could possibly be enhanced by close collaboration with Mark McLinden.
- Before this technology can be widely accepted, the drop-in capabilities of the low-GWP refrigerants, from a long-term benefit/problem basis, must be thoroughly analyzed.
- The nature of the work does not allow a very close relationship with the industry. On the other hand, the results of this research have been presented at conferences and published in journals.

### E. Proposed Future Work

This project was rated **3.2** for its proposed future work.

- The future work is totally in line with the project goals of evaluating refrigerant performance and summarizing them in open source LCCP code.
- There is no guarantee that this work will result in new, significantly better fluids, but the scientific approach, which can be extended to other types of applications, is of great value.
- This project looks good. The field test is critical for validation purposes.
- Not much progress was reported, but the future steps are in line with the main objectives.
- One reviewer did not enter a response.

### Project Strengths:

- The collaboration with refrigerant manufacturers is a significant strength of this project. The focus on the supermarket application is important.
- The project uses multi-institutional cooperation to develop a refrigerant performance and impact evaluation tool that is open to the public.
- Three reviewers did not enter a response.

### Project Weaknesses:

- This reviewer finds no weaknesses with the project.
- Other fluid properties may be important in the overall performance but are not included in the study, e.g., viscosity; density; and reactivity with the materials used in refrigeration systems, with lubricants, or with water from the atmosphere.
- It is not apparent that all of the needed analysis will be completed in time to allow for optimal refrigerant offerings that meet the immediate global requirements.
- Two reviewers did not enter a response.

### Recommendations:

- Compressor manufacturers should be involved at some point. The issue of leakage could be addressed more fully in the project. It appears the project is assuming the same amount of leakage for each candidate refrigerant. If this is the case, the environmental impacts are closely associated with the leakage, particularly the supermarket case. If a leakage reduction scenario is brought into the modeling, the rank order of refrigerants could change.
- Considering the significance of this problem and the market potential/size, it is hard to imagine that companies have not been significantly investigating the development of better refrigerants. Without a fundamental investigation/discussion on the physical limitations/barriers, it is hard to judge whether this project can be successful or not.
- The project should continue to evaluate fluids that will satisfy constantly changing environmental and political regulations.
- Two reviewers did not enter a response.

## Project # ET-12: Low Global Warming Potential Refrigerants

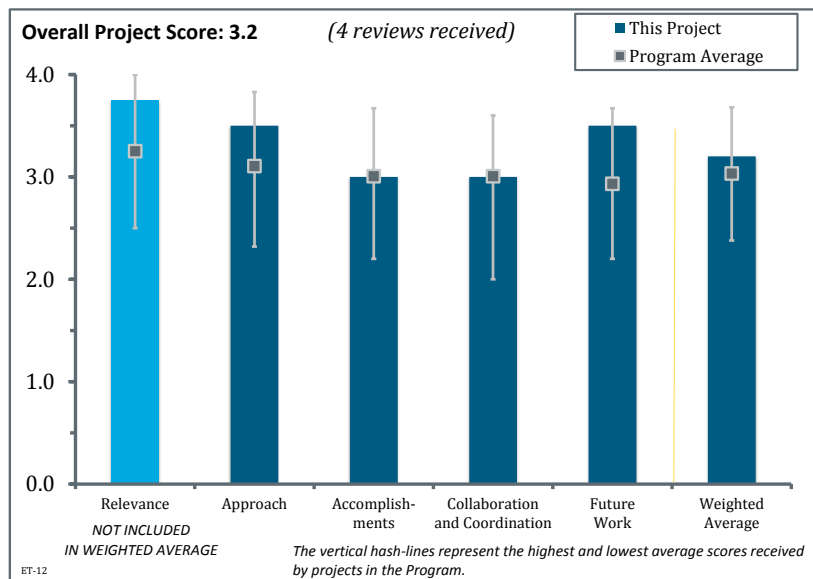
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### Brief Summary of Project

Most of the currently used hydrofluorocarbon refrigerants have a relative high global warming potential (GWP) and are expected to be phased out/down due to increased concerns over climate change. The refrigeration and air-conditioning industry subsequently faces a challenge to transition to new fluids. The goal of this project is to exhaustively evaluate refrigerant options to identify a new generation of refrigerants that best meet the selection criteria. The project has evaluated over 56,000 candidates and down-selected them to a group of about 1,200 candidate fluids based on low GWP, toxicity, Lower Flammability Limit (LFL), and

critical temperature. Additional properties will be predicted for these 1,200 candidates to allow a further down-select to about 100 candidates based on optimum thermodynamic parameters from the cycle analysis, and individual cycle simulations. More detailed properties will be predicted based on thermodynamic parameters and optimum chemical stability for these 100 candidates to allow a thorough analysis of performance in detailed cycle simulation studies.



### A. Relevance

This project was rated **3.8** for its relevance to Building Technologies Office (BTO) goals and objectives.

- Working fluids are very important components of building heating and cooling. Working fluids affect energy consumption and have significant environmental impact. The selection of the most efficient fluids within the regulations is totally in line with BTO goals.
- The project supports the BTO objectives. While it will offer tools to evaluate the impact on the environment and help the U.S. industry maintain competitiveness, the impact in this context will be difficult to evaluate.
- Development of low-GWP refrigerants with little/no impact on system efficiency is important to BTO's 50% energy saving objective.
- One reviewer did not enter a response.

### B. Approach

This project was rated **3.5** for its approach.

- Scanning an enormous pool of available fluids and selecting or designing the fluid that matches the property of an ideal fluid for a particular thermodynamic cycle is really an outstanding approach that has become possible with the development of computational technology. The authors of the project first recognized and realized such a possibility.
- Many more criteria are yet to be added to the screening process, which the presenter seems to be generally aware of. It is understandable that the refrigerant producers do not want to be involved because of the

intellectual property issues. However, components and system manufacturers could be interested, and their insights could speed up the screening process.

- The approach comprises dissimilar objectives (development of the life cycle climate performance [LCCP] tool, development of new refrigerants, and characterization of refrigerants in different systems). The interconnection between the different objectives is not very well defined.
- One reviewer did not enter a response.

### C. Accomplishments/Progress

This project was rated **3.0** for its accomplishments and progress.

- In this project, the methodology of screening the fluids has been developed, and many thousands of fluids were evaluated. Types of fluids and structure of molecules most suitable for refrigeration and air conditioning application have been determined. The scientific basis for fluid selection has been established.
- The LCCP tool was developed, but the impact was not evaluated and the validation and accuracy were not explained and/or evaluated. This task is shown for the fourth quarter of 2013, but it is unclear how the tool was published without validation. Calorimeter evaluations are not shown (many are in progress).
- In the presentation, it was stated that the first analysis would evaluate the fluids from a thermodynamic perspective, and the second analysis would look at the fluids from a viscosity basis. Although the possible number of working fluid candidates has been considerably narrowed down, the evaluation of the fluids' viscosity must also be analyzed.
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.0** for its collaboration and coordination with relevant stakeholders.

- There are excellent collaborations between Oak Ridge National Laboratory (ORNL), the industry, and academia. Work was published, and the Web tool was publicized. It is not clear if tests/results performed by the industrial partners are used or what expertise they will bring to the table in addition to the fluids.
- Collaboration with academia has been established. Collaboration with industry is not yet established.
- Two reviewers did not enter a response.

### E. Proposed Future Work

This project was rated **3.5** for its proposed future work.

- Future work is a direct continuation and completion of the current undertaking and application to other areas of BTO interest that will have a large impact on efficiency thermodynamic systems.
- Some of the future steps are vague ("provide recommendations" or "additional efforts"). No indications are provided on how to address the difficulties that have been encountered or that may be encountered in the future.
- Two reviewers did not enter a response.

### Project Strengths:

- The project's strength is a combination of recent advances in cycle analyses and optimization with chemical screening techniques used by the pharmaceutical industry, applied to working fluid selection.
- The open-source LCCP tool is up and running.
- Two reviewers did not enter a response.

### Project Weaknesses:

- One reviewer found no weaknesses with the project.
- The tools developed need support, extensive documentation, and further support. It is not clear at what level these are or will be provided.
- Two reviewers did not enter a response.

### Recommendations:

- Because of the nature of the National Institute of Standards and Technology's mission, is it possible to be more open about the project's findings and report them to the refrigerant manufacturers, even though the manufacturers have not wanted to be involved in the project? This sounds unusual, but solving this problem can have a major impact on millions of lives and the health of our planet.
- The developed methodology of fluid selection should be applied to other thermodynamic cycles and extended to fluid mixture analyses.
- Two reviewers did not enter a response.

## Project # ET-13: Nanolubricants for Chillers

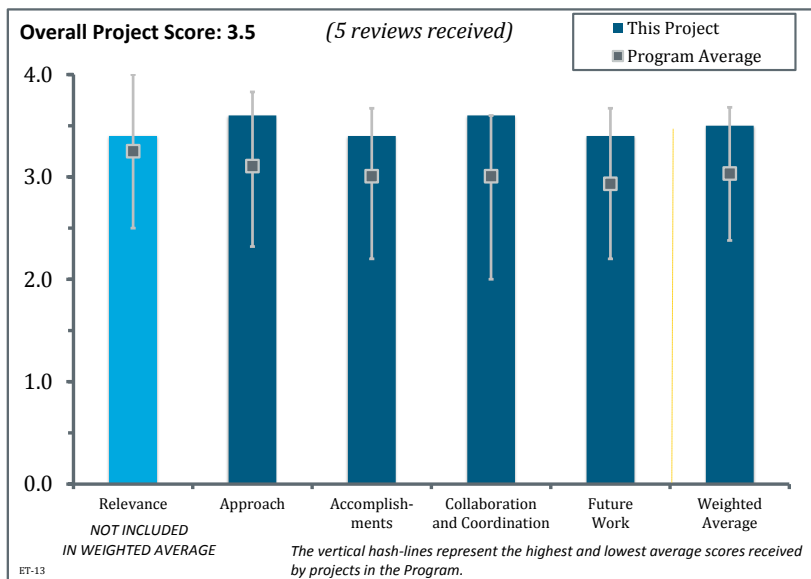
Mark Kedzierski, National Institute of Standards and Technology, mark.kedzierski@nist.gov

Bahman Habibzadeh, U.S. Department of Energy, bahman.habibzadeh@ee.doe.gov

### Brief Summary of Project

The main goal of this project is to develop technology to improve chiller evaporator boiling heat transfer by using acoustically enhanced nanolubricants. Acoustically enhanced nanolubricants are expected to yield between 1% and 2% improvement in chiller efficiencies. An efficiency improvement of 1% on existing chillers would yield 0.03 quads of energy savings per year. Because of the large number of influential parameters, it is impossible to conduct a full-factorial experimental design to determine which parameters are controlling and in what way. An existing pool-boiling rig will be used to measure heat transfer performance of three

R134a/nanolubricant mixtures. The nanolubricant will be an ester-based chiller lubricant with 20-  $\text{Al}_2\text{O}_3$  nanoparticles. The heat flux and the wall superheat of the test fluids while boiling on a test surface will be measured.



### A. Relevance

This project was rated **3.4** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This is an exciting project and highly relevant to the goals and objectives of BTO.
- The project, while very interesting, scientifically and practically valuable, and related to BTO objectives, does not attempt to quantify the short- and/or long-term impact other than in very general (non-committed) terms.
- Enhancing the heat transfer coefficient on the refrigerant side in the evaporator and condenser helps to reduce the chiller energy consumption. This project implements nanoparticles to enhance the boiling process. A significant enhancement is achieved over smooth surfaces. The performance achieved on Wolverine's enhanced tube is marginal (~10%). Enhanced tubes have been in the market for some decades, and implementing this approach for chillers using enhanced tubes will not result in significant benefits.
- Two reviewers did not enter a response.

### B. Approach

This project was rated **3.6** for its approach.

- The project focuses on understanding the effect of the nanoparticles on the heat exchange/boiling and on creating the tools to quickly implement this method in practice. The predictive tool will have to be used by practitioners, although it is not well explained what form this predictive tool will take, e.g., it is unclear whether fluid viscosity is included in the model. Acoustically enhanced boiling (with and without nanoparticles), which is listed as an accomplishment, was not presented. The particles' size and composition were studied, but apparently not their shape.

- The presenter and the team have done a great job of identifying barriers and dealing with each issue in a systematic way. The collaborative approach and high technical content presented at the peer review session attest to the understating and expertise of the team and the meticulous approach to handling the challenges of the project.
- Use of nanolubricant R134a/Al<sub>2</sub>O<sub>3</sub> is innovative for boiling in the building chiller system.
- Two reviewers did not enter a response.

### C. Accomplishments/Progress

This project was rated **3.4** for its accomplishments and progress.

- With the nanolubricant, a heat transfer enhancement of 10% was achieved, the results of which were published in the reputable International Journal of Refrigeration as the best paper award. Significant reduction in building energy consumption may be achieved with this new technology.
- The presenter has numerous exceptional accomplishments. It is difficult to understand which ones resulted from this funded project, as most of the listed publications occurred before this project started. The oral presentation and discussion were very helpful in understanding some major hurdles that were overcome.
- The project has made excellent progress thus far, with a good plan to make forward progress.
- Two reviewers did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.6** for its collaboration and coordination with relevant stakeholders.

- The team is doing a great job of engaging appropriate industries and keeping them highly interested and engaged.
- Because this technology is geared toward the retrofit market, it should expect to see a high market impact.
- Collaboration and technology transfer with/to several companies has been achieved. There is very good collaboration with selected partners; no indication was given on extending the technology transfer to a larger audience. Furthermore, there was no indication of a potential commercialization timeline (not even estimated).
- One reviewer did not enter a response.

### E. Proposed Future Work

This project was rated **3.4** for its proposed future work.

- Transfer of this technology seems to be made easily to the new and existing chillers in the field. The proposal to use a nanolubricant seems to be highly innovative.
- Even though the team encountered challenges with the original nanolubricant, the plan forward seems to be very good.
- The future work is listed in broad terms. Also, perhaps because of the nature of the work, there are no metrics of success listed.
- Two reviewers did not enter a response.

### Project Strengths:

- This is a challenging project with a great team making great progress.
- The positive results and fundamental understanding resulting from the project team's work are obvious and valuable.
- Significant scientific work was achieved with excellent publications, including the best paper award.
- Two reviewers did not enter a response.



### Project Weaknesses:

- Five reviewers did not enter a response.

### Recommendations:

- If increased thermal conductivity of the oil is not responsible for the heat transfer enhancement, then the nanoparticles should help break up the surface oil layer, or they enter the refrigerant phase. If they enter the refrigerant phase, it is likely that they deposit over the surface after some time, unless their surface properties are such that they do not like to stay on the surface and are washed off during the surface rewetting process. If they remain on the surface, they might increase the nucleation site density, which is a good thing. Basically, the particles deposit on the tube and enhance its performance. The reviewer suggests using particles that actually enter the refrigerant phase and deposit on the surface after a while. This enables enhancing smooth tubes without opening the chiller.
- Four reviewers did not enter a response.

## Project # ET-14: Supercharger for Heat Pumps in Cold Climates

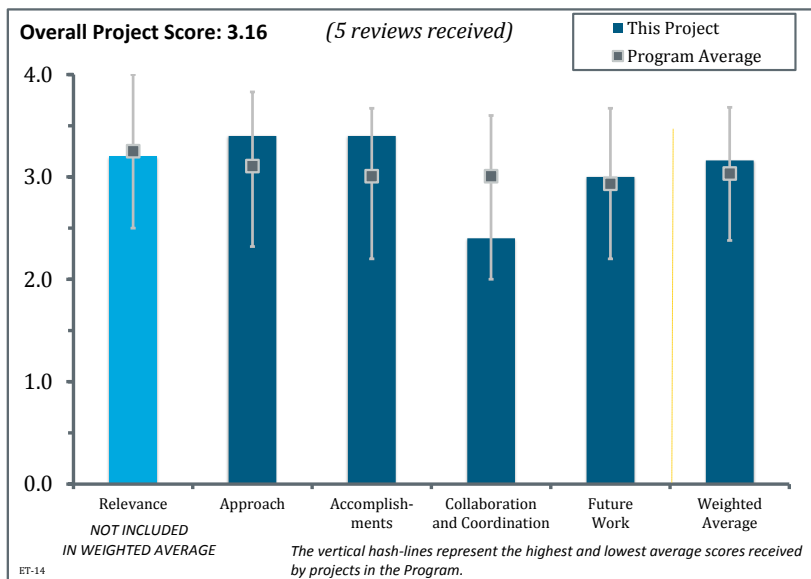
Thomas Walter, Mechanical Solutions, Inc., tom.walter@mechsol.com

Antonio Bouza, U.S. Department of Energy, antonio.bouza@ee.doe.gov

### Brief Summary of Project

The main goal for this project is the development a cold climate heat pump (CCHP) that maintains both capacity and coefficient of performance (COP). Meeting the U.S. Department of Energy (DOE) goal to reduce heating, ventilation, and air conditioning (HVAC) energy use by 20% will require the development and market implementation of CCHP technology. A high-performance CCHP would result in significant savings over current technologies (>70% compared to strip heating). The approach includes designing, building, and mapping the performance of a prototype supercharger/pre-compressor that will enable efficient operation in the

coldest U.S. climates with zero backup heat. The objective of this project includes the following: (1) develop a supercharger for CCHP application against DOE CCHP targets, both capacity and COP; (2) integrate the supercharger with a commercially available heat pump compressor; and (3) demonstrate performance of the combined system.



### A. Relevance

This project was rated **3.2** for its relevance to Building Technologies Office (BTO) goals and objectives.

- Development of a supercharger for heat pumps in cold climates that maintains both capacity and COP is highly relevant to the goals and objectives of BTO.
- The project is investigating a very useful technology with a broad applicability.
- Pushing heat pump performance in cold climates is a good idea, but with the large amounts of natural gas available in the northern population centers, it is not likely to have a large national impact. Nonetheless, it is good to look at what is available in the all-electric arena.
- Two reviewers did not enter a response.

### B. Approach

This project was rated **3.4** for its approach.

- The team understands the issues associated with the CCHP very well, and the proposed plan of using the supercharger is great. During the review session, the presenter exhibited an in-depth knowledge of superchargers and how they can be used. He identified key challenges and showed the prototype component that is expected to resolve the compression issues. It appears that system integration may encounter some challenges, but the presenter was very knowledgeable, and the project team plans to develop contingencies.
- Exploring the development of a retrofit option to boost the efficiency of existing equipment is a good objective. It appears DOE has already accepted this technology as worthy of such an exploration. With that

said, the approach looks good. The other components of the system need to be looked at as this investigation proceeds. For example, perhaps something on the heat exchanger side needs to be addressed to accommodate this compressor boost, e.g., larger coils or a different thermostatic expansion valve.

- More work is required on units smaller than 10 tons.
- Two reviewers did not enter a response.

### C. Accomplishments/Progress

This project was rated **3.4** for its accomplishments and progress.

- The project has achieved excellent results, including a COP of 3 and an increase in heat output.
- The team has achieved major progress, and a prototype is expected to be built per the project schedule and tested.
- The project is on schedule to deliver a prototype. It will be interesting to see how the prototype does from an engineering perspective. Whether it is a good choice to proceed will depend on not only the engineering success but many other factors as well, including potential market share, potential market acceptance, etc.
- Two reviewers did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **2.4** for its collaboration and coordination with relevant stakeholders.

- The project has good collaborators, and they are engaged in the prototype and integrated system development. Three consultants are also involved in the project. Other applications for the system are being evaluated.
- This technology should have an immediate market impact upon its design for the retrofit market. Low up-front-cost retrofit systems will be the most cost-effective approach to achieving usage in buildings.
- The extent of collaboration is limited. The presentation mentions only “discussions” with key potential collaborators. Something more formal is needed, particularly with compressor manufacturers. For example, without the compressor manufacturers, the developed retrofit technology could be disallowed by many.
- The reviewer is surprised that more manufacturers are not participating.
- No solid support from industry was presented.

### E. Proposed Future Work

This project was rated **3.0** for its proposed future work.

- The way ahead is clearly planned; however, analysis and comparison of the load profiles and equipment performance in potential applications should be included.
- The proposed future plans and schedule are appropriate. Building the initial prototype and mapping its performance on a test loop will dictate adjustments of future steps.
- The project needs to get to the testing-of-prototype phase. There is enough of a preliminary assessment of benefit to justify the planned future work.
- Two reviewers did not enter a response.

### Project Strengths:

- This is an excellent project and a highly competent team.
- The presenter is an expert in the proposed technology. Accordingly, there is a good chance the supercharger will work.
- Three reviewers did not enter a response.

### Project Weaknesses:

- Most heat pumps are smaller than what is being tested.
- There does not appear to be very much HVAC expertise on the project.
- Three reviewers did not enter a response.

### Recommendations:

- The presentation was a little lacking. It is not clear how the expected COP was calculated. The equation was not included in the presentation. Also, the graph on page four is confusing. It looks as though there are only 14 kilowatts of additional capacity at the low temperature rather than the 55 kilowatts indicated in the note. It appears that this technology cannot deliver the 3 COP asked for in the solicitation. However, it may be concluded that the 3 COP was overly optimistic.
- Four reviewers did not enter a response.

## Project # ET-15: Ground Source Heat Pump (GSHP) Data Analysis

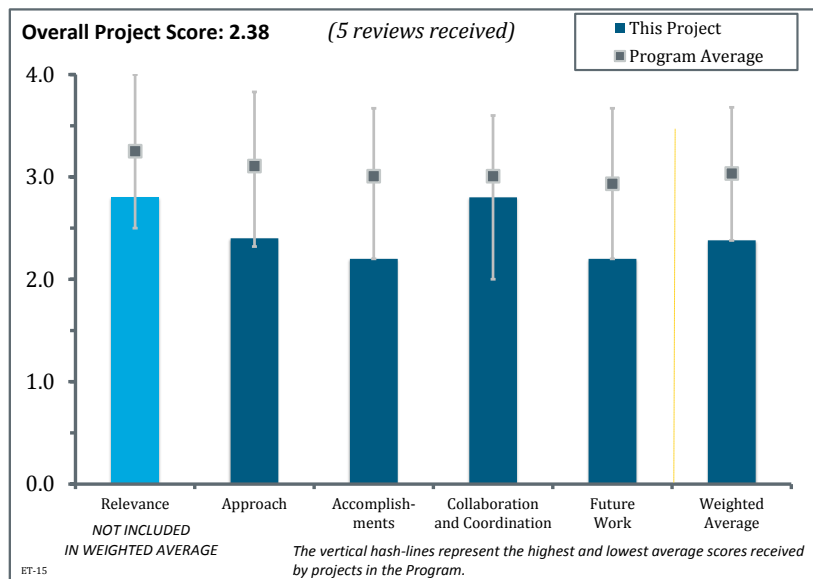
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### Brief Summary of Project

A recent assessment indicates residential ground source heat pump (GSHP) energy savings has a technical potential of 4.2 quads per year. This means a 10% GSHP penetration saves 0.4 quads per year. With improved design, reduced cost, and increased public awareness and trust, it is expected that GSHP systems will capture 10% of the target market segments by 2030. One of the barriers that prevents the rapid deployment of GSHPs is the lack of public awareness of and trust in this technology. The goal of this project is to analyze the hard data on the costs and benefits collected from the American Recovery and Reinvestment Act (ARRA)-funded

GSHP demonstration projects in order to address this barrier. The comprehensive analysis of these systems could identify good and bad practices in the design, installation, and operation of GSHPs, which will be valuable for the industry. In-depth case studies on the costs and benefits of ARRA-funded GSHP demonstration projects include a crosscutting summary of lessons learned and best practices for design, installation, and operation.



### A. Relevance

This project was rated **2.8** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This fits in with all aspects of the BTO ecosystem and could have a major impact on a technology that is a proven and useful tool to help reduce a building's energy use. The idea of comparing the different methods of GSHP technology is also worthwhile. Additionally, the comparison between U.S. and Chinese data adds to the value of this effort.
- It is valuable to collect, analyze, and document case studies to assess the real-world performance of GSHPs for various building applications. It is also important to document the design problem areas and operation challenges associated with GSHPs.
- Improving the information for designers and users of GSHPs is a worthy project to push this energy-efficient technology into broader use.
- Though GSHP is a technology with a good site energy reduction potential, the statement of work of this project does not support BTO goals and objectives.
- One reviewer did not enter a response.

### B. Approach

This project was rated **2.4** for its approach.

- While the project is still in its preliminary phases, the presentation lacked details about the analysis approach. It would be useful for the research team to define the general analysis approach to be utilized, including the approach to be used in collecting data and evaluating the performance of GSHPs. The

presenter focused on previous project findings and only mentioned some problems with data for a few ARRA sites where GSHPs are installed and monitored. More specific data about these problems should be shown and discussed.

- The intent behind this research—the international comparison and the comparison between technologies—ranks as “good.” However, the data are very limited, and there are a tremendous number of confounding variables between the data sets.
- The project is focused on breaking through the barriers to widespread use of GSHP.
- The project will result in limited information based on suspect quality data.
- One reviewer did not enter a response.

### C. Accomplishments/Progress

This project was rated **2.2** for its accomplishments and progress.

- This is a good effort to deal with data sets of inconsistent, potentially poor quality.
- There has been some progress toward comparing the use of this technology in China versus the United States. Being able to compare the technologies is also interesting. However, this project is still early in its evolution, and it is hard to fairly assess its progress to date.
- The presentation does not provide a good overview of the status of the project. More details about the analysis approach and current accomplishments and challenges should be highlighted and discussed. It seems that the research team will be limited and challenged with the availability of “good” data about the performance of real GSHPs. This issue should be discussed in more detail and provide some potential solutions and future plans for better implementation and enforcement of monitoring plans by DOE subcontractors, not only for GSHPs, but for any DOE-supported technology.
- The presentation did not provide enough details on project progress (nor were any details provided as a read-ahead).
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **2.8** for its collaboration and coordination with relevant stakeholders.

- The partnerships with China and ASHRAE are good approaches. Use of the ARRA data could also yield a larger data set if the varying geographic and weather conditions are factored into the approach.
- The research team seems to involve industry partners for collaboration with some good coordination between various partners.
- Case studies and detailed information to support users of GSHP are needed. It is not entirely clear how the data/information would become available.
- Two reviewers did not enter a response.

### E. Proposed Future Work

This project was rated **2.2** for its proposed future work.

- GSHP is a wonderful technology that has a lot of potential impact on energy use. Being able to compare methodologies to help bring the initial cost down could have a significant impact on the uber-goal of reducing building use by 50%. Additionally, this could help to make retrofits using GSHP technology more palatable. Gathering more information will only help the cause.
- The presenter did not pinpoint the future work needed to deal with some of the identified problem areas and challenges in collecting “good” and useful data about the performance of GSHP systems.
- Information about the future work was vague.
- Future work was not clear from the presentation.
- One reviewer did not enter a response.

### Project Strengths:

- This is a promising project that could have tremendous impact. The comparison of various technologies and the international comparison are two major strengths of this project. For the rather modest investment, this seems to be a good “bang for the buck.”
- Improved data quality and better engineering and economical analysis would result in a better product.
- The main strength of the project is the ultimate objective; that is, collecting, evaluating, and documenting the actual performance of select GSHP systems.
- Research is focusing on ways to overcome barriers to adoption of GSHP in the United States and China.
- One reviewer did not enter a response.

### Project Weaknesses:

- The main weakness is the lack of a clear analysis approach for all the collected data and the lack of a detailed description of the options available to extract some useful information from the data collected from all the case studies.
- The quality of data and the variability between the data sets are discouraging. The presenter did acknowledge that the project researchers are attempting to work through that. Additionally, the effect of HVAC controls with the savings that GSHP presents did not appear to be fully factored into the problem statement, though the presenter did briefly mention it. This should be a major piece of the data analysis.
- Limited, poor quality data sets may limit the applicability of the project results and case studies.
- Two reviewers did not enter a response.

### Recommendations:

- While GSHP technology has been around for some time, many of the installers and engineers do not seem to understand the different technologies available. Some education, training, and outreach for these entities should be part of the future work to ensure that the results from this data-gathering can have the maximum market impact. Additionally, comparison of maintenance costs for the various GSHP systems (both comparing the various GSHP types among themselves and comparing them to other technologies) would be a valuable tool.
- Below are a few comments that the research team should consider:
  - Better document the cost effectiveness of the evaluated heat exchanger alternatives and their long-term performance based on either measured data and/or simulated data.
  - Clearly describe the ASHRAE headquarters data and its quality (including uncertainties of measurements and quality control processing). The commissioning of both GSHP and variable refrigerant flow (VRF) systems should be detailed.
  - Better document the challenges encountered in collecting good quality data for the ARRA-funded projects.
- Three reviewers did not enter a response.

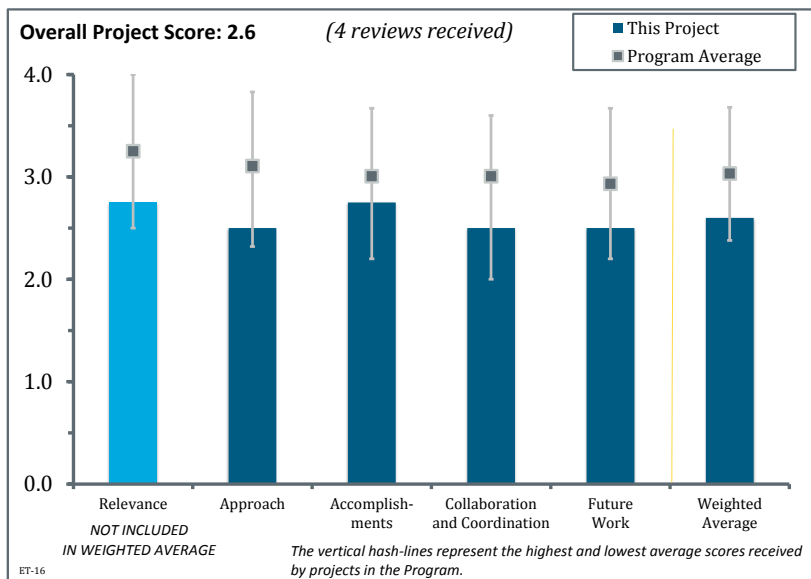
## Project # ET-16: Low Cost Solar Water Heaters

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### Brief Summary of Project

The goal of this project is to develop and demonstrate a durable, low-cost solar water heater (SWH) design in collaboration with an industrial partner. SWH has the technical potential to save up to 2 quads of energy per year. Therefore, it is vital to incorporate low-cost SWH technology into the U.S. marketplace. The current target for this project is to demonstrate a system with an installed cost of \$1,200 (which is within the proposed price range of \$1,000–\$3,000), 32% efficiency, and a lifetime of 15 years. Such a system could achieve over 50% market penetration.



### A. Relevance

This project was rated **2.8** for its relevance to Building Technologies Office (BTO) goals and objectives.

- The project is excellent on the technology development side, but the market analysis could use some improvement.
- The stated goal of the project aligns well with the BTO objective of reducing the cost of SWHs in the United States. However, the selection of the specific system and the industrial partner is not clearly justified.
- It is doubtful that low-cost/low-efficient plastic panels will, now (with current gas prices) or ever, have market penetration that will provide 10% of the BTO goal of 50% savings.
- One reviewer did not enter a response.

### B. Approach

This project was rated **2.5** for its approach.

- The project plan is fine in terms of achieving the objective of the project. However, the presentation does not do a good job of describing the expected challenges, alternatives, or major shortcomings of the selected technology and industrial partner.
- The analysis of barriers is worrisome as presented. The presentation seemed naive about differences between a new large-volume construction opportunity (e.g., building a whole subdivision, so there are very low general and administrative [G&A] costs) versus one-by-one retrofits, which is more like selling replacement windows to cash-strapped consumers. However, the technology work is quite good.
- SWH with a simple payback of 4 to 7 years is not applicable to low-income families. It is doubtful that for medium- and high-income families, plastic SWH panels will be attractive additions to their houses. The cost of panels is less than 50% of the installed cost of the system and can be further reduced with mass production. Therefore, high-efficiency panels with lower panel surface and load on the building will be more attractive. Also, in multifamily houses, individual SWH systems for each family require multiple roof penetrations. Therefore, shared solar fields for either multifamily houses or for a number of co-located



buildings, with the solar field connected to a single thermal storage, seems to be a more attractive solution. International experience shows that such installations reduce costs by at least a factor of three. Also, open-loop systems may result in calcination of pipes in regions with hard water (often the case in regions with high solar irradiation) and may have a negative impact on drinking water quality. Closed-loop systems may be preferable.

- One reviewer did not enter a response.

### C. Accomplishments/Progress

This project was rated **2.8** for its accomplishments and progress.

- The project team documented good progress in testing the performance of the SWH prototype, including the testing setup within the National Renewable Energy Laboratory (NREL). However, additional testing, especially to evaluate the long-term performance of the system in extreme hot and cold climates, should be considered.
- There are minor issues about the breadboard status. For example, some consideration of the probable need for a filter on the incoming water side to trap particulates that could lead to fouling of the heat exchanger would have been helpful. However, the heat exchanger approach employed is impressive.
- It is too soon in the process to assess accomplishments.
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **2.5** for its collaboration and coordination with relevant stakeholders.

- The project team is collaborating with an industrial partner. It is clear that there is a good synergy between the research team and the industrial partner. The main issue is the lack of other industrial partners and other low-cost water heater technologies. A clear justification of the selection of the industrial partner and technology should be provided in the final project report or future presentations.
- The project ranks “excellent” for its relationship with the manufacturing partner, but it was more constrained in its understanding of what it will take for success in the market with real builders, plumbers, etc.
- Collaboration is limited to a single manufacturer.
- It does not seem that enough manufacturers are participating.

### E. Proposed Future Work

This project was rated **2.5** for its proposed future work.

- The plans to address barriers seem solid.
- The presentation, at least, does not clearly identify possible challenges and the potential solutions if and when the proposed technology fails to achieve the proposed cost target throughout the United States.
- It is not clear what it means to work on technology transfer to industry after meeting the needs of what looks like a cooperative research and development agreement (CRADA)-type project.
- There is no indication of market acceptance for this technology.

### Project Strengths:

- The project is well focused on a particular technology with a strongly motivated industrial partner who wants to work with NREL for its technical capabilities.
- Solar water heating may have a more significant impact when combined with heating. However, it requires good system design and mass production. Solar water heating has a good potential in electricity-dominating locations. So far, low gas prices will not allow this technology to be competitive.

- The main strength is the stated objective of the project to build and test a low-cost SWH that can be promoted throughout the different regions of the United States. However, the particular technology chosen in this project has the potential to present several challenges in very extreme climates.
- One reviewer did not enter a response.

### Project Weaknesses:

- The main weakness is the lack of alternative solutions in case the proposed technology fails to meet the stated objective, especially in extremely hot or cold climates.
- There seems to be some uncertainty about the project participants' role in market conditioning and promotion, as well as what the next steps should be after the technology is evaluated and fully in the hands of the industrial partner.
- Two reviewers did not enter a response.

### Recommendations:

- This is the type of project that the U.S. Department of Energy should focus on.
- Below are a few specific comments to improve the project:
  - Improve references to the previous NREL work that identified specific components that contribute most to SWH cost.
  - Provide better justification of various assumptions about the target cost of \$1,200/unit. It seems several assumptions were made in defining the target cost, at least for the selected technology.
  - Provide better discussion of lessons learned from other countries about designing, manufacturing, installing, and operating low-cost SWHs. A detailed overview of the proven technologies in these countries and their associated costs should be clearly presented and discussed.
- Two reviewers did not enter a response.

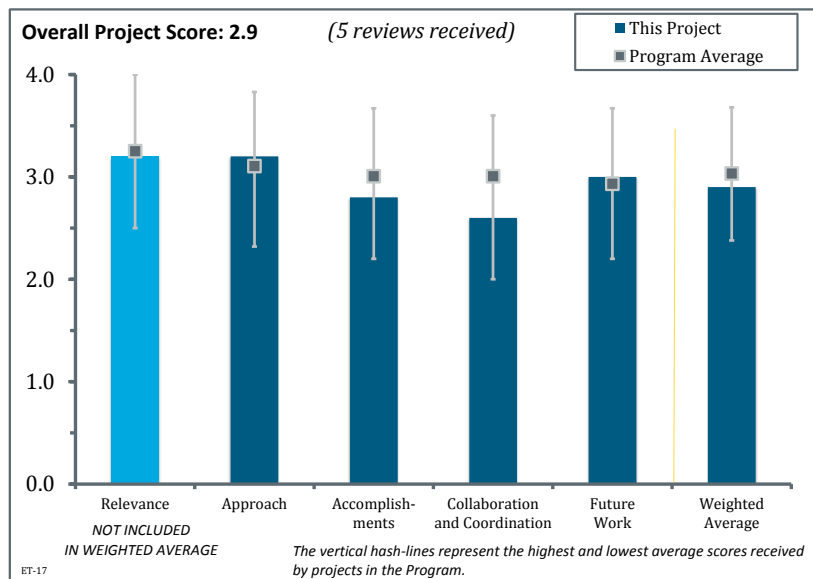
## Project # ET-17: Nanolens Window Coatings for Daylighting

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### Brief Summary of Project

Pacific Northwest National Laboratory (PNNL) is developing optical meta-material window coatings for daylight redirection. The coating consists of sub-wavelength nanoscale (20–100 nm) resonators that are responsive across the visible spectrum. The structures are embedded in a transparent matrix. Because it is a window coating, this approach is different from state-of-the-art light redirection technologies, such as tubular daylighting devices and light-shelves. Material designs are being optimized for increased light redirection while maintaining view and color rendering specifications needed for market penetration. The project aims to develop the coatings at a projected cost of \$2/ft<sup>2</sup> and is currently at a technology readiness level (TRL) of 3. PNNL is currently establishing a cooperative research and development agreement (CRADA) with an industrial partner that will carry out feasibility studies for large-scale manufacturing techniques.



### A. Relevance

This project was rated **3.2** for its relevance to Building Technologies Office (BTO) goals and objectives.

- Utilizing daylighting is an important part of reducing building energy use (by reducing electric lighting), especially in commercial buildings. There are several methods to achieve deeper daylighting, and this is one of them.
- Expanding the daylight area inside a room is a good solution toward the ultimate goal of achieving energy-efficient buildings.
- The project is relevant to BTO objectives since light redirection systems can reduce lighting energy use for areas deeper from the facade.
- Development of means of redirecting daylight deeper into buildings helps to reduce energy for lighting buildings.
- This is a potentially high-impact technology that directly supports the BTO Emerging Technologies Program goals. The one caveat is that this is an indirect energy-saving technology and relies on the users to also incorporate a daylighting control strategy for lighting fixtures. Further development of this technology would allow end users to more effectively capture daylight further into the interior of the building without installation of skylights. This potentially has a huge impact on residential and small commercial buildings with fluorescent lighting. There are potentially diminishing returns for available energy savings for this technology as light-emitting diode (LED) lighting emerges in retrofit and new construction.

## B. Approach

This project was rated **3.2** for its approach.

- The project identified many of the barriers for the technology: (1) broad wavelength coating response, (2) scalability and cost, and (3) how the technology impacts “view” factors in the fenestration. The team did a nice job with the comprehensive review of competing technologies to analyze potential competing technologies used for daylighting. The analysis gave the team a nice way to target a specific cost point where the technology would become viable economically. This technology competes with others in the category but also has a unique applicability. Certain customers may not like external shading devices or active louvers to achieve daylighting, so this would provide a nice alternative in those instances.
- Use of nanolens is an innovative approach, as this will scatter light wavelengths broader.
- The project takes a novel approach, but questions with regard to cost, quality, and application method remain. The project should also have the durability and quality of light redirection assessed for this technology. It is good to see plans for a CRADA with industry, paving the commercialization path.
- The approach with metallic nanoshells is logical. There are issues with redirection angles and scalability as well as cost.
- One reviewer did not enter a response.

## C. Accomplishments/Progress

This project was rated **2.8** for its accomplishments and progress.

- The team has made significant progress on its goals: (1) proof of concept shows that the team is able to get good response from a single wavelength of light on the order of 70% redirection, and (2) theory has suggested a range of sizes of nanolens particles could provide a broad wavelength response. Based on the proof-of-concept goals being demonstrated, future research should be completed to further validate this technology. The next step should be demonstration of proof of concept that, once applied, this nanolens film will still afford a view out of the window. This technology will not be viable compared to other daylighting strategies unless the end users are able to satisfy view requirements in the fenestration. The presenter indicated that color mixing and view have been considered with no show-stoppers, but it would be good to see the data supporting that.
- The proof of concept has been demonstrated with small-scale samples. Shallow redirection angles have been achieved. More work is required on appropriate materials selection, durability, cost, and broad wavelengths.
- The project is still in its early stages; there is a long way to go before proving the commercial feasibility of this technology.
- The reviewer questions whether the processing cost of the proposed periodical polystyrene with gold coating structure is really low.
- One reviewer did not enter a response.

## D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **2.6** for its collaboration and coordination with relevant stakeholders.

- Some collaboration exists on this project through the proposed CRADA agreement with PPG Industries. Additionally, the team has sent out communications to industry and other industry-specific journals, etc. The team identified that the nanolens film will need to be viable for application by existing manufacturing means. This is a key element of the success of the project, as rapid adoption by industry will require that they invest minimally in new infrastructure for the film deposition.
- It is good to see a commercial partner (PPG). The door should be kept open to have the technology made available beyond a single company to allow wider participation.
- Collaboration with PPG is a good step, but this needs to be expanded to more mainstream glass suppliers.

- Collaboration and tech transfer will be addressed in the future—up to now, the work has been completed at the sponsoring organization.
- One reviewer did not enter a response.

### E. Proposed Future Work

This project was rated **3.0** for its proposed future work.

- The proposed phasing of the work seems to address a plan for addressing go/no-go criteria but does not really address any alternate pathways for success. However, the alternate pathway would mean a different type of light-directing technology that is being developed concurrently through other BTO-sponsored programs. The materials and process selection, based on cost analysis, should be addressed earlier in the project phasing. Once the film is developed and demonstrated across a broad wavelength response, the next step to viability is addressing the manufacturability and cost of the film. It seems like this should be completed before the durability testing, in case an iteration of design is needed for a more cost-effective material selection.
- If this is a promising technology and its feasibility is proven to a reasonable extent, then perhaps the technology development period should be accelerated by providing more resources to reduce the timeline.
- The future plan is well described. Participation of industry partners in the next stages will be important.
- The ambitious goals set up are fine, but it is unclear whether they can really be achieved within several years.
- One reviewer did not enter a response.

### Project Strengths:

- This project has several strengths as compared to traditional daylighting technologies:
  - Ease of installation; no additional components other than the normal process of installing a window.
  - Passive technology that has no moving parts or any interaction needed by the user.
  - Effectively getting light deeper into the building envelope, enabling more aggressive daylighting control.
- There is a potential for energy savings through efficient use of daylighting without using internal or external daylighting systems.
- This is a high-impact project, but risks remain.
- Two reviewers did not enter a response.

### Project Weaknesses:

- The project has some weaknesses:
  - An active daylighting control building system is still required to capture any energy savings.
  - Further work to determine impact on view acceptability is needed.
  - The technology competes with other daylighting strategies and technologies for the same energy savings.
- The project seems to be at an early stage without clear indications on appropriate materials, ease of manufacturing/cost projections, broad wavelength applications, and scalability issues.
- Concerns remain about the quality, durability, and cost of this technology.
- Two reviewers did not enter a response.

### Recommendations:

- This seems to be a very worthwhile project and has a potentially large impact on energy savings. The team presented a compelling case to continue the project.
- The project should move away from gold as soon as the team is done with the proof of concept and work on alternative materials. Oxidation will still be an issue with silver. Spin coating is not a viable technique

for this application. Alternative approaches such as spray coating should be looked into. However, spray coating will produce thick films. Delamination should be studied.

- The team should consider combining low-emissivity coating with this technology in order to minimize cost. It is better to have one-coated glass than two to control the cost.
- Two reviewers did not enter a response.

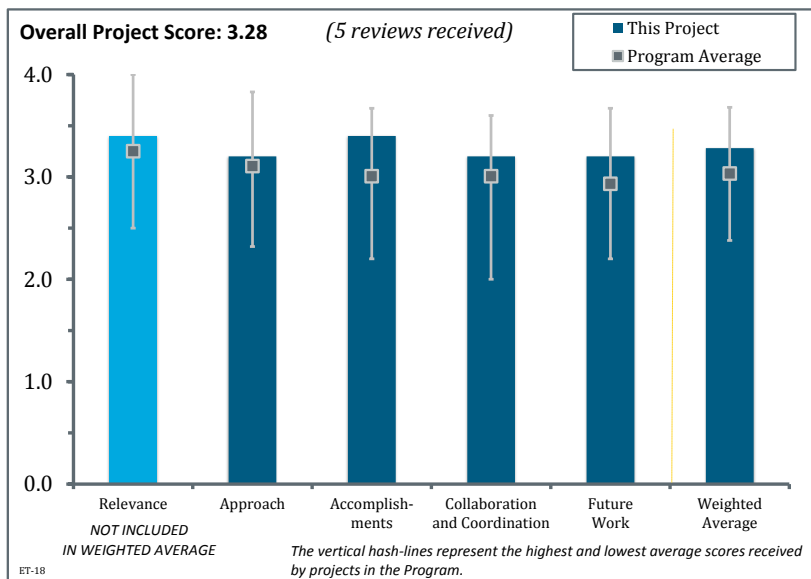
## Project # ET-18: Low-Cost Solutions for Dynamic Window Materials

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### Brief Summary of Project

Lawrence Berkeley National Laboratory is developing methods for replacing indium tin oxide (ITO) in the transparent conductive oxide (TCO) layers with lower-cost, widely available materials, such as aluminum-doped oxide, that can be applied by a scalable manufacturing approach that leverages existing equipment in manufacturing lines. The goal of the project is to reduce the cost of TCO by 75% relative to ITO. Sputtering and filtered arc deposition technologies are being evaluated. In a parallel effort, the project is investigating incorporation of nanocrystal films, based on preliminary work done at the Molecular Foundry that is currently supported by the Advanced Research Projects Agency – Energy (ARPA-E).



### A. Relevance

This project was rated **3.4** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This project addresses a fundamental goal of helping bridge a barrier to market entry for an energy-saving technology. The cost and some other aspects of dynamic windows have prevented wider market penetration of the technology. Task 1 of this project works to address cost issues with ITO films, and a critical function of the project team is to help industry reduce manufacturing costs, which will in turn potentially help with market penetration.
- Dynamic windows have a big impact on building energy use and loads. Current electrochromic (EC) windows are cost-prohibitive—hence, a low-cost EC solution is required to increase the market penetration of EC windows. This is a high-impact project.
- Development of alternative materials to ITO is important for large-scale implementation of smart windows. Also, alternative low-cost manufacturing methods are needed to enhance market penetration of smart-window technology.
- The search for lower-cost transparent conductive electrode material is a good direction.
- Lowering the cost of EC windows is related to the BTO objectives.

### B. Approach

This project was rated **3.2** for its approach.

- The approach followed is solid and was well described.
- This project addresses many of the technical challenges of producing a lower-cost aluminum-doped zinc oxide (AZO) replacement for the ITO films. The approach to utilize existing manufacturing solutions already deployed by window manufacturers is obviously a good solution to reduce cost, if the AZO deposition process lends itself to easy adoption on the sputtering manufacturing lines. Market research on

the adoption barriers for end users of the dynamic window materials as well as the methodology of capturing energy savings would be helpful. It would also help to see the trade-off between energy savings and view impact incorporated into the technology development. No doubt reducing heat gain/loss in a building saves energy, but it is not clear that dynamic windows outperform other technologies with the same end goals.

- Research is focused on conducting ITO cost reduction—specifically, a 25% reduction in ITO cost. It is not clear how much this would impact the overall cost of EC glazing.
- AZO seems to be a reasonable alternative to ITO, and progress has been made toward overcoming its deposition challenges. Scale-up issues and added sputtering costs were not discussed.
- AZO is one of the lower-cost transparent conductive electrodes, but its transmittance over visible wave lengths is still lower than that of ITO, and the processing cost based on physical vapor deposition (PVD) is still high.

### C. Accomplishments/Progress

This project was rated **3.4** for its accomplishments and progress.

- The project has demonstrated that the negative ion filtering approach has yielded better properties than AZO films made with the 90-degree filter. This technical barrier will allow further development of the system to produce AZO films more economically and with good results as compared to ITO films. Future testing on scalability will be critical to show that these films can be produced on a wide scale on the existing coating lines. Although this project provides a way to overcome a technical barrier to adoption of active windows, further evaluation on the adoption of this technology by the market as a whole should be studied. This technology also mainly addresses new construction; the likelihood or cost effectiveness of the technology for retrofit applications is not clear. Overall, this project does support the BTO goal of reducing barriers for energy-saving technologies.
- The project successfully demonstrated sputter deposition of AZO. The reported optical and electrical properties are reasonable.
- The project has made reasonable progress; a prototype of AZO deposited on glass was developed and shared with the reviewers and the audience. Invention disclosures have been filed already. Scalability and appearance need to be addressed at the next step.
- There has been good work so far in proving laboratory-scale models.
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.2** for its collaboration and coordination with relevant stakeholders.

- The project team has strong collaboration with some of the major window manufacturing companies that have expressed interest in AZO films. The team has done a nice job of identifying other opportunities with photovoltaic cell manufacturers. The team has done a nice job of promoting the progress through journal entries as well as invited talks relating to the technology. The team has also yielded two filed invention disclosures with the U.S. Patent and Trademark Office, which will aid in the technology transfer aspects of this solution.
- The project has good involvement of industrial partners and proposed collaboration, as well as very good technical dissemination of results.
- The fact that several companies showed interest in using AZO is a good sign; however, real use for commercial products is based on really low-cost processing of AZO while maintaining still higher performance, high transmittance, and lower sheet resistance.
- The project is in the proof-of-concept stage. Communications have recently been started with the industry, so this reviewer cannot evaluate the project on this criterion.
- The project team should plan to work with commercial partners. The market impact of low-cost EC would be significant.



### E. Proposed Future Work

This project was rated **3.2** for its proposed future work.

- Filter approach issues will be addressed; the issue of cost needs to be totally clarified.
- The future work includes a go/no-go decision for the two approaches by the end of 2013.
- Cost-effective scaling is the most critical aspect of this project.
- The long-term stability of AZO needs to be evaluated.
- The project should continue development with integrating low-emissivity coating.

#### Project Strengths:

- Project strengths include the following:
  - Lower-cost films compared to the existing incumbent technology.
  - Demonstrated success of the negative ion filter system films.
  - High interest from industry for improving an existing energy-saving technology.
- Lowering cost for EC windows is very important.
- The project has a new approach to lower the cost of EC windows.
- Two reviewers did not enter a response.

#### Project Weaknesses:

- The project team should evaluate the overall impact on the cost of the EC glazing compared to contemporary EC products. Durability tests should be planned early.
- The viability of the window systems for retrofit and deep market penetration is unclear.
- Three reviewers did not enter a response.

#### Recommendations:

- For high-impact projects such as this one, the timeline should be accelerated by reinforced resources.
- This is an interesting and worthwhile project and should be continued.
- Three reviewers did not enter a response.

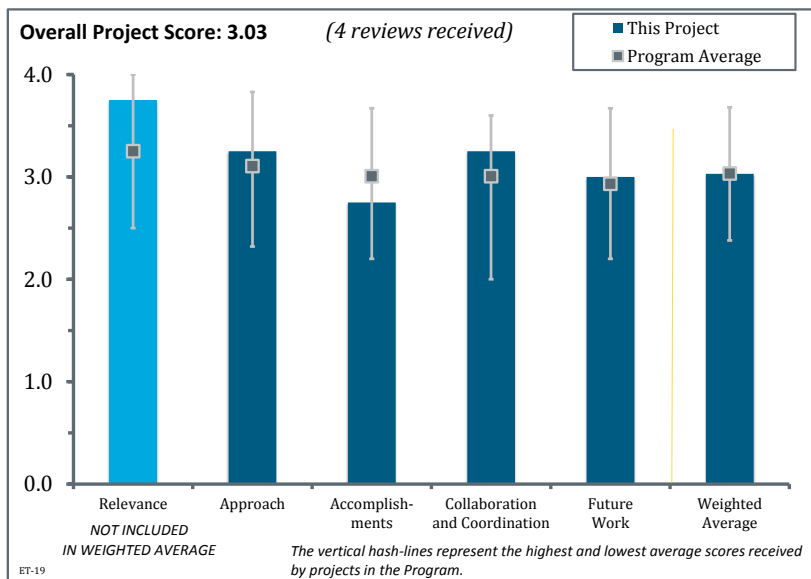
## Project # ET-19: High-Performance Window Attachments

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### Brief Summary of Project

Lawrence Berkeley National Laboratory (LBNL) is validating simulation models for fenestration attachments that were developed during fiscal year 2012, including a new version of the residential window selection tool RESFEN, incorporating EnergyPlus. Software tools incorporating these models will be released in beta form. The team is providing recommendations for an ENERGY STAR attachment rating, certification, and labeling program based on experimental and simulated results, field tests, and occupant behavior studies. A Web-based attachment selection will be developed.



### A. Relevance

This project was rated **3.8** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This is an outstanding project to enable better decision making relating to energy savings for window attachments. This could have an immediate and broad impact on energy savings. This solution really assists the general public to make more informed decisions on technologies with unbiased information and helps quantify energy savings that are otherwise difficult to quantify for the unsophisticated consumer.
- This is a very practical project that should (relatively) quickly have implications for consumers, as the information gathered is utilized by manufacturers, retailers, utilities, and programs to help make smarter decisions about attachment use.
- Developing low-cost, high-performance window attachments and the Web selection tool and rating system is very important to provide information on reducing energy use and increasing adoption by a wide range of the population.
- The overall objectives have good alignment.

### B. Approach

This project was rated **3.3** for its approach.

- The project takes a modular approach to rating window coverings and attachments. The problem is quite complex because of the millions of variations of systems available in the market. A particular strength is the concept of narrowing down the selection process and simplifying this for the end user to make an educated decision on the appropriate options. This includes a decision-making process for both energy- and non-energy-related options.
- It certainly appears as if the barriers are identified and the project has been well thought out. The actual presentation could be greatly improved to more clearly explain the process. In general, fewer pictures and a simple written description of the approach (flow chart) would be helpful on slides three and four.

- The reviewer noted the following strengths: an integrated Web-based tool, a broad database for realistic scenarios, and fact sheets. The reviewer noted the following weaknesses: failure to consider air leakage and too much emphasis on cellular shades. Also, it is not clear why the project has to pay for capital upgrades of facilities.
- The approach is quite clear except the development of rating system guidelines.

### C. Accomplishments/Progress

This project was rated **2.8** for its accomplishments and progress.

- The Complex Glazing and Shading Product Database is an invaluable accomplishment from this project. It allows for a complex issue and variation of systems to be evaluated on a common platform. The two methodologies described for inputting systems into the database allow for flexibility in the comparison of systems with good analytical models and those where no analytical models are available.
- This project is almost “outstanding,” but the presentation did not show and explain in a large format the portfolio of models that the project has already evaluated and is making progress on. Frankly, there should be some suggestions/ideas on a rating system at this point (U-factor or R-value and some type of attachment solar heat gain coefficient). Perhaps that is too political, considering some window manufacturers consider this project a threat to selling more windows. Also, although fact sheets and regional guides have been issued, the second-generation website is not yet up and running. Without any type of rating or ranking or product performance evaluation, it is very unclear what value to consumers all of this information is. While the information provided, so far, describes the characteristics of the products, it does not help consumers choose better-performing products...yet. Perhaps the regional guidance is better at that.
- The project has made the following achievements: nine fact sheets published, alpha version of the website, model migration to E+, and database creation. However, there are concerns: no treatment of air leakage and no apparent mechanism for determining which technology is included in the database.
- The Complex Glazing Database, modeling, measurements, and Web-based selection tool show adequate progress. Faster work is needed for development of the rating system and new versions of tools.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.3** for its collaboration and coordination with relevant stakeholders.

- The Web-based tool being developed will have a large market impact if used appropriately by the public. The tool allows for an unbiased platform to compare energy performance of rating systems using quantifiable metrics developed by the project team. Enabling consumers to make educated choices based on factual data is a big step in the market because most decisions currently are likely based on aesthetics or function of systems. Generally, the data published by manufacturers on energy performance are difficult to interpret or not consistent between manufacturers, which makes it difficult for the end consumer to make an informed decision based on energy alone.
- This project has great collaborations and has the potential for a significant market impact. The impact has not happened yet, though. There is testing technology transfer happening, but no performance ratings have been developed.
- The project has some coordination with industry but would benefit from a steering committee to help monitor progress and assign/suggest priorities. The website is a big plus.
- Collaborations are rather poor; more effort is needed on that part. The market impact is significant.

### E. Proposed Future Work

This project was rated **3.0** for its proposed future work.

- Developing models and algorithms for the products where no models exist is an important next step in the project goals. This allows the Web-based tools to become more robust in the evaluations. The team is doing a nice job of collaborating with other ongoing efforts. An ENERGY STAR program for window

attachments was alluded to in the presentation. If this program is developed, the Web-based tools provided by the team would be a great resource to the ENERGY STAR program to help customers rate different options.

- Here is where it is critical to assess when it is good enough. There does not seem to be a mechanism to decide the priorities based on energy impact and potential for market uptake. A steering committee could help with this, as well as helping by suggesting the basic design of the prototypes.
- The proposed work mentioned in the presentation and listed on slide 12 are good, but the discussion/explanation was a bit weak. By now, LBNL should have some ideas on ratings or rankings. Maybe that is too political.
- If the proposed tasks are completed, this will be a very useful project for a large audience.

### Project Strengths:

- The project has identified barriers, is well thought out, and has good collaborations. Initial accomplishments are quite good, and plans for the future are excellent.
- The project provides a resource for a complex data set and multiple options to streamline the decision-making process for consumers. There is potential for high impact on energy savings and influencing consumer behavior, as well as high potential for collaboration with other ongoing efforts.
- This is an important technical area. The Web-based tool will facilitate dissemination of information, and the fact sheets received good circulation.
- One reviewer did not enter a response.

### Project Weaknesses:

- It will be difficult to educate consumers on utilization of a new tool, nor will it be easy to quantify energy savings impact of certain systems where analytical models or test data are not available.
- The whole-building modeling approach is incomplete, and there is no mechanism for technology selection for inclusion in the database. Industry involvement is limited. The project seems to be very costly, so the value for the money is in question.
- To move this project forward, performance rankings must be developed so a certification body can be selected and consumers can start to make better choices about products and product use.
- One reviewer did not enter a response.

### Recommendations:

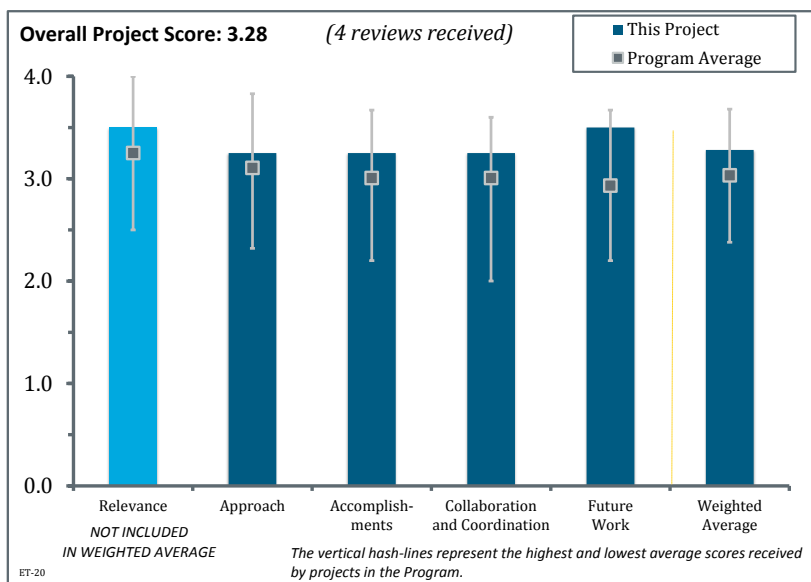
- This is a great project, and the reviewer looks forward to exploring the Web-based tool.
- Three reviewers did not enter a response.

## Project # ET-20: Advanced Facades, Daylighting, and Complex Fenestration Systems

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### Brief Summary of Project

Lawrence Berkeley National Laboratory (LBNL) is assessing the performance of daylight redirection films that achieve 30%–50% reduction in lighting energy use in a 30–40 foot deep perimeter zone while minimizing heating, ventilation, and air conditioning load and discomfort glare. The assessment is performed by simulation tools (Radiance and EnergyPlus) and field testing in the Advanced Windows Testbed Facility. Next-generation daylight redirection films are being developed with industry partners. Technology is being developed for the commercial building sector where a lack of data has traditionally hindered market penetration.



### A. Relevance

This project was rated **3.5** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This project has a high potential impact of 1–2 quads of energy usage, which would definitely support BTO goals. Some aspects of the project depend on the appropriate utilization of daylighting dimming control technology to capture the energy savings, so the impact could be viewed as somewhat indirect.
- Advanced facade systems have a significant impact on energy use for lighting and air conditioning.
- This appears to be a critical, practical, and well-organized and -executed project.
- One reviewer did not enter a response.

### B. Approach

This project was rated **3.3** for its approach.

- This project utilizes three primary focus areas, each of which has a unique impact on the energy consumption of buildings. The approach to daylighting technologies is primarily to extend the depth of useful daylight further into the building space without having an adverse impact on solar gains and visual comfort. This would have a high impact on energy usage if appropriately coupled with dimming strategies. This research addresses some barriers to daylighting with respect to glare and visual comfort; people generally are not willing to adopt technologies that are a nuisance or impactful to the function of the space. Angular selective shading provides another avenue to capture energy savings in buildings, in addition to maximizing the lighting energy reductions. Decreasing the solar heat gain in a building is a well-understood method to reducing overall energy consumption. Finally, the dynamic facade systems with model predictive controls take the best technologies in daylighting and angular selective shading and blend them with control algorithms to optimize the energy savings associated. The team could look to identify and overcome some additional barriers related to aesthetics and functional performance of

some of the exterior systems. A barrier to adoption for these technologies is the resistance to changing exterior elevations and looks of buildings by parties interested in the architectural feel of buildings (cities, architects, designers).

- The project focus, key issues, and approach are well laid out and clearly and succinctly explained. Barriers are not specifically identified but can be derived from approach details.
- The approach is well defined for the development of tools and testing, considering both energy and comfort metrics.
- One reviewer did not enter a response.

### C. Accomplishments/Progress

This project was rated **3.3** for its accomplishments and progress.

- The team has made some nice progress with regard to all three tasks being developed. The accomplishments in regard to modeling daylight and discomfort glare are particularly noteworthy. Glare aspects will inherently deter market adoption of daylighting systems because of the annoyance factor. Industry acceptance of the LBNL design for daylight redirecting is a nice accomplishment. Evaluation by companies for commercialization is an important step in realizing any actual energy-saving impacts.
- Accomplishments are laid out clearly by task and appear to be moving forward with some quantitative performance indicators. Tasks 2 (angular selective systems) and 3 (dynamic facades) seem to show particular performance improvement.
- Accomplishments are satisfactory, but progress has been a bit slow. Prototype designs and field testing are essential. COMFEN is a very useful tool and should be expanded with more options and capabilities.
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.3** for its collaboration and coordination with relevant stakeholders.

- The team has nice collaboration with industry partners with a wide variety of manufacturers, software developers, and building management control system providers. Adoption of the radiance simulation capabilities in OpenStudio is a nice way to move the capabilities into the hands of designers and hence into the marketplace.
- There is good industry participation and strong evidence of potential commercial impact.
- The project has good collaboration with industry. COMFEN is an excellent example of technology transfer.
- There are many collaborators and some work to immediately incorporate designs into industrial prototypes. There is some basic technology transfer. Market impact is unclear at this point, but certainly there is potential.

### E. Proposed Future Work

This project was rated **3.5** for its proposed future work.

- Future work builds and expands on work to date and should improve the potential for greater market impact.
- The project has solid future plans with field testing and prototypes.
- Two reviewers did not enter a response.

### Project Strengths:

- The project has the following strengths: development of practical tools that assist designers in addressing energy use from lighting and solar heat gain, strong collaboration and interest from industry, and high engagement with professional associations and the design industry.

- This is a valuable topic. The project has a good approach and industry involvement. The team uses active and passive technology approaches, as well as laboratory and field studies, and the field studies consider human factors.
- The presenter was very impressive, knowledgeable, and organized. The project reflects these traits also.
- This project can have a big impact on energy use and market penetration.

### Project Weaknesses:

- The only weakness was market impact, but it takes time to incorporate these new technologies, and opportunities do always come around easily to test products and systems.
- Some barriers to market acceptance are difficult to overcome, such as aesthetic issues. The technologies appear to be more focused on new construction opportunities, so the impact for retrofit energy savings is uncertain.
- There is a large “ask.”
- One reviewer did not enter a response.

### Recommendations:

- Four reviewers did not enter a response.

## Project # ET-21: Atmospheric Pressure Deposition of Electrochromic Windows

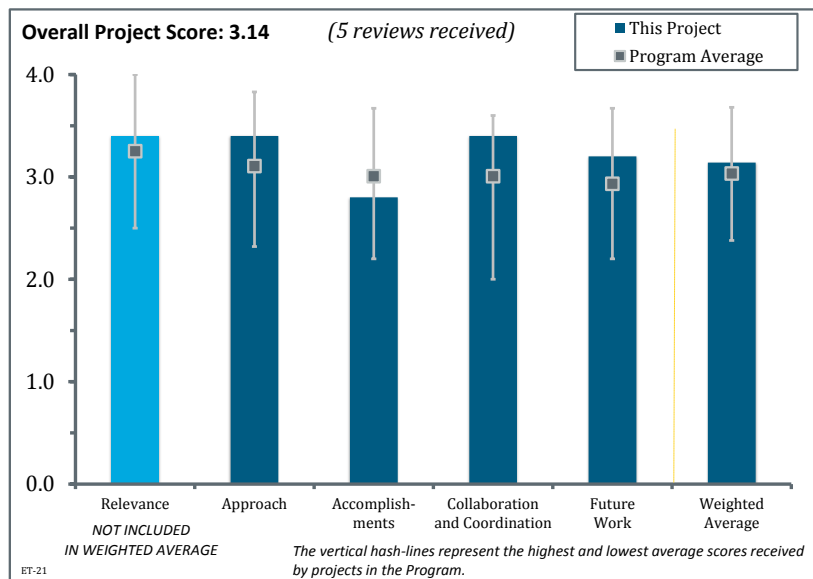
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### Brief Summary of Project

The National Renewable Energy Laboratory (NREL) is developing dynamic window materials that are compatible with existing high-volume manufacturing channels, similar to low-e glass products. To this end, the project is focused on developing air-stable materials that are amenable to high-volume manufacturing and new, low-cost processing technologies, such as atmospheric pressure deposition technologies. This strategy has the potential to reduce the cost of the glazing to \$10/ft<sup>2</sup> and to limit the risk of high up-front capital investment. NREL is also continuing its work with Sage Electrochromics through a cooperative research and development agreement (CRADA)

focused on integrating a nickel-oxide-based counter electrode, improving its performance, and improving its color contrast to improve market acceptance.



### A. Relevance

This project was rated **3.4** for its relevance to Building Technologies Office (BTO) goals and objectives.

- The dynamic windows will assist with the reduction of thermal heat gain into the building and would thus support the end goals of BTO to reduce energy consumption of commercial buildings by 50%. Reducing the cost of the technology also supports the goal to speed the adoption into the market.
- Low-cost electrochromic windows (ECWs) have huge potential.
- The proposed ECW system is in line with the BTO goal to reduce building energy.
- The project is quite relevant to BTO objectives, but it is unclear whether this technology will ever really have a broad market impact.
- The project is reducing the cost and improving the appearance of ECWs.

### B. Approach

This project was rated **3.4** for its approach.

- The approach to develop solutions to attack the three limiting factors in large-scale adoption of the technology is good. The team has developed strategies to address both performance and cost aspects and perform third-party validation of the solutions.
- The goal of developing a new paired ECW system based on cathodic WO<sub>3</sub> and anodic NiO is an innovative design.
- The approach seems reasonable and promising.
- Goals and barriers/limits are clearly identified. The project is focused on overcoming limits but seems to be bumping into technical limitations.
- The project is addressing the manufacturing method for electrochromic (EC) deposition.



### C. Accomplishments/Progress

This project was rated **2.8** for its accomplishments and progress.

- The team has made nice steps in improving the performance of the counter electrode with the lithium doping innovation. This has important implications in the visual appearance of the windows, which is identified as a barrier to adoption in the market.
- As to the counter electrode side, transmittance change data based on lithium-doped NiO and NiO alone indicate that the optical performance needs to be improved. The spatial uniformity of the ECW processed by the proposed low-cost method has not been measured, as these data are key performance data. As to the working electrode side, the use of mesoporous WO<sub>3</sub> indicates very high performance data of transmittance change. As to the electrolyte, use of polyvinyl butyral (PVB), plasticizer, and lithium-salt seems to be a noble design, but its long-term stability needs to be demonstrated, such as by using gel electrolyte mode.
- The project has some good accomplishments: lithium doping, better performance of WO<sub>3</sub>, and lamination process improvements. It is hard to measure quantitatively what impact these have on the process overall.
- The project is still at an early stage. There are issues with broad wavelength transmission, scalability, and cost.
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.4** for its collaboration and coordination with relevant stakeholders.

- The team has developed a CRADA and collaboration with industry partners to further develop these technologies. This project has the potential for market deployment and impact through the licensing agreement with Sage Electrochromics. Additionally, the team has done a nice job of communicating the technology developments through peer-reviewed journal entries and participation in the key trade organizations.
- The project has collaboration/partnership with industry and, in addition, is keeping the door open to allow other companies to use this technology, leading to wider adaptation.
- There seems to be good collaboration and some technology transfer. A few companies are very interested, but it is basically the same group that never seems to have a real market breakthrough.
- Collaborations with many groups among industry, academia, and other government institutes are ongoing.
- There is good collaboration with several partners.

### E. Proposed Future Work

This project was rated **3.2** for its proposed future work.

- The future work that is most important to the overall BTO goals is supporting the effort to transfer the LiNiZrO technology into the Sage manufacturing process. This will get the technology deployed in the market to increase the likelihood of realized energy savings. Also, support for the low-cost processing of EC materials will be another important aspect to assist with deployment efforts. More information about how the expanded testing services proposed would promote the goals of BTO would be helpful.
- The prototype development is a priority.
- Future plans are laid out, but explanations of progress just seemed to have lots of caveats.
- Two reviewers did not enter a response.

### Project Strengths:

- The reviewer listed the following project strengths: a clearly defined objective to overcome market adoption barriers, nice collaborative efforts with industry and technology transfer to manufacturing processes, and innovative and patented design features.
- Goals and barriers have been identified. Some good progress has been made.

- The project aims for a lower manufacturing cost for EC.
- Two reviewers did not enter a response.

### Project Weaknesses:

- There are still significant cost issues that need to be considered in order to make the technology viable on a wider scale.
- The technology is expensive, and the research seems to be bumping into more limitations.
- Durability concerns remain, and the cost model is uncertain.
- Two reviewers did not enter a response.

### Recommendations:

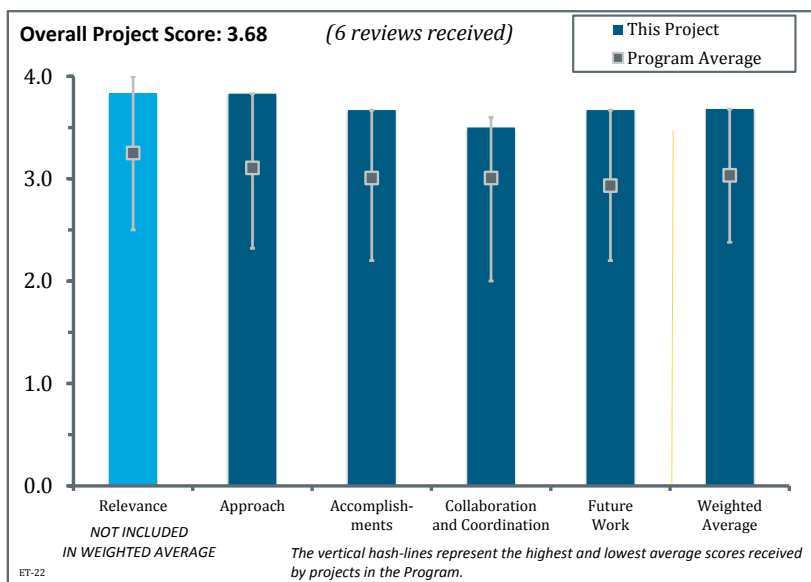
- This is another high-impact project; the DOE Office of Energy Efficiency and Renewable Energy should accelerate the timeline for such projects if feasibility is proven to a reasonable extent.
- It is unclear whether this expensive technology will have a broad market impact.
- Three reviewers did not enter a response.

## Project # ET-22: Advanced Surfaces and Accelerated Aging Technology Integration

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### Brief Summary of Project

Lawrence Berkeley National Laboratory is developing an accelerating aging methodology for cool roof products that reduces the requirement for three years of natural exposure to two weeks, increasing the rate and development and market introduction of new products. The fiscal year 2013 efforts are focused on validation of the methodology based on naturally aged samples as well as ASTM and International Organization for Standardization (ISO) standards. The project has the support of a large network of industrial partners.



### A. Relevance

This project was rated **3.8** for its relevance to Building Technologies Office (BTO) goals and objectives.

- Roof solar reflectance degradation is a major problem that needs to be addressed. Current methods such as actual field study and three-year test methods are too slow. This research is very relevant to giving design professionals the confidence to use a solar reflectance number in their modeling and analysis to help better estimate a building's potential energy performance.
- The reduction of testing time frames (and development of associated methods and standards) for cool roof products will allow the development and manufacture of more cost-effective roofing materials, as well as increase competitiveness in the industry. This directly supports BTO objectives.
- This is development work that can advance adoption of cool roofs—it exactly parallels the Commercially Available LED Product Evaluation and Reporting (CALiPER) program in that regard and has the same order of magnitude of potential importance.
- This is an important and practical project that will help get energy-saving products to market more quickly.
- The project is developing an accelerated aging test protocol to reduce time to market for new energy-saving roofing products and systems. Energy savings were estimated and given in the presentation. The reviewer suggests that this be a requirement for all project presentations in the peer review.
- Assessment of the long-term behavior of proposed solutions is critical to the BTO objectives. The impact of the aging on the energy use is not clearly stated.

### B. Approach

This project was rated **3.8** for its approach.

- The approach had several facets. Not only did it look to develop the process for reducing the testing time frame, but the team completed the process by including ASTM and ISO standards for the aging process and the patent of the tool used to accomplish the testing.
- A wide range of roof materials were considered. Actual data were used as calibration for an accelerated method. The project addresses regional considerations. Four soiling methods were considered.

- The fact that the test method is able to be patented is a testament to the effort that has gone into thinking through the problem statement and designing an apparatus that meets the task.
- The project uses a methodical approach and has identified barriers and issues.
- The “Accomplishments and Progress” slide stressed the context for this work and its path forward.
- The project has an excellent problem definition and approach. It is not clear how the results can be used for other roof tilts. It is also not clear how differences between different variations of the same material (such as shingles of different colors) are considered.

### C. Accomplishments/Progress

This project was rated **3.7** for its accomplishments and progress.

- Comparison to three-year field studies versus the accelerated testing method is positive and reproducible. Especially strong is the agility of the apparatus and the soiling chemistry to be changed to match a different set of regional and time-based climate variables. Progress is outstanding.
- The team has successfully accomplished its objectives to date. It has overcome the barriers that were encountered during the development of the process, and the results have been published at various stages. The progress can be clearly measured, and all milestones have been reached. The results so far indicate that the team will most likely meet the remaining milestones. The standards have been written and submitted for approval, and the test results are positive when compared to long-term results.
- The project is on track: significant data were measured, the aging method was completed and tested, the patent was filed, etc. The workshop organized was used not just for dissemination but also for receiving feedback from industry. The integration of soiling with a commercial weatherometer should be more detailed in terms of goals and procedure. Some details on the soiled surface analysis and the conclusions resulting from this analysis should be provided.
- Results and a draft standard have been transferred to standards communities (ASTM and ISO) for consideration and possible uptake. The project has organized workshops with practitioners and industry. An Inter-Laboratory Study Program is underway. A patent has been awarded.
- The project has done excellent, methodical work. The team has made great progress on an ASTM/ISO rating/test method. There has been less consideration of how to adapt for future regional products, or how to migrate the challenge media if the relative importance of different components evolves (e.g., SO<sub>x</sub> decreases greatly with better control of electricity generation and further refinement of automotive fuel). It is not clear from the presentation whether freeze cycles could be important for the rating.
- A good method has been developed and seems to be working. The R-squared correlation looks pretty good.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.5** for its collaboration and coordination with relevant stakeholders.

- Use of ongoing cool roof research and collaboration with other laboratories and industry partners to springboard the work of this project is well done and a very effective use of current research dollars and past investments.
- The accelerated test period (reduced from three years to two weeks) will reduce the prototyping time frame and reduce barriers to the introduction of new materials. The team’s efforts have been supported by the roofing manufacturers, which will benefit from the results of this project. This technology will improve the end products available on the market for consumers.
- Collaborations are OK. Coordination or updates for the U.S. Environmental Protection Agency (EPA) on the methods used for ENERGY STAR products are not happening. The reviewer questioned whether developing standardized tests is technology transfer. There is no impact on the market yet—but there is good potential.
- The parallel cooperative research and development agreement (CRADA) work is appreciated, in part as validation of the respect shown by industry partners for the team and the approach.

- There are strong collaborations with industry, academia, and other laboratories; the team works on a new ASTM and ISO standard for technology transfer. It is not clear what level of participation is received from industrial partners other than providing coupons.
- One reviewer did not enter a response.

### E. Proposed Future Work

This project was rated **3.7** for its proposed future work.

- The future plans are a natural extension of the work to date and include completion of the natural aging cycles and expansion of workshop collaboration. The team will complete the approval and adoption of the supporting standards. The methods will be extended to other climate regions and other materials. There may be some challenges faced as a part of this expansion that may require adjustment of the methods.
- The plan to introduce materials science and materials surface characteristics and resistance to soiling would be beneficial. An important aspect to this research's relevancy is the fact that the research team understands that once a material is soiled, it essentially becomes a hybrid or new composite material with possibly significant differences in its properties as compared to the original sample.
- Short- and long-term plans are shown. A future analysis of the sensitivity of the reflectance with each deposition component would be helpful.
- This project is clearly a step in a long-term process.
- This project is almost done and should be mostly wrapped up by the end of 2013.
- One reviewer did not enter a response.

### Project Strengths:

- A clear scientific process was outlined and followed, and the results were clear and measurable. The application to cool roofing products will be a direct benefit to both manufacturers and consumers as new materials with improved performance capabilities are brought to market faster and more cost effectively.
- The research team's attention to detail in addressing the problem and the focus on creating a test method and apparatus that is not only cost effective but that allows manufacturers to bring products to market or make go/no-go decisions on product development is a major home run for this project.
- The project shows good progress with solid results and will achieve strong technology transfer to standards communities. The project has industry involvement. There is a reasonable approach for future work.
- The project has a well-defined research plan along which the researchers are confidently stepping. There are excellent capabilities across the disciplines required.
- This is a good project with a well-laid-out approach and indications that the method will work.
- This work will have a strong impact after developing the new standards.

### Project Weaknesses:

- The biggest weakness right now is the project's integration with materials science. Also, the test method has great potential to be used for testing many more building components and finishes other than roofs. Future work should include some thought on how to apply this work to other existing materials aging, soiling, and materials science research.
- The roofing industry is pretty conservative, but some emerging trends might affect long-term performance—for example, reflective additives for asphalt shingle roofs that change albedo much more than color by strong selective reflectivity. It is unclear whether the methods being developed are going to be able to find shortcomings in non-conventional approaches or highlight strengths. This is at the boundary of the project, but still important.
- These preliminary results need to be delivered into the hands of ENERGY STAR, and the methods need to be standardized.
- The project is rather high cost.
- Two reviewers did not enter a response.

### Recommendations:

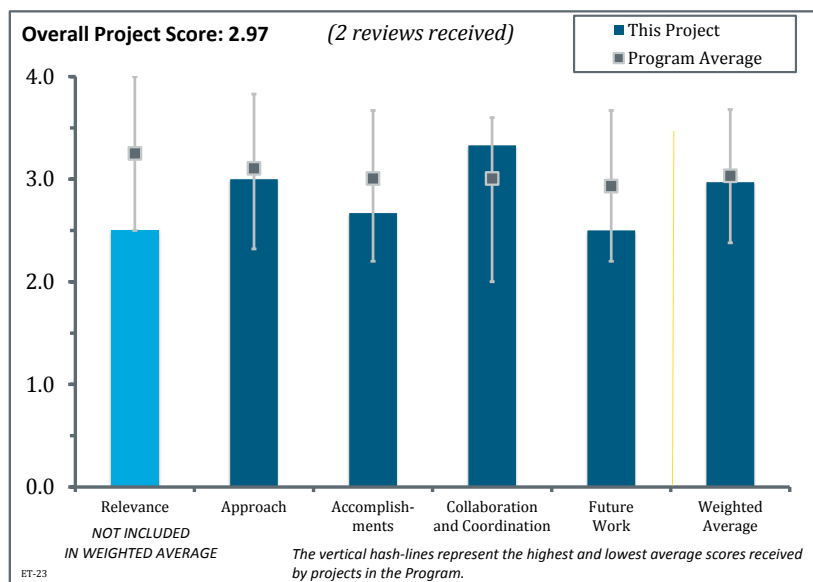
- This project is good, but it should be completed as soon as possible and the information delivered to the laboratories, companies, and ENERGY STAR so it can be put into practice.
- The test method has great potential to be used for testing many more building components and finishes other than roofs. Future work should include some thought on how to apply this work to other existing materials aging, soiling, and materials science research.
- The reviewer congratulates the project team on good work.
- Not all elements of the soiling mix have the same impact. For example, it was stated that soot is by far the most important component. The study should consider the use of simplified methodologies (soiling compositions).
- Two reviewers did not enter a response.

## Project # ET-23: New Cool Roof Coatings and Affordable Cool Color Asphalt Shingles

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### Brief Summary of Project

Oak Ridge National Laboratory is developing accelerating aging protocols for microbial growth on cool roof products to improve market penetration of high-performance products for the retrofit market. The products aim to reduce the testing time from three years to approximately two weeks.



### A. Relevance

This project was rated **2.5** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This project seems to entail deeper growth in supporting what is already a mature technology. Creating practical products to meet the current (very strict) performance definition of a “cool roof” product is what appears to be driving this project. Perhaps changing the definition to something that manufacturers are capable of meeting (and incrementally making the definition harder to achieve over time) is a more realistic goal toward achieving market impact.
- Development of the test method would lead to higher-performance roof coatings. The impact on energy savings from these improved coatings should be determined.
- One reviewer did not enter a response.

### B. Approach

This project was rated **3.0** for its approach.

- The project approach is technical in nature and is well thought out. Unfortunately, pure economics prevent larger-scale testing to have been undertaken. Thus, the project attempts to address the harshest, worst-case conditions possible, and if successful solutions are found to meet those environments, they will very likely work elsewhere.
- The project establishes factors controlling the change in solar reflectance and thermal emittance, zeroed in on the specific microbes by geographic region, and develops an accelerated aging method. Details on coatings are very sketchy.
- The scope of microbial coating is very wide and varies geographically.

### C. Accomplishments/Progress

This project was rated **2.7** for its accomplishments and progress.

- It is good that industry is defining the economic performance criteria—this will ensure uptake. It is even better that an activity was successfully completed—the cool color shingles—but no further work was done because the industry did not need it.
- The failure of the cooperative research and development agreement (CRADA) arrangement for cool color asphalt shingles to produce a viable product is disappointing. The project presenter suggested the production costs are simply too expensive, with little opportunity for reduction until scale is reached. The progress on the new cool roof coating is promising, and it appears there may be a viable product here.
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.3** for its collaboration and coordination with relevant stakeholders.

- The project is attentive to the needs of industry, as industry is actively participating. There ought to be good market uptake.
- The project clearly demonstrated collaboration with key external and internal stakeholders, including manufacturing and research partners.
- It is good to see industry partnerships.

### E. Proposed Future Work

This project was rated **2.5** for its proposed future work.

- As the project is scheduled to end in 2013, with continuing testing and measurement studies occurring, the goal of optimizing a cocktail of microbial communities with slight variations for climate zones is planned. It is not clear how manufacturers would support distribution, production, and general product management of a regional roof coating product such as this.
- What is not clear is the nature of the work on coatings.
- One reviewer did not enter a response.

#### Project Strengths:

- Strengths include industry contact and engagement.
- Two reviewers did not enter a response.

#### Project Weaknesses:

- Because of geographical limitations of the test method (microbial samples), perhaps it would be cost-prohibitive to test for multiple regions. Also, the impact on energy savings is unknown.
- Two reviewers did not enter a response.

#### Recommendations:

- The project needs to determine the impact on energy savings from better cool roof coatings, and project results should lead to industry specification(s) and/or test method(s).
- Two reviewers did not enter a response.



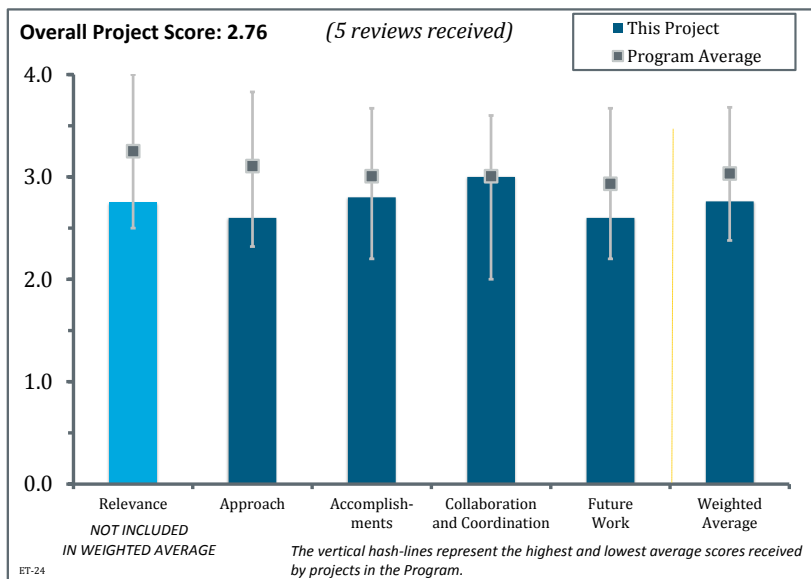
## Project # ET-24: Next Generation Attics and Roof Systems

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### Brief Summary of Project

Oak Ridge National Laboratory (ORNL) is developing new roof and attic designs with a goal of reducing space conditioning requirements caused by attics by 50% compared to International Energy Conservation Code (IECC) 2009 code requirements. This project includes hot-climate field tests for sealed and conventional attics with and without duct leakage and whole house demonstrations. The work is supplemented with tracer gas testing that can be used to benchmark analytical work. Partners include GAF and 3M Corporation.



### A. Relevance

This project was rated **2.8** for its relevance to Building Technologies Office (BTO) goals and objectives.

- It is really important to think about attics as systems interacting with heating, ventilation, and air conditioning (HVAC) and pressure issues in the envelope, and the team is doing that. The project makes excellent use of the ORNL facilities.
- The project involves retrofit of existing residential construction and is targeting a niche segment of the market where ducts are located in the attic space. The estimated energy impact is given and is significant.
- The stated objective is to develop a sealed attic approach that is superior to the conventional spray foam approach. However, the reviewer does not believe the objective listed represents the actual study itself. If the goal of the study is to develop a sealed attic approach that is superior to conventional spray foam, then it seems that the study would need to include more than one sealed attic test case. There are at least five sealed attic approaches, in addition to the one that is being studied, none of which is being addressed in this research project. A more accurate objective may be to “develop a sealed attic approach, using externally applied fiberglass insulation, that will exceed the performance of a conventional open-cell foam approach.” A broader research project, focusing on multiple sealed attic approaches, would be of greater value to the objectives of BTO.
- The project concept seems in line with BTO objectives. It is a bit unclear whether real progress is being made on new roof and attic designs.
- It is unclear whether reduction by some percentage from 15% of total building load can contribute to the 50% BTO goal. The impact is smaller: +10% increase in cooling load due to leaky ducts.

### B. Approach

This project was rated **2.6** for its approach.

- The research summary presented was: This new sealed but ventilated attic approach will resolve thermal and hygrothermal problems incurred in conventional sealed attic construction. The research summary is represented as known when it is actually a hypothesis. There are concerns about the design of the research and the likelihood that this hypothesis will successfully be answered under the current approach. For

example, the conventional sealed attic (control) is a mock-up building, with low interior volume and an unknown (to the reviewer) cooling/drying strategy, and is located in a hot, humid climate. The new sealed attic (test) will be a conventional home with greater volume, a different cooling/dehumidification strategy, and most likely in a cold climate, according to the verbal presentation. Given the variables, the reviewer is not confident that the two systems can be adequately compared. Several questions also remain regarding the test setup in Charleston, including (1) what the results of the tracer gas test on the sealed attic are, (2) whether the tracer gas test was performed with the cooling system running or off, (3) whether the partitions separating each attic space are insulated and air sealed, and (4) what the moisture content of the trusses and roof decking is. Despite reasonable experience measuring humidity, the reviewer has never measured humidity greater than 100%, as represented in the graph on slide 5, which causes the reviewer to question the accuracy of the equipment. At 100% humidity, all surfaces in the attic should be below dew point, so visual observations of bulk water would help to substantiate the moisture issue and the accuracy of the testing equipment. The comparison homes in slide 5, which are vented and should track closely with the outdoors, drop considerably in relative humidity to around 20%, at the same time that the sealed attics rise in humidity to more than 100% at times. It would be nice to see the internal temperature of the attic in relation to the external temperature to better understand how it is driving this change in humidity. If the attic is gaining high levels of moisture, beginning at approximately 11:00 a.m. and continuing to approximately 5:00 p.m., it is unclear where the moisture that was gained is going. The attic might be expected to remain wet rather than drying to the point that it comes more in line with the vented attics and at nearly the same time. This suggests that there may not be a significant change in the grains of moisture but more of a significant change in relative humidity due to temperature fluctuations. Mapping dew point to better compare each attic is recommended, because the goal should be to ensure that dew point never rises above the coolest possible temperature in the attic, which is very similar to what slide 6 represents with vapor pressure. Having one mock-up of the test attic, using fiberglass, would be ideal.

- While the approach is novel and might exhibit good energy performance when installation is executed well, there is good potential for building envelope problems associated with moisture management if the roof liner system is not airtight after installation. Nails for the roofing shingles, or screws from the metal roofing, will often penetrate the above sheathing ventilation (ASV). Critical to the successful performance is adequate ventilation in the ASV cavity enabled by a perforated soffit. To attain this, consideration needs to be given to the robustness of the design to workmanship and on-site mistakes, as well as the impact on thermal performance and moisture management of the roof system. Additionally, the approach will potentially increase the temperature of the exposed roofing material, and hence the durability may be reduced, especially if there is not adequate ventilation between the oriented strand board (OSB) and ASV.
- Sealing or not sealing attics is almost entirely a retrofit/existing buildings problem. Progress is being made with building energy codes on making it more difficult to put ducts and equipment in attics than to move them out—and this will be supported by complementary equipment trends. These include “combo” units and ductless equipment/distribution. But despite the hard work at ORNL, Building America, Florida Solar Energy Center, etc., retrofitting attics looks even harder than fixing the HVAC systems in them. Hard, dirty, labor-intensive work is required to strip an attic so all the living area-to-attic infiltration paths can be sealed and then the space reinsulated. But converting to a sealed attic requires at least as much attention to detail and manual labor—e.g., consider the issues of sealing around every point at which truss members hit rafters, or the join between rafters and joists/walls at the perimeter, where access makes it almost impossible to do a seal. The inference is that a closed-cell foam will be required to impersonate a 100% membrane. Still, the team should be credited with testing open-cell approaches and learning the issues. It is surprising to see no results of infiltration differences among the various attics; hopefully the project team will carry the approach into the field.
- It will be interesting to see the case when air, vapor, and thermal barriers are combined along the attic ceiling and ducts have at least a Class B leakage rate. That increases useful volume of the building and reduces loads and equipment size.
- The problem is stated as extreme temperatures. Moisture damage is also mentioned, but a clear connection is not made. A “ventilated attic approach” is mentioned but not described. Various attic cavities are developed, but how permeability of products relates to dealing with extreme temperatures is unclear. If the attic is ventilated, then the moisture would vent. This has been known for decades. The research seems to focus down to moisture issues related to open-cell spray foam on the underside of roof decks, but that was not clearly stated.

### C. Accomplishments/Progress

This project was rated **2.8** for its accomplishments and progress.

- A significant number of mock-ups have been tested; results provided interesting humidity data from the open-cell foam insulation case, which pointed to a critical issue for the approach.
- Progress has been made in measuring the conventional technology, but the new technologies have not been applied.
- The reviewer has both qualms about the perimeter sealing quality that needs to be achieved and surprise at what was not discussed, particularly variants on Approach 5 (ASV) of slide 4. By working externally at the time of re-roofing, this would seem to have potential for labor-saving innovation (panelized approaches) that could simultaneously address issues around lengthening eaves for greater solar control. The reviewer also expressed concern about slide 11; it is unclear what the “liner” is attached to around the perimeter, where access is all but impossible in most houses (at least on the sloping parts). It is not clear how the project established the claimed reduction in infiltration.
- It is not very clear what the real accomplishments are for this project. The issue of sun-driven moisture into roof decks with open-cell foam on the underside has been identified, but only one proprietary solution is really identified—the droopy moisture control lined with some insulation that looks hard to install correctly and cannot be finished if someone wants to use their attic. There should be many more approaches, such as a rooftop vapor barrier, but that is not mentioned. Also, it is not clear what is being done with 3M and GAF.
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.0** for its collaboration and coordination with relevant stakeholders.

- They have the attention of industry, to be sure.
- Collaborations with big companies are apparently happening. However, the projects seem more like a proprietary testing opportunity for a few companies than real research on insulating attics better. Also, everyone knows ducts should be kept out of attics (at least, all the building scientists do).
- The reviewer noted the following pros: Aggressive participation by industry is good, and the project involves demonstration projects, small- and large-scale, involving industry (component manufacturers and builders). The reviewer noted the following cons: One industry segment (fiberglass) might be driving the project toward a specific solution that favors fibrous insulation, and it is unclear why the cold climate demonstration was switched to a hot climate demonstration.
- The project partners are not broad enough to answer the current objective. Involving other industry members, such as Icynene, Demolac, Dow, Knauf, Masco, and Green Fiber, could help to ensure technologies are appropriately applied and could increase impact by developing more sealed attic strategies.
- Collaboration with building scientists from other organizations in addition to manufacturers would be beneficial.

### E. Proposed Future Work

This project was rated **2.6** for its proposed future work.

- The use of go/no-go decision points is positive, but is it not clear who provides the review and makes the decision. The project could benefit greatly from a steering committee to review progress and suggest technical direction.
- It is unclear what next steps are coming now that issues have been identified. Because the key approaches seem to be proprietary, it is unclear how costs can be reduced (the reviewer wondered whether cheaper labor was considered an option). It is also unclear what the 3M project is.
- Three reviewers did not enter a response.

### Project Strengths:

- The project has the right team, the right support from industry, and the right facilities.
- The project is focusing on a new technology for which there are many questions regarding performance and application. This information could prove to be very useful to the market.
- The approach seems OK. A few targeted issues are being researched and explained.
- Two reviewers did not enter a response.

### Project Weaknesses:

- The project is addressing a really important problem. A key question is why it has taken so many decades before the U.S. Department of Energy focused some big guns on it. A deeper approach to imagining potential retrofit strategies that might reduce costs and improve quality across the huge variability in the housing stock would have been helpful. Of particular focus should be the potential for rolling re-roofing with re-insulating—a significant fraction of roofing jobs seem to discover enough damage (from condensation) to the plywood or other roofing base to require a lot of replacement, so there would seem to be a real market for a really good, integrated replacement. Certainly, the metal roofs have not taken off, assumedly because they are not comprehensive, although they are also high cost.
- Actual accomplishments seem targeted to a very few proprietary products. The research does not seem broadly applicable to more generic systems, which would save costs.
- There is concern regarding the validity of the claims, given the current research structure.
- Two reviewers did not enter a response.

### Recommendations:

- The project ought to have a steering committee. “Fiberglass” is a trade name; “glass fiber” is generic. It is not clear whether the project has considered the relative cost of relocating the HVAC equipment from the attic space to the interior of the home or to the basement. Perhaps this is economically viable, given that the roof need not be replaced, complex insulation system installed below the OSB decking, duct work heavily lagged, etc. The “ask” is very high.
- As for so many other products, this one needs stronger involvement by the most important decision influencers—in this case, the roofing and installation installers and their trade associations. It is unclear what the leading edge can sell and what will sell it.
- Three reviewers did not enter a response.

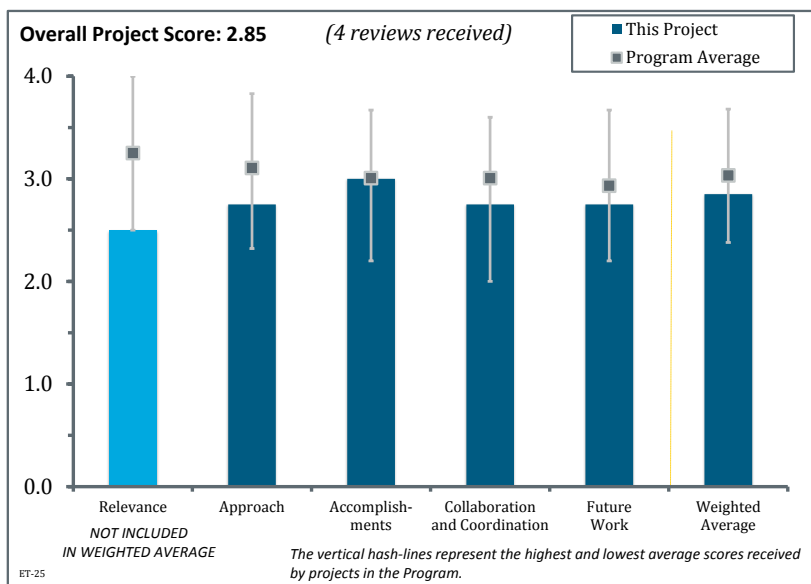
## Project # ET-25: Air Barriers for Residential and Commercial Buildings

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### Brief Summary of Project

Oak Ridge National Laboratory (ORNL) is quantifying the efficacy of air barrier systems on air leakage by reporting results from field experiments done at the Syracuse Air Barrier Test Facility and laboratory testing at ORNL. The work is done in collaboration with the Air Barrier Association of America (ABAA) via a cooperative research and development agreement (CRADA). The project will yield a list of best practices for existing products and will support the use of products with the most extensive test data.



### A. Relevance

This project was rated **2.5** for its relevance to Building Technologies Office (BTO) goals and objectives.

- The air barrier is an important component of energy exchange for a building, thus its study is relevant to BTO goals and objectives. On the other hand, the subject is narrow and, while the overall importance of air leakage is stated, it is not clear what the impact of the current study will be on the BTO objectives. The presentation was very good.
- Air tightness is important for building energy performance. No new technology is being developed here—the project is more about finding the best practice for air tightness and understanding it better.
- Air leakage is addressed in this project (a weakness in others). However, this points to the need for cross-connection between projects so information and knowledge are transferred.
- Similar work has been already done internationally for residential buildings with much higher air tightness requirements for both new construction and renovation. International Energy Conservation Code (IECC) 2012 requirements of three air changes per hour (ACH) are way too weak compared to 0.6 ACH from the Passive House Institute. Specific architectural details providing good air barriers for U.S. types of buildings are needed for designers and contractors to achieve much more stringent goals.

### B. Approach

This project was rated **2.8** for its approach.

- The approach and procedures used are well defined and thorough. Extensions to the approach would be beneficial, such as the study of the barrier aging, or comparison with state-of-the-art solutions, such as structural insulated panels.
- What matters is the air tightness of the complete building, so rather than focusing on the elements, a systems approach is needed in which all sources of air infiltration are examined, including chimneys, bathroom vent fans, kitchen exhausts, etc. The project team should prioritize the work to align with the greatest impact and focus on the greatest source of air leakage.
- The project's pro is development of a best practice guide. There are several cons:
  - It is not clear the project is building on work done by others.
  - Some tracks are behind.

- The project lacks a plan for future work and technology transfer.
  - The project could benefit from a steering committee.
- The Airtight Drywall Approach approach is not durable and in some climates can result in moisture issues within walls.
- One reviewer did not enter a response.

### C. Accomplishments/Progress

This project was rated **3.0** for its accomplishments and progress.

- While the agreement with the main partner was delayed, it is now finalized. The study findings are significant and valuable for predictions and adoption of new solutions.
- Progress seems limited—possibly 4 small-scale tests from a matrix of 22, and 2 subassembly tests.
- Two reviewers did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **2.8** for its collaboration and coordination with relevant stakeholders.

- The results have been or will soon be presented at conferences; the partnership with ABAA and various companies is excellent. It is not very clear how the results of the research will be implemented in the market.
- ABAA is participating, which is very good, but what is not clear is how the results will be transferred to the ABAA and how they will be disseminated by the ABAA. It is unclear whether “cost-effective” (slide 4) has been defined and is being used as a stage-gate to weed out non-viable approaches.
- There is a good collaborative partnership for technology transfer.
- Collaboration is primarily with manufacturers. The project needs more collaboration with building scientists.

### E. Proposed Future Work

This project was rated **2.8** for its proposed future work.

- The project is well laid out in terms of future plans and will continue the current activity toward the stated objectives.
- There are no decision points, and there is no mechanism for deciding what should be tested. Future plans suggest more of the same with the addition of light commercial buildings. Perhaps there could be a review of the current work with an assessment of whether enough information is known to reduce or redirect the scope of work to address the most important sources of air leakage.
- The project shows limited results for a \$1.2 million effort. Design recommendations on cost-effective methods to achieve air tight buildings would be helpful.
- One reviewer did not enter a response.

### Project Strengths:

- This is an excellent fundamental study using the available U.S. Department of Energy (DOE) resources.
- The study covers a very important topic.
- Two reviewers did not enter a response.

### Project Weaknesses:

- The budget seems very large, and the DOE contribution seems very large for the amount of output—\$1.3 million to date. Connections to other projects were not identified.
- Three reviewers did not enter a response.

### Recommendations:

- A study of the barrier aging (including subassembly) could provide valuable data. The project should assess variations from ideal installation conditions. The researchers should indicate how the new knowledge will be implemented/used in practice.
- It is unclear whether the results from this project could be transferred into code language for wider adaptation.
- The researchers should consider a review of the methodology. The project should also consider a steering committee to review the scope, approach, and progress.
- One reviewer did not enter a response.



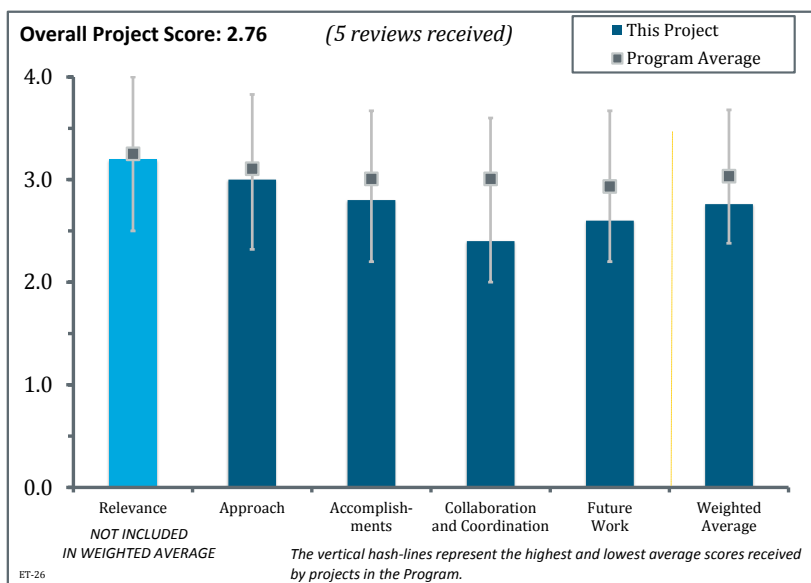
## Project # ET-26: Aerogel Impregnated Polyurethane Piping and Duct Insulation

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### Brief Summary of Project

InnoSense LLC is developing an aerogel-impregnated polyurethane piping and duct insulation technology with increased R-values over state-of-the-art technologies. Aerogel materials are incorporated into existing insulation matrices. The team has succeeded in incorporating aerogel materials into cellulose insulation to increase R-value. New insulation materials are being tested at Oak Ridge National Laboratory (ORNL).



### A. Relevance

This project was rated **3.2** for its relevance to Building Technologies Office (BTO) goals and objectives.

- Increasing the R-value of insulations is important and fully supports BTO objectives. In addition to reducing the energy loss, it can help with the condensation problem.
- This project has high relevance to the BTO goal: an increase in the R-value of insulation materials.
- Higher R-value insulating material would help building energy performance.
- The objectives support those of BTO. Here they aim to improve insulation performance with the addition of aerogel. However, the potential impact is not quantified.
- The researcher/partner was not able to share much information with the group. This project was too early in its development to warrant a peer review.

### B. Approach

This project was rated **3.0** for its approach.

- The project takes a novel approach. How much improvement can be achieved in R-value is not clear. Aerogel is highly insulating but not cheap. The manufacturing cost impact is not clear.
- The project is taking an interesting approach. Aerogels are light and can have a very high R-value.
- The use of aerosol in the existing insulation material is a rich concept.
- Very little detail was given regarding the approach—the presentation was too high-level. The presenter identified the key technical challenges (issues) but did not address them in a meaningful way in the presentation. The project picked a winner, “aerogel,” in the beginning and has not explored other options. The presenter realizes there are others, and perhaps some are better suited; but by picking a winner and defining the development track around aerogel, the project is most likely pursuing a path that is far less than optimal.
- Typically cost is a large barrier to success. Cost could not be shared. This is very difficult to review without data.



### C. Accomplishments/Progress

This project was rated **2.8** for its accomplishments and progress.

- The concept has been proven, and an 8% increase in R-value has been achieved. Phase II recently started, and hopefully higher R-values can be reached.
- The thermal conductivity data of the insulation material with aerosol demonstrate an increase in the R-value to a larger percentage, which is impressive.
- The product showed good results in increasing the R-value of both cellulose and soy-based spray foam insulation. What the review did not show is whether the addition of aerogel to these products was or will be cost effective.
- The presentation suggests the project is not focused and has achieved limited success. The objective is to develop an efficient insulation system that will adhere to ductwork and pipe structures. New insulation must increase R-value. The project team claims to have “increased the R-value by introducing aerogel additives to both cellulose and polyurethane materials”; however, there are the following issues:
  - Very limited data are given.
  - It is not clear that cellulose insulation could “adhere” to a duct.
  - Data that are given (in slide 9) show improvement is less than 10%, yet there is likely a substantial cost premium.
  - From questions following the presentation, it is not clear the researchers understand the physics behind the change in insulation performance.
  - By their own admission, there are better products that can be added than aerogel—ones that are cheaper and will offer similar or better performance improvements.
- This project is in its early stages. There are several initial hurdles to pass. The project needs to firm up material cost, manufacturing cost, and extent of R-value improvement. Additional cost versus insulation space saved is not clear for this project.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **2.4** for its collaboration and coordination with relevant stakeholders.

- Collaborations with the ORNL group and Bayer Material Science are ongoing.
- The project is at an early stage. More time is needed before meaningful collaborations with manufacturers could be started.
- The results of the work are only being tested by one U.S. Department of Energy researcher, according to the report. There are discussions under way for applications in appliance insulation. It was not clear from the presentation how this technology will be shared with the industry.
- The presentation did not in a compelling way explain why the new material was better. Results given showed (1) performance improvements are incremental, at best; (2) there is likely a substantial price premium; and (3) there are other additives that are potentially better suited. Collaboration was limited to thermal testing (ORNL) and some very preliminary discussions with firms. While the project is not complete, there is evidence that the value for investment is weak. It might be useful to get an assessment from the industry as to the viability of the approach being pursued. Bayer Material Science, with which the project team has had discussions, could possibly provide comment.
- The project should develop collaborations.

### E. Proposed Future Work

This project was rated **2.6** for its proposed future work.

- It seemed like the researchers/partners were already setting their sights on potentially more effective additives and chemistry other than aerogel. If aerogel is not cost effective, perhaps resources would be better spent developing more promising alternatives using this research and lessons learned as a starting point.
- The project needs to prove the feasibility of the technology along with the R-value and cost impact.

- A cost/benefit analysis should be conducted.
- Plans are sketchy and do not address the shortcoming of weak thermal performance.
- One reviewer did not enter a response.

### Project Strengths:

- The promising thing about this product is that it increased the R-value of cellulose insulation while keeping the cellulose from settling/consolidating. This could be of great benefit in a retrofit market for blown-in wall insulation for which air barriers and condensation in the cellulose is not a concern.
- The project takes the novel approach of using an additive to improve thermal performance of foams.
- The project uses a new method and is developing higher R-value material.
- Two reviewers did not enter a response.

### Project Weaknesses:

- The presenter gave no indication that this additive promises to be cost effective. The reviewer would have been more convinced that this product is worthy of continued research if the presenter had said something such as, “Early indications are that this product will increase the R-value by xx% and the cost of the product by yy%, which results in a zz% return on the investment and a simple payback of abc years.”
- The project seems to be behind schedule, has limited results to show progress, is producing limited performance improvements, and has limited external interest. In addition, other products/additives would be better suited.
- The improvement in R-value and cost impact are uncertain.
- Two reviewers did not enter a response.

### Recommendations:

- The project team should consider the following:
  - Get an assessment from a potential recipient of this technology, and revise the scope or terminate the project if there is little interest.
  - If there is interest, set up a steering committee to oversee work and set direction and priorities and ensure that the project works more closely with experts in the area.
  - Set decision points, including early exit. The value in this project appears to be weak and to benefit a niche product, aerogel. Special management, and a steering committee to provide oversight, would likely improve value, if BTO decides to continue the funding.
- One reviewer had no recommendations.
- Three reviewers did not enter a response.

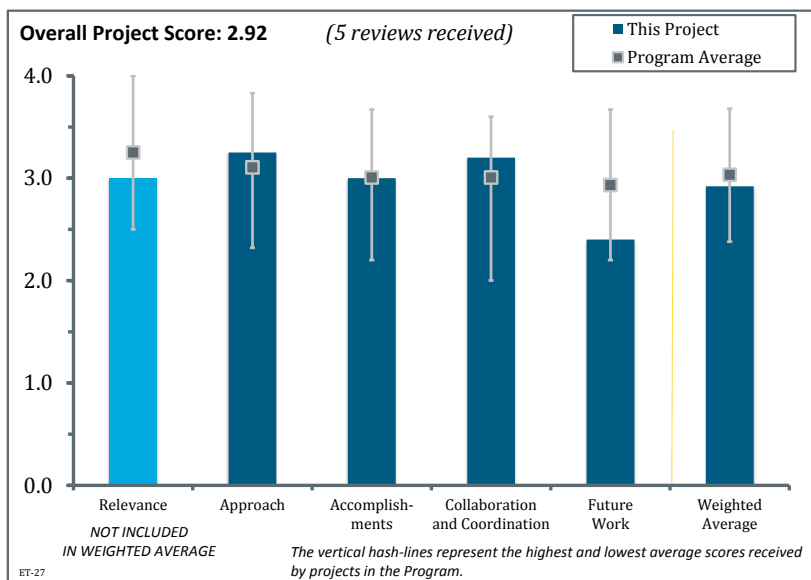
## Project # ET-27: Open Energy Information System

Jessica Granderson, Lawrence Berkeley National Laboratory, [jgranderson@lbl.gov](mailto:jgranderson@lbl.gov)

### Brief Summary of Project

Most commercial buildings are not operated as designed or as they should be, leading to significant wasted energy, with estimates ranging from 10% to 50%, and/or serious comfort issues. One underlying reason is the lack of feedback to the building operations staff on how their building systems are performing. Energy information systems (EISs) can help provide this important feedback. Although there are a number of commercially available EISs, most of them provide the infrastructure only to store and present the building operational data and, in some cases, energy consumption data. In most cases, the building operations staff has to create

custom “widgets” that utilize this operational and energy data to identify opportunities to make the building more efficient and comfortable. Most building operators lack this expertise, so the EISs generally do not add value or the value that they were intended to provide. Also, because each EIS vendor uses proprietary methods to store and present the data, it is difficult for third parties to build applications or “widgets” to assist in digesting this data and providing actionable quantified actions for the operators. Furthermore, most building owners perceive commercial EISs as costly and therefore are reluctant to purchase them. An open source EIS has the potential to bridge this gap and encourage the use and implementation of various benchmarking, diagnostics, and optimization strategies that have been developed and validated by experts in this building operations field. An open source EIS can be defined as one that is built on an open architecture software platform and allows users to import operational and utility data from their buildings. An open system could allow third-party diagnostic and analytical tools to leverage the building data and provide useful information to building operators. PNNL is proposing to provide technical support to DOE and the organization DOE chooses to build the open source EIS platform. PNNL will also modify diagnostic tools that it has developed to be compatible with an open source EIS platform.



### A. Relevance

This project was rated **3.0** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This is a very important topic because today, with smart metering and inexpensive sensor technologies, there is a large “acceleration” of data collection related to building performance. Most of the data are scattered and disorganized and without algorithms and procedures for data processing, and there may eventually be a large amount of data that has little value. The “simple analytics” tool that Lawrence Berkeley National Laboratory (LBNL) researchers are working on could help in screening these data and using them for identifying failing systems as well as successful technologies that can help with BTO objectives. Also, the project focuses on the existing building stock of small commercial buildings, which has very large role in achieving the BTO goals. Project results can stimulate the market for energy-efficient technologies.
- Three items are addressed: lack of awareness, risk averseness, and prohibitive costs. The aim of this project is in line with the main BTO goal: energy savings of 40% in existing commercial buildings, particularly small commercial buildings.

- The project is totally in line with BTO objectives. Its implementation can potentially lead to significant energy savings.
- This is potentially a very useful, user-friendly tool for a widely diverse group of users.
- It does not appear that this project has an approach that offers either new or helpful information. The examples shown—economizer malfunction and improper night setback—are not in any new or more-informative format than standard trend graphs available with existing controls. And because this is aimed at small buildings, the presentation did not address the fact that many (most) small buildings do not have automated controls, meaning that this information is not available and would be quite costly to obtain because instrumentation would first have to be installed to gather such information. The first question that should be asked is why the availability of such information—in many buildings it already exists—does not lead to correction or repair of the dysfunctional system. Two reasons come to mind. First, this issue (energy efficiency) is not on the radar of operators of typical buildings—and even less so as the size of the building gets smaller. Second, this sort of troubleshooting requires some expertise and time to review. Consider that any kind of program could easily require poring over considerable amounts of information to figure out what has happened, why, and when. Having an economizer suddenly fail may be easy to find, but that is seldom how such faults occur. More likely, the failure slowly develops over time. The situation is similar with night setback. One needs also to know if the reason for overtime operation was someone in the building working late, so analysis in the forms shown do not generally provide as straightforward a solution as implied. It is therefore hard to imagine any significant success or market penetration with what this project proposes to develop.

## B. Approach

This project was rated **3.3** for its approach.

- The project seems to take a common sense, collaborative approach. The reviewer particularly noted the incorporation of other commercially available software tools and databases into the open-architecture platform. There may be potential problems with such a broad array of contributors, but it seems like a great way to establish a widely used forum for exchanging information and tools.
- The development of open-source software for analyzing building operational data will raise awareness of the severity of the problem and increase activity in energy saving in the building sector.
- It is difficult to provide detailed evaluation of the approach based on a few slides in the presentation, but it seems that the approach is generally effective. The project has well-defined objectives, and the presenter is aware of the complexity of the problem, but it seems that the approach is not precisely defined. It is not clear what kind of algorithms and procedures are going to be used. Information needed includes what the metrics to evaluate success are, who the users of the energy information system are, and how much technical knowledge is needed.
- It was telling that no part of the presentation addressed the issue that most smaller buildings do not have any automated systems for data collection (no building automation system). Those small buildings that do have such systems often have a variety of different constraints on how often or how much information can be collected and saved and how it can be presented in a graphical format. There are considerable barriers to the consistent collection and presentation of information in the format shown for smaller buildings—even if it could be shown that information alone may be helpful to improve the operation of the building. Even if the information is available to be presented as the examples show, the project team appears to believe that simply seeing a graph will provide an automatic realization of whether or not a system is performing properly. This is often not the case.
- One reviewer did not enter a response.

## C. Accomplishments/Progress

This project was rated **3.0** for its accomplishments and progress.

- The project is on schedule. Two workshops with wide representation of the building-infrastructure-related community are helping to keep software architecture in the high-acceptance direction that is needed for open source software.

- The easier activities have been done; the more difficult tasks lie ahead. Completing the high-impact algorithms should stimulate usage, and the attractive, user-friendly platform should make this a great tool for a wide variety of users.
- The project results are not substantial: one workshop with identified algorithms and open-source architecture. However, the project is in a very early phase. The project is on schedule.
- The presenter proposed four tasks: Task 1 is providing, via workshop, the algorithms for 30 participants, for example, (1) load profiling with emphasis of AM time energy wasted, (2) high-priority algorithms for longitudinal and cross-sectional benchmarking, and (3) heat maps. Tasks 2 to 4 will be delivered one by one.
- The project has identified several issues that most certainly do lead to performance drift in buildings—particularly in smaller buildings. But it does not have a realistic path toward reaching a correction of these issues. Simply presenting graphical representation of parameters that could show an abrupt change in the operation of an affected device or system is not sufficient to improve building performance. Nor did the project description give a valid process for moving from information to resolution. It appears there is an underestimation of the effort required to (1) interpret the kinds of data presented in the examples under most realistic performance drift conditions, (2) determine next steps once data are correctly interpreted, and (3) promote who and how such a process can lead to resolution. There are simply too many unanswered questions about how such problems would be resolved.

#### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.2** for its collaboration and coordination with relevant stakeholders.

- The open architecture and incorporation of other tools and databases inherently encourage collaboration. It seems like the project team has done a good job of inviting many of the most appropriate key players to participate in the early stage formation of this platform. It seems logical for this program and the Technology Performance Exchange to cooperate closely; no mention was made of that in the presentation. There appears to be a great deal of potential overlap between the two programs.
- The project has a good list of collaborators/workshop attendees from various sectors: government, designers, maintenance, owners, and utility services—these are very relevant groups.
- There has been wide involvement of industry, academia, and government organizations from the beginning of the project.
- The main partners are Pacific Northwest National Laboratory and Navigant Consulting.
- This project has conducted workshops to try to identify problems that lead to excessive energy use, but the project has failed to work with industry and/or others to arrive at any new or innovative methods of resolving those problems that show any possibility of improving the current state of building performance drift.

#### E. Proposed Future Work

This project was rated **2.4** for its proposed future work.

- The research steps are logical and build on the previous results.
- The future of the project is straightforward—open source software development. It is not clear what steps will be taken in the software development and who will take the initial steps.
- Future tasks envision developing protocols and formats for accommodating some sort of standard presentation of these data. But the presentation examples are not more advanced than formats now available, and the project does not address this or the fact that most smaller buildings have no means of acquiring or storing such data because digital controls are either not present or do not have data collection capabilities.
- Barriers were not mentioned in the presentation; it was not clear whether many have been recognized. Stated plans for future work were very general.
- One reviewer did not enter a response.

### Project Strengths:

- Having a working model for pilot participants to try out, and that will generate feedback, is a great way to encourage participation. Focus on a limited number of simple, cost-effective algorithms keeps the scope manageable. An open source database could stimulate use, stimulate interest in energy efficiency measures, and encourage incorporation of other tools and databases, making the platform even more valuable as a forum for information exchange.
- The project is totally in line with the BTO goals. Open source software enabling building energy flow analysis will catalyze activities in energy saving. Wide involvement of industry, academia, and government organizations in the project will ensure the right aspects of software development.
- The project identifies several elements of building operation that certainly are prone to failure or human adjustment and that lead to energy waste.
- The project has the strength of proposing effective algorithms by which the small commercial building energy management can be accurately evaluated.
- The project will have a very large impact on BTO goals.

### Project Weaknesses:

- The elements identified that lead to excessive energy use are already quite well known. Means of displaying information (and the information itself) in order to track down energy issues are not new. Furthermore, availability of this information is very limited as building size becomes smaller because very few smaller buildings have systems that can measure and collect such information. So the unanswered question is how this project would reasonably add to the current ability to track down and resolve issues that lead to excessive energy use. It is very doubtful that it would.
- Lack of standardization of data, as well as lack of controls over data quality, could affect the usefulness of the system. It is unclear whether the lessons and findings of the Buildings Performance Database and the Standard Energy Efficiency Data (SEED) platform are being incorporated into this platform.
- It is not clear what steps will be taken in the software development or who will take the initial steps.
- Specific objectives and metrics can be defined better.
- One reviewer did not enter a response.

### Recommendations:

- The project is totally in line with BTO goals; open-source energy saving software will enhance attention to energy saving and make it easy to implement. BTO may lead in taking the initial steps in the development of such software.
- It seems like a project worth further funding.
- A suggestion is to reorient the project to look solely at metered building energy use and compare that with a benchmarked value that may be generated from Open Studio or some other means to provide monthly or perhaps even daily comparisons between expected and actual building energy use. Then, when added energy is being consumed, the project would start looking for reasons through some more advanced fault detection and diagnosis techniques. Such a project would require only simple data collection from buildings that would not require an automation system and could lead into the era of continuous meter data, wherein the time or conditions of excessive energy use could lead to a projection of the cause. For example, if excessive energy use over time is at night and/or weekends, then the cause may be a lack of night setback. If it were in moderate weather during day hours, the cause might be a faulty economizer. The benefit of this approach is that utility information could be made available for all buildings, and more robust but simple-to-apply benchmarking systems are becoming available.
- Two reviewers did not enter a response.



## Project # ET-28: Small-Building Control Systems

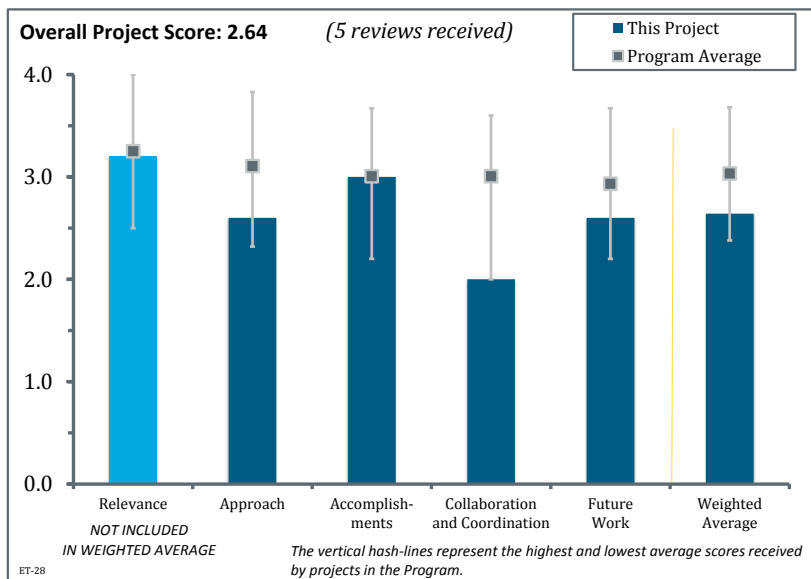
Michael Brambley, Pacific Northwest National Laboratory, Michael.Brambley@pnnl.gov

George Hernandez, Pacific Northwest National Laboratory, george@pnnl.gov

### Brief Summary of Project

According to the Commercial Building Energy Consumption Survey (CBECS), less than 10% of the buildings in the United States use building automation systems (BASs) or central controls to manage their building system operations. Buildings that use BASs are typically large (>100,000 sf). Over 90% of the buildings are either small (<5,000 sf) or medium-size (between 5,000 sf and 50,000 sf); these buildings currently do not have a cost-effective way to monitor and control their building systems from a central location. This project is a scoping study to identify the monitoring and control needs for small/medium-sized commercial buildings. The study has

the following elements: (1) identification of the BAS needs (end uses and systems to be controlled) for small/medium-sized buildings; (2) identification of control capabilities to address the needs identified in item 1 above; (3) development of a case study to show that building controls for small/medium-sized buildings can be cost effective; and (4) identification of monitoring needs to ensure proper and persistent operations.



### A. Relevance

This project was rated **3.2** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This project is a clear winner if successful, from the standpoints of both energy savings and market education. A truly innovative and cost-effective BAS for small buildings could open up the market and increase awareness on the part of people who might never consider energy-efficiency measures, especially if communicated to them in an easily understood way, e.g., “a programmable thermostat for your lights and air conditioning, as well as your heat.”
- This study is the first study within U.S. Department of Energy (DOE) laboratories to focus on the control of building energy. Control of energy use is a key technology to save energy in large buildings, while real control of smaller-to-intermediate buildings is currently missing; thus the principal investigator (PI) focuses on these buildings, enabling savings of 10%–25% of the building energy.
- The project is a preliminary study toward using automation and control systems for energy savings in certain types of buildings. This objective is well aligned with BTO objectives. On the other hand, the stated objective is fairly narrow, and it is unclear how it would be interconnected with other means of reducing energy needs. The project’s potential impact is grossly overstated: 10%–25% of energy is said to be wasted, which gives a potential savings of 750 trillion Btu; 10%–25% means that some waste 10%, others 25%, and most in between, while 750 trillion Btu means all waste 25% and all of it will be avoided using automation and control.
- If energy control is implemented in all small and medium commercial buildings, the energy savings can potentially reach 25%. However, many technical and legislative challenges have to be overcome to achieve this level of energy savings.

- It is not clear that this project provides any new elements or features that are not already available in the control systems in the marketplace today. One stated objective is to incorporate control features that are mandated by energy codes. These are already being implemented into application-specific controllers already available in the marketplace, and encouragement of that process is far more likely to succeed than working to develop hardware and software independently. The sample control system configurations are already available. Reducing the cost of small-size systems is a reasonable objective, but it is not clear from the presentation that any element of this project will do so.

## B. Approach

This project was rated **2.6** for its approach.

- Viewing and establishing target objectives from the perspective of the end user is great. It is not clear whether the project team looked at user interface/ease of understanding and operation for amateurs. The project should emphasize the need for simplicity and ease of operation for people who might have difficulty programming a modern thermostat. Also, the project did not seem to focus on “pull-through” marketing techniques to sell the concept. The “policy recommendations” seemed much too far-reaching for this project and a little naive, considering the number of building code jurisdictions in the country. It seems as though the product could be sold on its merits and word of mouth, assuming collaboration and involvement of the right groups in a follow-on “controls challenge” project.
- Technical and legal barriers are identified. Most attention is put into technical aspects and the demonstration of the technical possibility of achieving the required energy savings and payback. However, this class of commercial buildings has mixed ownership and renting occupancy. Therefore, the legal aspects of implementing control systems may be more complicated than the technical.
- It would have been wise to do a much more in-depth analysis of the control systems now available before moving ahead. One approach that has been discussed and shows promise that could lower the cost of such systems is to have building control capabilities incorporated into the digital controls of unitary equipment so that for a very small marginal cost, this equipment can incorporate the various items required of a building control system in addition to operating the unit in which it is assembled. Also, such systems could be encouraged to have stronger fault detection and diagnosis capabilities as a part of the controls. This might be a more productive path to economical small building controls. Creating easier financing and getting utilities to encourage such systems may be helpful, but it is not clear from the presentation how such steps would be integrated into the project. So simply working to develop a new stand-alone control system in a field that already exists and is quite competitive does not appear to be a viable project.
- The approach is not well defined, at least not on the slides; the objectives are vague, and no metrics for evaluating when and if the objectives were attained are shown. The slides provide almost no indication of what work was performed, what methodology was used, or how it was evaluated. Fortunately, the oral presentation shed some light on a few of these aspects.
- The project group plans to install its automatic control system in medium-sized buildings.

## C. Accomplishments/Progress

This project was rated **3.0** for its accomplishments and progress.

- The technical possibility and magnitude of energy savings and the payback period for energy control of this class of buildings were demonstrated. The objectives of the proposal have been met. Possible obstacles in the way of implementation of control technology have been identified. It was a short, low-cost study. However, the subject of implementation of control systems in small and medium commercial buildings is very complicated and would require a much more comprehensive study of economical and psychological aspects.
- The general scope for a “controls challenge” project aimed at a BAS product line suitable for small buildings appears to have been determined. More guidance on promoting/publicizing the anticipated final products might have been helpful, as well as more consideration of the operational simplicity of the final system. More emphasis on a simple user interface and features that could help facilitate re-commissioning/continual commissioning might have been desirable.



- The small building realized 20% savings with the proposed control system.
- The conclusions of the study are not well explained and are fairly general and vague. It is true that this is a preliminary study, but the presentation states that “significant savings are possible,” yet it does not explain what significant means; uses the phrase “can be cost-effective” rather than stating whether they are or not; and uses the phrase “need to be packaged into open standard” but does not explain why it must be open. Such statements cannot be considered the main conclusions of a scientific research study. Similarly, an obvious recommendation that the “solution may have to be tailored...” has little value. On the other hand, the study resulted in a funding opportunity announcement (FOA), which probably means that it did not need to look further.
- The project funding is nearly spent, and no substantial developments were described.

#### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **2.0** for its collaboration and coordination with relevant stakeholders.

- Collaboration was conducted within the network of DOE national laboratories. Industrial partners were not participating in the study.
- Three teams are mentioned: Pacific Northwest National Laboratory, Oak Ridge National Laboratory, and Lawrence Berkeley National Laboratory, but it is not clear how the PI actually collaborated except for data collections from these three national laboratories. Technology transfer of this control system may still need to be made to commercial buildings in the near future.
- The study was continued with a FOA, which is supposed to launch new developments and collaborations and have an impact on the market. On its own, the study has limited impact on the industry, or at least no indication is provided in this sense.
- There is no evidence of collaboration with potential user groups, just technology developers.
- Collaboration with current manufacturers of controls and/or unitary equipment appears to be lacking.

#### E. Proposed Future Work

This project was rated **2.6** for its proposed future work.

- The proposed approach seems technically sound, but there is not much information regarding the trade-off between the energy cost of running this control system with sensors and the amount of energy saved by the proposed control system.
- A challenge to the industry, if correctly developed with cost and performance criteria, could be helpful; however, it would seem that these controls would have to be part of the equipment rather than stand-alone, as apparently envisioned by this project, for them to be cost effective.
- The subject is complex and needs substantial funding that could be provided through other DOE sources of funding.
- The proposed future work seems to focus on technology, appropriately enough, but it did not seem to identify any need for innovation in the area of user interface or ease of operation.
- The study ended and was followed by a FOA.

#### Project Strengths:

- A challenge that expresses the needs for small buildings—systems that include the current state of optimized control but also keep track of building energy use and highlight excessive use and provide fault detection and diagnostics—might prove useful to get the industry moving more toward small building control improvements.
- This is a focused study aimed at an underserved market. It provides good guidance for market-specific technology “challenge” programs.
- The project is interesting, overall, and the presenter gave a good presentation.

- It is a short study that demonstrated the possibility of implementing cost-effective energy control systems for small and medium commercial buildings. Potential obstacles and ways of implementing such control were identified.
- One reviewer did not enter a response.

### Project Weaknesses:

- Controls in the architecture examples and with the basic features provided in the project presentation already exist. It does not appear that this project has provided any new concepts in terms of how to cost-effectively configure such systems.
- No mention was made regarding specifications for ease of installation, which might be a consideration for small building owners. The study seemed to ignore non-economic and non-technical factors that might contribute to a lack of market penetration for the target segments.
- The presentation file was not very helpful in understanding the work performed.
- It is a short project that just briefly looked at the subject.
- One reviewer did not enter a response.

### Recommendations:

- This project should consider a reconfiguration in which the intelligence of building controls for smaller buildings resides in the unitary equipment rather than in separate controls or thermostats. Because the intelligence is specific to whatever unitary equipment it is, it can include fault detection and diagnosis and should also include the ability to track and evaluate building energy use on a real-time basis.
- The economical potential of implementing energy control systems for small and medium commercial buildings is vast and in line with BTO goals. Extensive study of the technical, economic, and psychological aspects of implementing such controls should be conducted by BTO.
- The project is closed.
- Two reviewers did not enter a response.

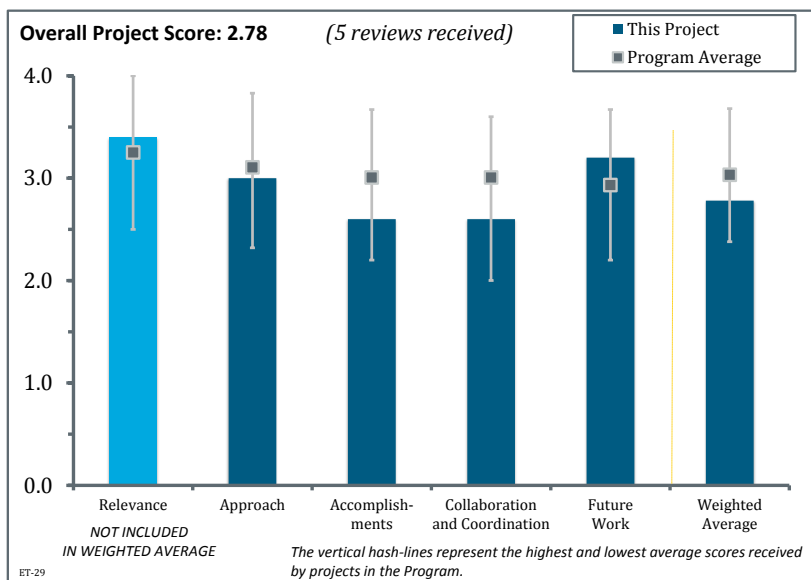
## Project # ET-29: Rooftop Unit Network

Michael Brambley, Pacific Northwest National Laboratory, Michael.Brambley@pnnl.gov

### Brief Summary of Project

Packaged rooftop units (RTUs) are used for comfort cooling and heating in more than 60% of the total U.S. commercial building floor space. Operational faults that increase energy consumption are pervasive in packaged heating, ventilation, and air conditioning equipment commonly used for space conditioning small commercial buildings (with floor areas <50,000 ft<sup>2</sup>) and many larger buildings. Complaints and unplanned reactions to equipment failure usually drive maintenance. Energy savings can be achieved through improved maintenance of packaged units. In many regions, utility peak consumption coincides with the RTU consumption; therefore, these units

can be used to provide temporary demand relief to the grid when there is imbalance between supply and demand. Also, these units can be used to mitigate variations in distributed renewable energy generation and to provide ancillary services. The RTU Network Project focuses on improving the operating efficiency of the RTUs, ensuring persistence of operations and making RTUs grid responsive so they can help in mitigating variable distributed renewable generation.



### A. Relevance

This project was rated **3.4** for its relevance to Building Technologies Office (BTO) goals and objectives.

- The sheer number of RTUs in the field is reason enough for the project to be relevant to BTO.
- This is a very ambitious project that could in the longer term help buildings operate more efficiently, but mostly it could help balance the load and grid if flexibility decreases as renewables are added to the generation side. However, there are a number of concerns about the ultimate success of the project.
- The project deals with retrofitting the RTUs and integrating them with the smart grid. The impact is difficult to calculate with accuracy. It is also unclear what the relationship is between the lack of equipment maintenance (stated as a problem) and the current project (it is unclear if it is just a through diagnosis).
- The project shows good potential for savings, but the proposed claim of 30%–40% of all RTUs or the best way to commercialize is unclear.
- One reviewer did not enter a response.

### B. Approach

This project was rated **3.0** for its approach.

- The idea of developing an open local area network (LAN) in each building that is specifically designed to allow energy-consuming or -generating devices to plug in and communicate, similar to how devices can be plugged into personal computer (PC) networks, is needed for homes and businesses. It is not clear why the chosen network, which is not well known, is the right one, other than this apparently has been developed in-house. So long as the focus is demonstrating how, what, when, and why data need to be exchanged

around this network and externally in order to improve building and grid performance, the project can have an impact on building and grid efficiency, whatever networks and interfaces evolve to accomplish this goal. While it is fine to employ the simple add-on RTU fault detection tool developed in a separate project, the focus must be on encouraging all manufacturers of all equipment that might be included in this network to include fault detection and diagnostics in their equipment package and to be certain the network has the ability to transmit and receive data as well as provide alerts and other information to operators or users. This could be very simple using conventional data management, visualization, and transmission strategies, and care must be taken to ensure this does not turn into the unnecessary boondoggle of reinventing existing technologies that other demand response research projects have.

- The project is well laid out. It is not clear how the controllers will interact with the building controls and how much the RTU manufacturers and/or owners will adopt the platform.
- It is not clear whether an RTU network challenge could be a complementary approach.
- Two reviewers did not enter a response.

### C. Accomplishments/Progress

This project was rated **2.6** for its accomplishments and progress.

- The project is relatively new, but the focus needs to be primarily on finding commonality from device to device about the kind of information that is necessary and how it is presented and exchanged to accomplish what is desired. This aspect is likely to be the primary benefit of this project—not the specifics of the network.
- The project is in its incipient phase, so it is difficult to judge its accomplishments. In addition, some of the original proposal's components were de-scoped.
- The project got a late start and has aggressive goals.
- Two reviewers did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **2.6** for its collaboration and coordination with relevant stakeholders.

- There is excellent collaboration between laboratories, but not much collaboration is reported with the industry.
- Further collaboration is needed to move this concept forward once an understanding of the “whats, hows, whens, and wheres” of the data exchanges are determined. To be effective, this would have to be integrated into gargantuan networks. And there is the potential to use current standard elements such as integrated Web servers to assist in data and diagnostic efforts.
- It is unclear how the different laboratory approaches will be evaluated, whether Catalyst is the only vendor for the demonstration, and what the technology transfer plan is.
- No specific collaborations are stated in the file.
- One reviewer did not enter a response.

### E. Proposed Future Work

This project was rated **3.2** for its proposed future work.

- The project is ambitious and will become a stepping stone toward integrating other devices.
- A long list of desired outcomes was presented. It is of paramount importance that the outcome focus on what data and what representations and processing are required rather than on the specifics of the network necessary to make this happen. Once the information technology (IT) industry has a blueprint for what information needs to be exchanged within and external to buildings to enable smoother and more-efficient operation, that industry should be listened to insofar as how best and most cost effectively to accomplish all these tasks.
- The proposed project will be extended to many buildings and many devices.
- It is unclear how future work will be accomplished or what the technology transfer plan is.

- One reviewer did not enter a response.

### Project Strengths:

- A local network that permits plug-and-play compatibility for all energy-associated systems for buildings is a potentially important step toward managing those systems more effectively to coordinate with the grid and to detect and diagnose problems.
- There is a clear need for “connected” savings and use of application programming interface (API) applications.
- The project implementation has excellent flexibility (as presented, although this is not in the presentation slides).
- Using three laboratories will enable different approaches.
- One reviewer did not enter a response.

### Project Weaknesses:

- To be effective, this project cannot attempt to solve the whole issue, as appears to be the design, by setting up three separate demonstrations. Rather, the focus should be on determining the type of information and how it could be used to keep each included component, the system to which it belongs, and the overall building and its connection to the grid operating at maximum efficiency at all times. The presentation of this project did not seem to focus on this as much as simply linking components together. The details of the network are likely the least important aspect because in the future, these data will likely be communicated on whatever the primary network and services are for the building’s operation.
- The project needs a long-term commercialization plan, a plan for how the different laboratory approaches will be evaluated, and a technology transfer plan.
- The project needs a plan for adoption on a large scale by the private sector.
- The project is not providing integration with existing building automation systems.
- One reviewer did not enter a response.

### Recommendations:

- It is recommended that the project describe specific sets of data and analysis desired for each type of component considered for the network such that its operational integrity and efficiency are assured, as well as ensuring that it can operate as a component in any type of system that might be applied in such typical applications of such equipment. It is also recommended that closer collaboration with industry be considered, as much of the operator’s or user’s interface to each component (to find out if it is operating properly or what to do if it is not) could be addressed starting with the growing trend of integrating a Web server into the processor of each component.
- The project should develop an RTU network challenge.
- Three reviewers did not enter a response.

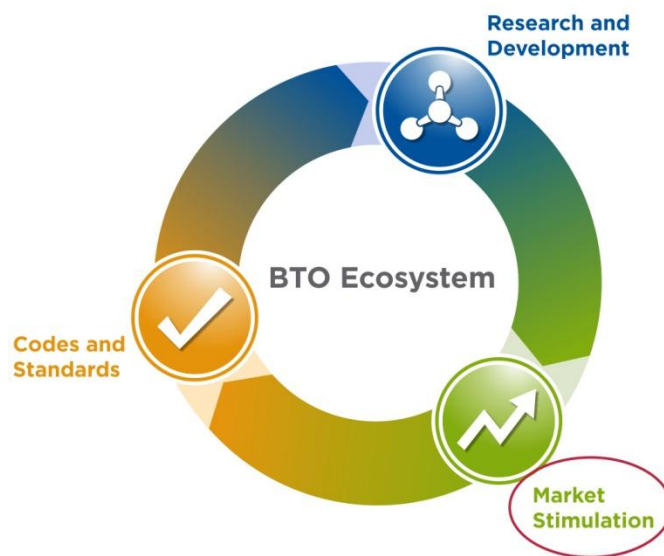
#### 4. Commercial Buildings Integration Program Summary

By teaming up with industry and national laboratories, the Commercial Buildings Integration Program focuses its efforts on researching and deploying advanced technologies and systems to reduce energy consumption in commercial buildings. The Program promotes voluntary activities to prime and support the commercial building sector with an emphasis on high-potential technologies that are market viable but underutilized.

The Commercial Buildings Integration Program pursues goals for both new and existing buildings. For new buildings, the Program's 2020 goal is to demonstrate at convincing scale (in all climate zones and major building types) that it is cost effective to reduce the energy required to operate new commercial buildings by 50% relative to ASHRAE 2004 90.1 and 27% relative to ASHRAE 2010 90.1. The Program's 2030 goal is to demonstrate at convincing scale that it is cost effective to operate new Net Zero Energy Ready (NZER) commercial buildings. For existing buildings, the goal is to demonstrate at convincing scale commercial building upgrades with 20% cost-effective savings by 2020 and 50% cost-effective savings by 2050, relative to the prior operations for those buildings.

These goals support the targets defined in EISA for low-energy new and existing commercial buildings: Develop and disseminate technologies, practices, and policies for the development and establishment of zero net energy commercial buildings for (1) any commercial building newly constructed in the US by 2030; (2) 50% of the commercial building stock by 2040; and (3) all US commercial buildings by 2050.

The keys to changing energy use in commercial buildings are: understanding what drives companies to adopt efficiency improvements, and removing informational, financial, market, and institutional barriers. To accomplish the Program's energy-saving goals, work focuses on (1) developing tools and solutions to remove barriers to investment and increase the understanding of efficiency measures and (2) demonstrating and deploying actionable products through market partnerships to drive technologies into the marketplace (see Figure 5).



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

The Commercial Buildings Integration Program will track its progress toward goals by analyzing the impacts of program-funded activities on building energy codes and standards, examining energy trends, and tracking the cost of energy-efficiency measures in the commercial buildings market.

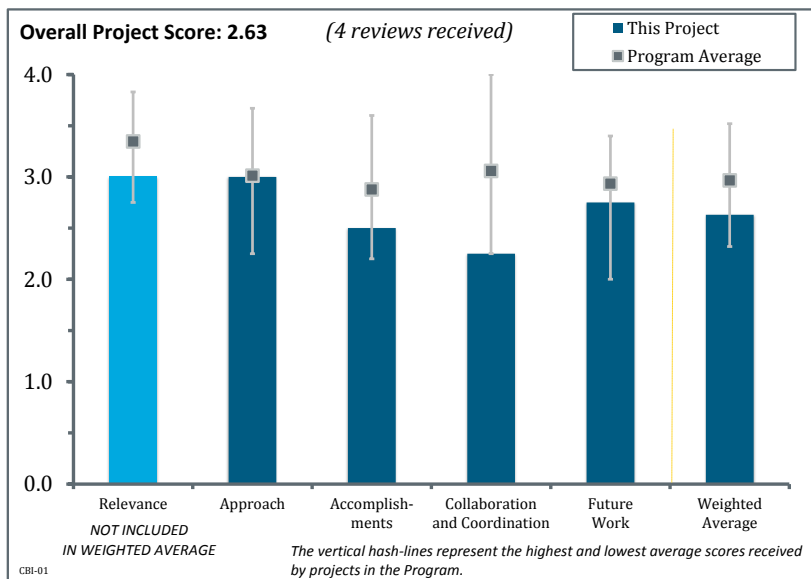
## Project # CBI-01: Building Energy Modeling (BEM) Library

Ellen Franconi, Rocky Mountain Institute, efranconi@rmi.org  
 Amir Roth, U.S. Department of Energy, amir.roth@ee.doe.gov

### Brief Summary of Project

The objectives of the Building Energy Modeling Library project are to document, vet, formalize, and eventually standardize best-practice procedures and codify deliverables for various modeling tasks from design guidance and code-compliance to evaluation, measurement, and verification. The project is organized by common modeling subtasks (e.g., measure evaluation), which can then be composed into task flows. Rocky Mountain Institute (RMI) is working with the National Renewable Energy Laboratory, its partners and stakeholders, the International Building Performance Simulation Association (IBPSA), and the members of ASHRAE SPC 209

“energy-model driven design assistance” to populate and vet the library, which will eventually become part of the 209 standard. This project is entering its second year.



### A. Relevance

This project was rated **3.0** for its relevance to Building Technologies Office (BTO) goals and objectives.

- The reviewer was impressed with the project’s dual focus on building use by designers and promoting confidence among owners. The work process seems very strong, although perhaps a bit too constrained. The work products envisioned and in the pipeline are impressive.
- This project is very relevant to BTO’s goal of developing the workforce so that broader and deeper adoption of energy efficiency in buildings is possible.
- Current building modeling techniques are far less effective in improving building energy performance than many non-practitioners among government, utilities, and elsewhere believe. Truly effective design practitioners increasingly see modeling as a very minor part of the actual design process. Computer modeling could be much more helpful in analyzing heating and cooling loads for buildings if a much more in-depth picture of how loads vary over time is provided. Some practitioners import the 8,760 hourly load data points into spreadsheets that can be manipulated to help them understand the characteristics and dynamics of everyday loads in order to more effectively configure heating, ventilation, and air conditioning systems. But this is an awkward process that needs to be streamlined. Furthermore, the systems sections of modeling programs often fail to address actual operational requirements. Current modeling procedures employ specialists who often do not understand the finer points of building operation, equipment, systems, and most importantly—controls. The transfer of information about what should, could, or has been modeled between the designer and the implementation and commissioning processes is poor. Consequently, relying on building modeling as a key element of energy-efficient design results in most buildings operating far less efficiently than is possible or expected. As potentially important as modeling could be, it is probably the most overvalued and underutilized element in the building design and construction process. To overcome this deficiency, new approaches focused on more-effective model output must be considered and applied. The process of standardizing inputs rather than focusing on more



robust model output features may provide only limited help to start this process. Therefore, a successful completion of this project will likely have little impact on BTO building energy improvement goals.

- One reviewer did not enter a response.

## B. Approach

This project was rated **3.0** for its approach.

- This project seems to be accomplishing a great deal, given the limited budget. It reflects a very organized and thoughtful approach to developing the building blocks needed to improve the quality and consistency of building energy modeling.
- One reviewer did not see how the approach will achieve the project's stated goals.
- The work statement shows that there is an understanding that current building modeling techniques are not currently very effective. Helping modelers understand and employ more-effective input data based on standards may provide some help. The real issue is the lack of effective output to help building and system designers fully understand the dynamics of a building's operation in order to design equipment—especially control systems—much more effectively. There is a complete lack of ability to use these models in the commissioning and operations phases to verify that the various building components operate in accordance with the projected design.
- One reviewer had no advice on improving this work.

## C. Accomplishments/Progress

This project was rated **2.5** for its accomplishments and progress.

- The reviewer found it a bit hard to judge, but it seems like a fine job.
- As with many software products, it is not certain whether stated objectives will lead to an effective outcome. This project does not address the greatest weaknesses of current modeling practices.
- The reviewer did not see results that will address the goals.
- One reviewer did not enter a response.

## D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **2.3** for its collaboration and coordination with relevant stakeholders.

- There is good collaboration with the relevant workforce development efforts at BTO, ASHRAE, IBPSA, and elsewhere.
- No collaborators are indicated; RMI is doing the work. Technology transfer and market impact are hard to assess.
- The project should spend more effort to determine why simulation modeling has been so ineffective and to collaborate with design and commissioning practitioners who are working to develop more energy-efficient buildings.
- The project would benefit from stronger external advisory processes.

## E. Proposed Future Work

This project was rated **2.8** for its proposed future work.

- The next steps continue the logical completion of this work.
- Future work should concentrate on making modeling tools useful throughout implementation, particularly during the commissioning process. There is no better way to implement performance-based commissioning than to compare equipment, system, and whole building energy usage under actual conditions with model projections. Such features do not appear to be included in plans for future work.
- Two reviewers commented that no future work was listed.



### Project Strengths:

- The difference between emerging and mainstream technology is captured by the extent of support “infrastructure” (e.g., allies, experienced practitioners, design tools, code acceptance) between the former and the latter. The team is addressing key parts of this information and the perceived infrastructure.
- Providing guidelines and standardization for modeling inputs will likely be helpful in improving the modeling process.
- Two reviewers did not enter a response.

### Project Weaknesses:

- The resources now invested in the standard hourly modeling exercises for building design would achieve much better results with simpler but more effective tools that provide designers with a real understanding of the operational dynamics of the building and interior zones. To achieve more realistic and effective modeling, new approaches are needed that provide a much more robust suite of outputs that can be used by the designer to optimize equipment and controls selections and by commissioning agents and building operators to maintain performance. This project does not address these critical issues.
- Weaknesses of this project include the following: (1) There was nothing explicit in the presentation about involvement of actual designers or owners as an advisory committee to increase the odds of uptake. The Environmental Defense Fund and RMI are nationally prominent groups in the building efficiency community, but that does not guarantee standing among the key stakeholders for the work. (2) Piece-parts seem overly bureaucratic (e.g., slide 7) and jargon-rich. It is not clear who benefits from this or if feedback, adaptability, or creativity will come through the maze as the project progresses.
- There seems to be overlap between this project and the other three about modeling.
- One reviewer did not enter a response.

### Recommendations:

- This reviewer encouraged the project team to keep up the good work.
- It is recommended that this project consider refocusing on improving the output options of current modeling programs to make them much more useful throughout the building design, implementation, and operation stages.
- Two reviewers did not enter a response.

## Project # CBI-02: ISO50001: Conformant Management Systems

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### Brief Summary of Project

The primary goal of this project is to ensure, facilitate, and expand long-term energy savings resulting from building energy management through the application of ISO 50001.

Primary objectives of this project include determining whether commercial buildings (1) will experience positive results from implementing ISO 50001, (2) can be expected to achieve full conformance to the standard, and (3) find value in third-party certification of ISO 50001 conformance.

### A. Relevance

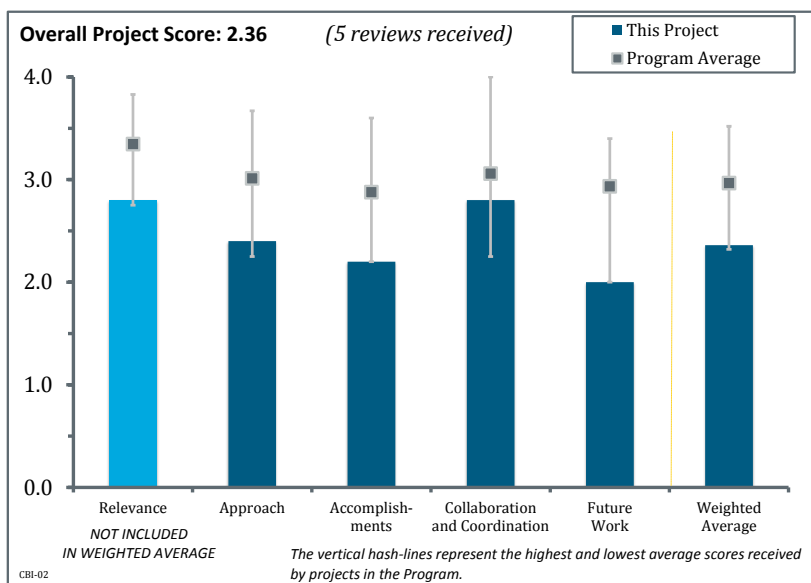
This project was rated **2.8** for its relevance to Building Technologies Office (BTO) goals and objectives.

- The project has good potential for savings, but it is not clear how the savings will be achieved without long-term funding for coaching, work plans, webinars, and audits.
- The project's goals fit in with the larger BTO goal of accelerating the adoption of technology in the commercial sector. Energy-efficiency technology is mostly understood; however, effective adoption is still a challenge due to internal planning processes, strategic planning, and managerial issues. In addition, energy-efficiency measures are often not sustained due to a lack of an energy-management-focused process. ISO 50001 (Commercial) attempts to address these issues through a cultural shift.
- This reviewer's company piloted ISO 50001 in some of its manufacturing facilities in Europe and considered doing so in the United States. Given the costs and complexity associated with certification, it is questionable whether the standard will be particularly relevant in the commercial building market. Also, given the tremendous focus of BTO on small- to mid-sized commercial buildings, this effort is somewhat disconnected from the broader focus on where to achieve big gains, as the standard will definitely never be significant for such buildings. This is the proverbial low-hanging fruit.
- The project would support BTO objectives if it could achieve its stated objectives of determining whether full implementation of ISO 50001 provides value (as compared to a less rigorous approach) and determining whether savings can be achieved in the commercial market similar to those in the industrial market. However, the project is not following a path to accomplish those goals. The actual results will support BTO objectives in only a limited manner. The presentation outlined the relevance in a theoretical manner and was unable to show relevance to any activities that were taking place.

### B. Approach

This project was rated **2.4** for its approach.

- The presenters needed additional time to really discuss all of the identified challenges and how they were overcome. In general, one year may not be a sufficient amount of time for the project to identify lessons learned and address them. In addition, the project may have benefitted from enrolling more customers because few companies seem to have finished the program. ISO 50001 (Commercial) did do a good job of



setting up the program so that there were off ramps and opportunities for companies to make different levels of commitment. The project set up a good Web-based tracking system, which could be quite useful; however, it is not clear what happens to that information in the long term once the program stops. An opportunity to view this system would have been helpful. Overall, the project addresses the key issues of how to change corporate culture and integrate energy management into larger processes. This is a very challenging topic and most likely needs additional resources after the current effort ends. Follow-up with the companies that completed the program, in order to demonstrate self-sufficiency or to provide additional follow-up resources, would be a great way to check sustainability and perhaps help justify the large initial investment.

- This project features a good approach, but it is not clear how to extend it beyond the initial projects. Alignment with utility programs would have been beneficial.
- Many of the barriers that exist are acknowledged and plans are in place to mitigate the associated risks; however, there is not much connectivity to other efforts. ISO 50001 logically connects with building energy benchmarking and disclosure, yet this connection is not apparent within the project. Also, connectivity could be enabled by including building controls and approaches, but it does not seem to be. The reviewer questioned where the ISO 50001 application is and how the standard is integrated with workforce development efforts, such as funding to train energy managers. It is unclear if 50001 can be used as an adjunct to the nascent commercial building asset rating tool (e.g., if a building scores well on the asset rating tool but has a high energy use intensity, inferring that operational changes are needed and therefore ISO 50001 is a place to look).
- One reviewer noted that this project builds off the existing system described in ISO 50001.
- The slides include a problem statement that indicates the project would determine whether existing commercial buildings: (1) are likely to experience similar positive results from implementing ISO 50001; (2) can be expected to achieve full conformance to ISO 50001, or if a less rigorous approach is needed; or (3) find value in third-party certification of ISO 50001 conformance. The approach is then defined as the first two of these three statements. However, throughout the presentation, it does not appear that results have been achieved that definitively answered any of those questions. It is unclear whether the pilot sites that are attempting certification will achieve it, and what savings they will achieve. It was not stated how the savings of an ISO 50001 site would compare to one that received only technical assistance (thereby justifying the more rigorous approach), and no mention was made of the value or implementation of the third-party certification process.

### C. Accomplishments/Progress

This project was rated **2.2** for its accomplishments and progress.

- This project features good case studies and resources.
- The effort is too early to fairly judge on this criterion. The reviewer rated it as “fair” but felt that more time is needed.
- This topic was not fully addressed during the presentation and needed more time. It is unclear what the ISO 50001 (Commercial) companies or the non-ISO-50001 companies have achieved, or if insights were gained into setting up a second-tier system or an official third-party certification process. In addition, it would be helpful to have heard more about the projects selected and the state of their implementation. Overall, it is hard to say what has been accomplished and how close the project team is to identifying answers to its questions: positive results from ISO, interest in a less-rigorous program needed, or desire for a third-party certification (as opposed to the popular Leadership in Energy and Environmental Design [LEED] and ENERGY STAR certifications). These need to be answered before larger goals can be addressed. The reviewer questioned if this process can be implemented on a larger scale in a cost-effective and efficient manner.
- Although the project is well on its way to completion, the accomplishments are still being outlined in terms of “potential impact” to the overall commercial market, rather than providing any relevant data from the pilot. The information shown would have been accessible prior to the project by applying savings from the industrial sector (which does not necessarily directly translate to the commercial market). Pilot sites were identified and technical assistance was provided, but the project was not defined as an organizational energy management system (EnMS) implementation project—instead, it was intended to compare and

contrast different approaches. There was no discussion on the metrics that would be used for this comparison (these should have been identified at the start), what results would be measured, or how the results would be measured.

- No results were shown. However, the project demonstrates success in recruiting pilot sites.

#### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **2.8** for its collaboration and coordination with relevant stakeholders.

- There is excellent collaboration on these projects. However, outreach to utility programs would have been beneficial. There is no clear technology transfer plan to extend beyond these projects.
- There seems to be a good level of collaboration among various parties to achieve objectives. This collaboration would appear to capitalize on many existing resources. Market impact could be heightened by moving from a case study focus to a larger sample size. Ultimately, ISO 50001 requires resources. There needs to be evidence showing return on investment (i.e., attractive paybacks); anecdotal indications are not persuasive. This would also enable access to other resources such as demand-side management funding from utilities, which is a longer-term goal, but additional actions are needed to get there.
- The program is based on participation from industry. That goal seems to have been achieved, because several large corporations were recruited and engaged. Calls and webinars indicate that there has been a large amount of interaction and involvement of industry leaders. However, it is unclear if there was any outreach and sharing with similar programs, such as the U.S. Department of Energy's (DOE's) Commercial Buildings Partnership or state-run programs. Collaboration across programs may have allowed for a quicker identification of challenges and options for solutions. Finally, having multiple groups involved with the implementation does allow for each to add its set of resources; however, it is unclear if participation by the National Renewable Energy Laboratory, Lawrence Berkeley National Laboratory, and the Georgia Institute of Technology are all required. Having three different groups involved in the launching and management of a program can cause confusion and inefficiency.
- There was good diversity of building types for the pilot group.
- Project success required the cooperation of outside property owners willing to implement some level of the ISO 50001 protocol. Eight pilot sites were selected; however, it is not clear what stage of completion they are at compared to the remaining program time. The complex relationships between the lead team, the subcontractor, and the multiple layers within each organization may have contributed to the difficulty with implementation.

#### E. Proposed Future Work

This project was rated **2.0** for its proposed future work.

- The proposed future work looks to scale the current efforts without any acknowledgement that the pilot does not achieve the goals. The remaining time in the project would be better utilized trying to quantify the accomplishments and determine the cause/effect so that future efforts can incorporate the successful elements. The proposed future work suggests exploring ways to align with LEED credits—this is a positive direction that may add value to the certification process.
- The follow-up activities shown on slide 10 will ensure success of the pilot group.
- The project planning cannot be faulted, but the reviewer questioned whether pushing 50001 to the commercial building market is an important goal. Focusing on the “ISO 50001-lite” approach that was discussed makes more sense and more closely aligns with other BTO focus areas. Much of what BTO is doing concerns barriers to market entry. Ultimately, the market is not clamoring for an energy management standard, so the barrier is really customer pull, and BTO or DOE are both capable of dealing with that.
- An internal report summarizing lessons learned will not help with technology transfer. The reviewer questioned if lessons learned can be provided generically. A nationally scalable approach would be excellent—especially if it is aligned with utility programs.
- A fair amount of work still needs to be completed. Not only do customers need to complete the program, but the main program's questions need to be addressed as well. There still are key outstanding elements,

such as how this can be replicated on a larger scale. It is unclear if there is time and resources, along with a detailed plan to ensure all of this is achieved.

#### Project Strengths:

- There has been excellent collaboration on these projects. A nationally scalable approach would be excellent.
- The program addresses the key issue of how to change behavior. Subsequent mindset shifts will result in deeper and more sustained savings. This is one of the next major steps to ensuring that energy efficiency is achieved on a broader scale.
- Implementing a protocol such as ISO 50001 with commercial customers who do not have the structure for similar policies in place is a challenge, and the team's coaching efforts and resources have supported these implementations.
- Focusing on modifying 50001 for commercial buildings is a logical place to take this. The office should abandon pushing the full standard and just take portions it thinks make sense.
- One reviewer did not enter a response.

#### Project Weaknesses:

- The inability to measure results is the project's biggest weakness. The need exists to evaluate whether the significant investment in ISO 50001 produces commensurate results, or whether a lesser commitment could produce the same. Also, the differences between commercial and industrial facilities in their management approach and physical opportunities for energy efficiency need to be looked at closely. The project should have created a benchmark for comparison in order to support that goal. It will be tempting to compare the pilot sites to each other and eliminate low performers due to "management" factors, leaving the true question unanswered.
- There is a lack of connectivity to other BTO initiatives and a lack of focus on the workforce as a way to generate some interest from building professionals.
- An internal report summarizing lessons learned will not help with technology transfer. The reviewer questioned if lessons can be learned generically. A nationally scalable approach would be excellent—especially if it is aligned with utility programs
- It is hard to describe the current level of success or how this process can be modeled on a larger scale in a cost-effective manner.
- One reviewer did not enter a response.

#### Recommendations:

- The presenter mentioned the importance of a champion at the pilot sites—this should become a key component for any other pilots. The project should be closely examined to determine how the pilots proceeded to find elements that can be used to identify future participants that will be more likely to succeed. An EnMS requires heavy investment in human resources and is not a good fit for all property owners.
- The project team should follow up with the companies that completed the program at the 1, 2, 3, and 5 year milestones in order to document results, demonstrate self-sufficiency, or provide additional follow-up resources. This could be a great way to check sustainability and perhaps help shore up the big initial investment with follow-up resources. The team should also consider another round with a new set of customers, implement lessons learned, and try a step-down approach. It should attempt to show that once lessons learned are implemented, this process can be accomplished on a larger, more cost-effective scale. An eGuide is great; however, in order for it to be effective and impact the industry, it will likely need to be accompanied with webinars, conferences, or other more direct communications. If not, there is a chance materials are just posted on "another website."
- A report summarizing lessons learned will help with technology transfer. A nationally scalable approach, aligned with utility programs, would be excellent.
- Two reviewers did not enter a response.

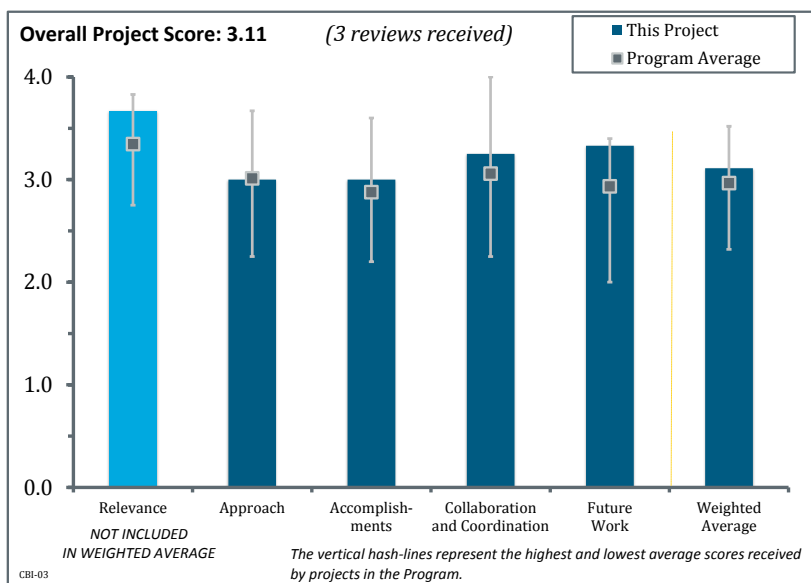
## Project # CBI-03: Window Daylighting Demo

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### Brief Summary of Project

This project seeks to accelerate adoption and widespread deployment of improved shading and daylighting systems in new and retrofitted commercial buildings. Some of the project objectives include completing a scoping study to survey and evaluate candidate shading and daylight systems; developing a field test performance database; and creating a toolkit for outreach, replication, and commercial deployment.



### A. Relevance

This project was rated **3.7** for its relevance to Building Technologies Office (BTO) goals and objectives.

- The project is highly relevant to BTO goals regarding reducing energy consumption. This program offers the opportunity to market and advance marketplace adoption of many of the technologies being developed by the Emerging Technologies Program. The project's wider focus on the market in general for deployment of emerging technologies in daylighting and shading is positive. It is important to see the broader perspective in addition to having cutting-edge technology development from some of the other teams.
- If it is more widely scaled, the project has the capability to significantly reduce cooling and lighting energy usage in commercial buildings. Wide-scale adoption of proven technologies (commercialization) is the barrier that needs to be broken.
- The envelope provides BTO with the first opportunity to optimize a building's energy consumption. Glazing is a major component, and there seems to be no inclination to reduce the amount of glazing in modern design and construction. These simple, quick tools are absolutely needed.
- The project's goals of providing improved data and tools related to shading and daylighting are consistent with BTO objectives and will support improved energy savings in new and existing buildings.

### B. Approach

This project was rated **3.0** for its approach.

- The approach takes a realistic view of two pathways to market, one for the high-end, cutting-edge consumer, and one for lower-end, simplified products. The long-term goal of creating a market pull for the enhanced product lines is key. This reviewer likes the approach of developing unbiased tools to help understand what products are available and how well they will perform.
- The project will need interoperability with other tools, i.e., the capability of pulling data from an architect's studies in this tool into the whole building simulation and heating, ventilation, and air conditioning (HVAC) analysis tools so that it does not have to be recreated.
- The project has just started and has only completed its scoping effort. The approach as outlined is twofold—improve the selection of existing products, and increase savings through better use of existing



products or modified existing products. By improving the tools available to designers, the results are expected to improve.

- The project approach incorporates a range of strategies designed to support the emergence of a commercialization pathway. Each specific approach is designed to reach and influence a different set of stakeholders.

### C. Accomplishments/Progress

This project was rated **3.0** for its accomplishments and progress.

- Major milestone accomplishments have been met on time and on budget. A focused shift to attempting to reach a larger number of projects that involve shorter measurement and verification periods will provide a larger set of shading and daylight measure performance data (savings), which will be beneficial to the broader marketplace.
- The team has achieved significant accomplishments in evaluating the existing technology through the scoping study that was performed. The commercial building fenestration design software tool (COMFEN) looks interesting and this reviewer would like to learn more about the system's benefits, but cannot comment on how well it supports BTO goals.
- The project scoping has been completed as the first milestone. Products and buildings have been identified for field case studies, and simplified assessment methods are being developed. These efforts will support the improvement of the evaluation tool, along with links to websites. No barriers were identified; the project appears to be slightly behind schedule.
- It is hard to evaluate progress as the study is just starting, but it has great potential.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.3** for its collaboration and coordination with relevant stakeholders.

- The project clearly demonstrates collaboration with both internal and external stakeholders, including manufacturing partners, building owners, architecture/engineering (A/E) firms, and agency partners.
- The project team has identified diverse collaboration and a cross-functional team with building owners, technology suppliers, and the A/E community. This is critical to building momentum for wide-scale market adoption of the new technologies. This reviewer is excited about the webinars and training opportunities on the COMFEN tool and plans to attend.
- Partnerships have been developed with manufacturers, designers, and specific agencies. The material has been presented at numerous conferences to increase awareness. Use of the tools, once deployed, should improve the awareness and adoption of high-performing technologies.
- This reviewer felt that no real collaborators were identified. It is not clear how the investigator plans to get new products into the database and provide quality control—especially for attachments and shading devices.

### E. Proposed Future Work

This project was rated **3.3** for its proposed future work.

- The project team has an excellent plan and identified a roadmap to grow this tool and its capabilities.
- The future work plan (projected to fiscal year 2015) appears to be manageable. This is largely due to the shift in field studies from a few large, highly instrumented projects measured for a long time period, to a larger number of less-instrumented projects that are measured for a shorter time period. This shift creates a larger data set with sufficient granularity to judge savings estimates and shading and daylight harvesting control measure performance and effectiveness.
- The plans for the project are logical and do not appear to have any major barriers. Most steps are building on past experience and should have few unknowns involved. The team will need to manage the scope of incorporating new data and products into the demonstration site to maintain the schedule. If “crowd sourcing” is pursued, it will introduce an element of uncertainty/potential unreliability into the information

in the database, and that has not yet been addressed. During the deployment phase, a process will be needed to incorporate feedback.

- One reviewer did not enter a response.

### Project Strengths:

- This project's strengths are: (1) it provides a vehicle to help create market demand for other emerging technology projects, and (2) it assists with educating end users and decision makers for technology adoption.
- The project's strengths lie in the existing high-quality data on glass materials.
- The project's ideas and approach are sound, and so far the team is proceeding in a manner that supports the stated objectives.
- One reviewer did not enter a response.

### Project Weaknesses:

- The project's weakness involve growing the product database to include components other than glass and being reasonably certain of the quality of the data.
- It is difficult to quantify the direct energy impact of the program.
- Two reviewers did not enter a response.

### Recommendations:

- There was limited detail provided about the plans for field studies, buildings, and test beds. This portion of the objectives needs to have adequate focus in order to track on the schedule outlined, and the process needs to be clearly defined to incorporate results from the studies.
- Three reviewers did not enter a response.



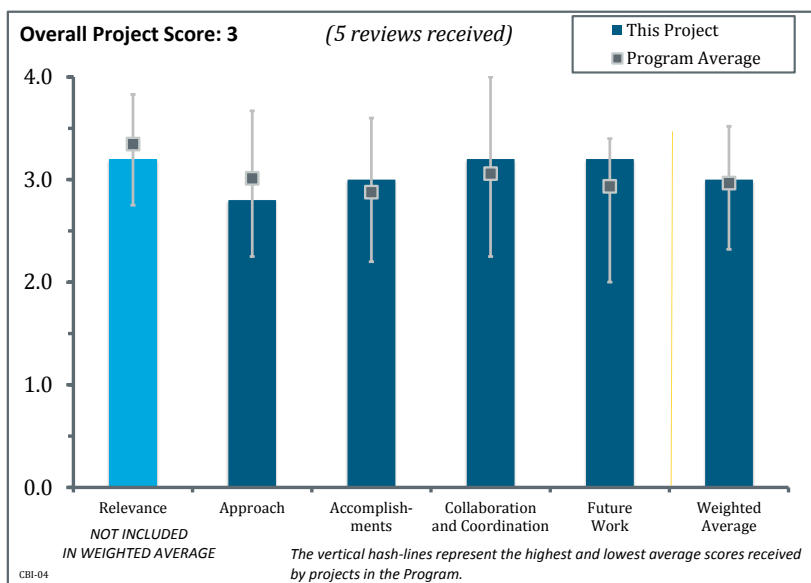
## Project # CBI-04: Tech Portal

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Jason Koman, U.S. Department of Energy, [jason.koman@ee.doe.gov](mailto:jason.koman@ee.doe.gov)

### Brief Summary of Project

The project's goal is to ensure that necessary energy performance data are easily accessible for a broad array of technologies to reduce investment risk and drive uptake of cost-effective efficiency measures. The objectives of this project include defining characteristics necessary to credibly predict energy performance and creating the infrastructure necessary for stakeholders to find, share, and leverage submitted data.



### A. Relevance

This project was rated **3.2** for its relevance to Building Technologies Office (BTO) goals and objectives.

- A comprehensive source of performance data on energy-efficiency technologies would be of major benefit to service providers, engineers, building owners/operators, and possibly even investors/financers of energy-efficiency projects.
- Projects that provide the end user with information that supports informed purchases create an avenue for deployment of new technology. They also create transparency to the consumer and standards for the manufacturing industry to use as production guidelines.
- The project supports BTO goals of reducing building energy usage and improving manufacturing processes in the United States. The reduction of building energy use is indirect; it makes information available but assumes the major barrier to technology adoption is the lack of available data. Other factors come into play as well. There is no limitation on use of the site by U.S. manufacturers.
- There is a distinction between (1) a regime of standards and institutions for evaluating performance and (2) tools for gathering and analyzing the outputs of that regime. Obviously, this project is focused on the latter. However, while a useful marketplace can be built, the quality of information available for exchange is the most critical factor for evaluating new technologies and products. In many cases, that regime of standards and quality assurance is insufficient to meet the needs of building simulation and technology evaluation by buyers in the marketplace. Therefore, BTO should complement this work with such activities as in-depth review and development of standards for measuring efficiency and other characteristics, assurance of the quality and integrity of measurements, and so on. There is value in this project to removing those important barriers identified in (1); namely, the Exchange's role in bringing together stakeholders in the marketplace. The Exchange can and should provide the means towards a better regime for evaluating the performance of new and emerging technologies. This reviewer encourages the team to appreciate the value of data from the deployment of technologies in operational environments. For example, it should look for opportunities to gather feedback in the same way as Yelp.com.
- Having good data about energy performance is important. It was not clear, though, how this effort fits with other BTO data collection activities.

## B. Approach

This project was rated **2.8** for its approach.

- This project provides a convenient means to compare and evaluate energy-efficiency technologies. The approach of using existing resources to populate the database is efficient and encourages participation from technology suppliers.
- The present collaboration and sharing of data is effective; however, sharing among a much broader spectrum of organizations and industry leaders would support the adoption of standards within the industry. Inclusion of additional manufacturers would provide greater acceptance of findings among industry leaders.
- How this initiative fits in with other U.S. Department of Energy (DOE) building energy data efforts, such as the Building Performance Database or Standard Energy Efficiency Data (SEED), was not made clear through this or other presentations. There seems to be real confusion about how the different efforts support or complement one another. Without a clear, well-articulated idea for how these projects fit together, it may be better to work on “data-standards-making” activities by attempting to define data fields to allow better comparison of technology performance.
- The site collects data from other sites, as well as allows data to be directly submitted. There are concerns about the quality and accuracy of the data, some of which is balanced by indicating where the data comes from. The “indirect” collection of information may cloud this chain of ownership somewhat. The assumption that others will independently create “apps” may be overstated—there is no clear incentive for someone to do this. There was also a mention of expecting the utilities to validate the data within the system—this may not be reasonable unless there is a specific commitment from a partner utility (none was stated). The concept of being able to compare multiple technology solutions to one another is good, and the website appears to be well thought out.
- Better identification of users would be helpful, along with “use cases” for each user, and convening of key user groups to develop features and collaborate toward a quality regime.

## C. Accomplishments/Progress

This project was rated **3.0** for its accomplishments and progress.

- The project has made significant progress and appears to be on target to meet all milestones and objectives. The incorporation of “power users” from the Better Buildings Alliance (BBA) will provide strong feedback and testing of the beta system. There needs to be enough outreach to manufacturers to encourage the submittal of product data, and that process needs to be relatively painless in order to succeed.
- The project has made good progress despite the National Renewable Energy Laboratory (NREL) not having a core competency in database design. This reviewer has slight concern that a private-sector partner may be able to produce a better product for less cost.
- It is not clear how “success” will be measured—the people most interested in providing data to this type of portal are the manufacturers and agents of efficient products, but they will only want to share information about successful projects. It is good to see that this has linked into some utility-program-funded projects, but more linkage to existing “case study”/data collection efforts is needed.
- This is a relatively new focus; progress has been made, but the rating and/or ranking of equipment will support greater industry deployment as more information is released.
- Data provenance is key to data accuracy: following E-Star procedures for data accuracy, coordinate with many agencies that provide this type of data now, and work with major purchasers (Walmart, etc.).

## D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.2** for its collaboration and coordination with relevant stakeholders.

- The partnership with the BBA provided both additional funding and database information, which appears to have helped the project to succeed. Having BBA’s support for implementation will speed up the adoption rate. There is a self-supporting cycle—if the BBA partners become strong users, manufacturers will be

encouraged to add their products, which will then increase the usefulness of the site. It will be important to get this cycle started, and it appears the team is building the relationships to do that.

- All of the critical participants seem to be included. However, the current scope of eight technologies will need to be expanded significantly for this portal to be useful to a broad range of users.
- Collaboration seems to be substantial among the present members, but expanding the membership will better support the deployment of data goals established for this program.
- The project team needs to pay more attention to establishing incentives to contribute. It is not clear what transaction costs are associated with using this tool for each type of user. If the costs exceed the perceived value, there is little reason for users to share.
- This initiative needs to be carefully coordinated with other evaluation efforts from utilities and other program funders. As presented, it seems to want to be the primary source of information on efficiency project/technology evaluation, and it is not clear that DOE is the best vehicle for that role.

## E. Proposed Future Work

This project was rated **3.2** for its proposed future work.

- Planned activities address the major needs identified in the earlier stages and seem appropriate for the successful launch of the program.
- The remaining goals based on the beta Tech Portal site launch are focused on usage metrics and improving the number of included products. The team appears to have plans in place and adequate funding to accomplish these goals. Previous publication and presentations of the site show a willingness and understanding of the need to publicize the site in order to gain acceptance by various stakeholders, and this will likely continue.
- It will be critical to see how widely populated the Tech Portal becomes in the coming year—if there is a lot of independent, useful information, then users will find it worth viewing and projects/technologies will be added. This seems to be working on an “if you build it they will come” premise; it is not clear that the platform is sufficiently compelling for users to flock to and populate.
- The integration of utility companies in this program will be instrumental to the next steps and future success of the program.
- The proposed future work needs improvement. There is great potential for working toward a similar regime as for automotive standards and miles per gallon (mpg) testing. The reviewer would like to see more focus on the strategy and planning needed to get to that tremendous potential. It seems like NREL is narrowly focused on building the tool, while success will be almost entirely determined by how well the Office of Energy Efficiency and Renewable Energy (EERE) creates value and meets the needs of key stakeholders.

## Project Strengths:

- The Technology Performance Exchange is a means for collecting information from a variety of sources into one centralized location. As a means of overcoming the risk concerns that center around reliable data for new technology, this provides a more comprehensive solution with more features than has been attempted elsewhere. The premise for the project is sound, and the team shows well-documented progress toward the end result. With the incorporation of user feedback, and support from manufacturers and utilities, the website will be very useful.
- The project team has strong project management and implementation skills. The project addresses one important barrier to national collaboration in the testing and verification of the performance of new products and technologies.
- The project features a straightforward, simple approach. It is easy to understand and use, and it disseminates energy-efficient technology information quickly and understandably. Data provenance is clearly displayed, minimizing opportunities to “game” the system.
- This program supports the market needs and will enhance future purchase decisions as data and greater partnerships in the industry evolve, but to create success, the end-user outcome must be kept at the forefront of the goals and objectives.
- This project features a very good concept—the market needs more information about the performance of efficiency technologies.

### Project Weaknesses:

- The biggest challenge is the issue of data integrity. Although the team talked about transparency and labeling of data sources, it is not clear if there is a process in place for verifying the data as it is submitted. It is not enough to depend on the honesty of an entity submitting information electronically, and unlike “crowd sourced” sites such as Yelp, there is not likely to be a large enough quantity of information on a product to balance out any false data (especially without reviews/recommendations). There was no discussion of a process for people to dispute what they may believe are inaccurate claims on the site. The next challenge will be adoption of the database by both users and manufacturers. This is likely to be achieved, but the team should not lose sight of this necessary step. It can be tempting to focus all efforts on developing the best website possible, and not put enough resources toward publicizing the use of the site.
- This project needs complementary investment in the collaboration on the regime for measuring and verifying performance—for example, mileage standards for light-duty vehicles. This reviewer wonders whether NREL would have a better chance of success if it partnered with a private-sector firm with extensive experience developing business software and databases.
- Performance data verification may be difficult to police. Also, the currently limited number of technologies will restrict the usefulness of the portal. Expansion of the technology base and keeping it up to date are essential.
- The process of sharing data with end users needs improvement; partnerships with utility companies are paramount to project success. More inclusion of industry manufacturer leaders is required.
- This project is just setting up a portal; it will have no value unless the portal is widely populated with validated information. It is not yet clear whether the market will populate the portal, so it may end up not delivering the desired impact.

### Recommendations:

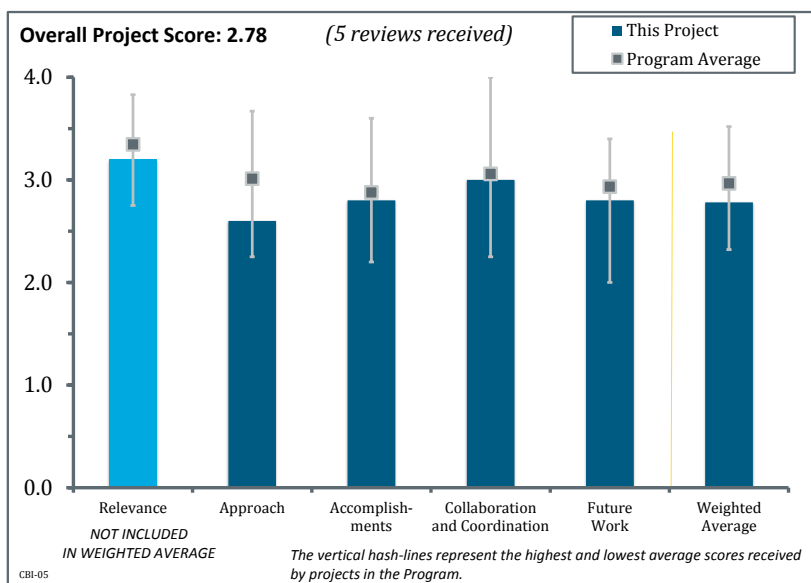
- It is essential to tie in product categories with related work at EERE, the U.S. Environmental Protection Agency, and other entities. It should be explicit and a rich source of information and support (see the GATEWAY program and other work done under the BTO solid state lighting program).
- The team should work with utilities and other groups that are involved with funding and tracking efficiency project progress (regional efficiency organizations, Consortium for Energy Efficiency, etc.) to access their measured/evaluated performance data in order to have a better chance of achieving a well-populated, robust dataset that will attract more users.
- Three reviewers did not enter a response.

## Project # CBI-05: Submeter Challenge

Jason Koman, U.S. Department of Energy, [jason.koman@ee.doe.gov](mailto:jason.koman@ee.doe.gov)

### Brief Summary of Project

The Submeter Challenge project seeks to encourage meter manufacturers to develop a low-cost meter to engender further metering of commercial building energy use. The project's objectives include successfully demonstrating and producing low-cost meters and engaging manufacturers and building owners to encourage technology adoption.



### A. Relevance

This project was rated **3.2** for its relevance to Building Technologies Office (BTO) goals and objectives.

- Improved metering is definitely an important area to investigate in order to better understand building energy consumption patterns and opportunities for improvement. Moving toward lower cost, yet reliable and accurate submetering is a good way to get better information to decision makers to cut energy waste.
- The lack of affordable and practical submeters, and therefore detailed data for energy use, is a significant problem when evaluating buildings for energy-efficiency opportunities. This project proposes a strong solution to the problem.
- Measurement of data is critical to engage and create end-user feedback. The information obtained will create educational opportunities for the entire industry and will support building owners' decision making in regards to future energy-efficient investments.
- The goal of the project addresses a key need to verify actual savings via real-time usage data, and in a way that enables potential savings in a sector that is hard to reach.

### B. Approach

This project was rated **2.6** for its approach.

- The need for the submeters has been well defined. In addition to the general community need (e.g., improved energy-efficient measure and retro-commissioning opportunities), this will support the needs within specific cities that have adopted ordinances related to energy efficiency. The team has worked with stakeholders to develop a specification that is aggressive but achievable, in a cost range that will keep the hardware component affordable. The team has chosen to keep the focus only on the hardware aspect. However, the software and installation costs can far exceed the hardware itself. Although this reviewer understands the need for a clearly defined project, a parallel or supporting project addressing the software aspect may improve the chances for adoption. Without a clear understanding of how to collect and analyze the data provided by the submeters, there may be hesitance to install meters, regardless of the costs. The project makes the statement that metering will enable actions that can deliver savings of 2%. Installation of a meter on its own will not reach this goal.
- The "challenge" approach seems like a valid method for getting industry engagement, and having some large purchasers such as the Federal Energy Management Program involved is important.

- The project effectively applies lessons learned and proven strategies from the Rooftop Unit (RTU) Challenge by engaging the Better Building Alliance (BBA) to develop an efficiency specification and pricing challenge for wireless submeters.
- While the reduced cost of the metering system is one key element to the success of this program, working with Building Automated Systems (BAS) and industry leaders to find the nominal installation costs of attaching to the power source and the ease of connecting to the BAS in buildings is paramount to end-user deployment.
- The stated goal is to achieve lower cost submetering at the panel level. It was not made clear how this plays out into lower building energy use. A submeter and base station is a small piece of an information system. It is unclear how this project integrates into a larger information system that provides information displays, reporting, tracking, and metrics. The claim seems to be that a low-cost submeter and base station on their own will lead to 2% savings. If this is the assertion, it needs more support. The main barrier identified was the current high cost of submetering. It was not made clear that this is a key barrier, or if there are other relevant and significant barriers left unaddressed. Also, there was no good discussion of how this is expected to work in the marketplace. A number of submetering systems are currently available, but these are not low cost for a number of understandable reasons. This and other market issues should at least be addressed in describing the project approach. Low costs are strongly related to high volume. The reviewer wonders if the \$100 cost is expected for low volumes, and whether there is thought as to how this submetering might progress from higher to lower cost as volume increases.

### C. Accomplishments/Progress

This project was rated **2.8** for its accomplishments and progress.

- The team has made good progress, including a soft launch on the BBA website; they are looking at feedback via a webinar before conducting a full launch to industry. The team has recognized manufacturers they have worked with before, they encourage and demonstrate new technologies, and work collaboratively. The team plans to engage with potential users of products that meet the specification (e.g., “pull mechanism”), including building owners, utilities, and nonprofits that would like to see greater deployment of metering devices. There are plenty of market actors with lots of square footage that would like to see wireless meters adopted in the market. The project includes a mix of federal and private sector participants; a challenge will be gaining much more after launch and demonstrations. The project is at or under budget—the total budget is \$179,000.
- The team has made strong progress toward the creation and issuance of a meter specification. The specification has been issued for review to manufacturers and federal agencies. More review is needed by private-sector stakeholders to ensure that it is satisfactory. The incentives for manufacturers to participate may not be clear enough at this point (it was not clear from the presentation). The potential market and avenues for recognition/promotion of the successful products will need to be strongly promoted. The project is on schedule to meet current milestones.
- This is a relatively new project, so there did not appear to be any significant accomplishments yet. It appears that the progress has recently picked up significantly, so hopefully there will be more results in the coming months.
- Due to the infancy of this program, more short-term goals will help in the overall success. The Web platform completion is key to success and prioritization for the short-term goals should be reexamined.
- It was hard to understand financial progress on this project. It appears that \$160,000 was spent in 2012 and \$340,000 so far in 2013, but the chart on page 7 only shows progress in the latter half of fiscal year (FY) 2013. It is unclear what this money was spent on, what the overall budget is, whether this is the expected progress, and what was accomplished in FY 2012. There may have been expected progress, but the presentation does not make this clear.



#### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.0** for its collaboration and coordination with relevant stakeholders.

- The collaboration aspect is key for this project's success. The input from manufacturers prior to release of the specification will help to ensure there are suppliers available. In addition, receiving letters of intent from potential purchasers will encourage the manufacturers to incur the cost of developing the prototype and adjust their manufacturing and supply processes as needed. The completion of the project will have a significant impact on the submetering market for this particular application.
- This project would not be possible without the ability to mobilize and engage the BBA. It also has a direct technology transfer element and market impact and will be an important source of information for other BTO programs.
- Involvement by the public and private sectors is required to create a successful conclusion to this program; a roundtable or survey will support end-user feedback and identify how the split incentive issue affects this deployment opportunity. Greater involvement with the utility companies will also provide an opportunity to collect data and potentially support an incentive program.
- Utilities already meter energy and many utilities have a large interest in end-use metering for energy efficiency. This reviewer wants to know how the project team will coordinate and collaborate with utilities and whether they expect owners to spontaneously buy and install meters to save 3% energy once low-cost meters are available. Slide 10 speaks in the future tense about collaborations with owners and utilities. It is not clear if any of this has happened yet, and what value that collaboration is expected to add. Some technology transfer may be planned or underway, but it was not clear from the presentation of specific accomplishments.
- There was discussion about conversations with industry partners and that an "aspirational specification" had been developed, but the progress to date did not demonstrate significant engagement with manufacturers or other market players. It seems too early to really rate the market impact and other criteria at this stage.

#### E. Proposed Future Work

This project was rated **2.8** for its proposed future work.

- The plans for the roll out of the submeter challenge are logical and well planned. The time frame is somewhat aggressive, but it should be achievable based on the work accomplished to date.
- The "challenge" process has worked for other emerging technologies; this seems like a very useful next step for this project.
- The future work focuses on data collection and analysis, which is good. The project team should also consider stronger outreach to utilities that are struggling with proving savings in their commercial building retrofit programs.
- It was not clear whether the low-cost meter is plausible, or if industry would deploy the meter even if the device was created. Savings from the consumer education side, tenants, or owner entities housed in their building seem to indicate this is a very viable opportunity, but the data presented does not seem to support this conclusion with just a report from a government-sponsored study.
- The proposed future work description is quite vague, so it is hard to comment.

#### Project Strengths:

- Overall, the project has a clear and straightforward objective. It has identified the stakeholders and is collaborating with them to improve the specification, which should encourage both bidders and purchasers of the end product. Simplifying features as a way of driving down price is a good approach because the existing technology has limited room for improvement and cost reduction.
- Better metering is critical for providing feedback to building operators to improve their building efficiency. This seems like a good way to get more reasonably priced metering equipment into the marketplace.
- This is a great way to leverage the market forces and model from the success of the RTU Challenge. The L Prize is another example.

- The “challenge” approach seems to be an effective way to overcome barriers to submetering. The high cost of submetering is a relevant barrier to address.
- The ability to measure data and create feedback for occupants and ownership will speed deployment of energy-efficient products, processes, and innovation.

#### Project Weaknesses:

- Factors outside the project goals appear to be the biggest challenges to its success. Unlike the RTU Challenge, where installation of the product would result in direct energy savings, the meters will not provide any value directly. Their indirect nature adds to the importance of the data collection/analysis tools and implementation of changes based on that data. Cost has been noted as a key barrier to submeter deployment, but it is unclear if enough organizations are considering submetering deployment (regardless of cost) to meet the potential savings outlined.
- There is a split incentive due to the fact that the tenant pays the cost. The team should build a “coalition of the willing” to demonstrate that savings are possible and can substantiate future utility incentives (i.e., make the economic case for utilities to put their research money into incentives). The reviewer wonders if the market for this is the same as the current meter market in terms of sales and channels. It remains to be seen what will happen and how the market will respond, although there is interest in making it open and accessible.
- Seeing the whole system interaction is a key component to the success of this program; the project team must engage occupants, owners, and utility companies in this discussion to move forward with a successful climax to the program.
- Wireless and other metering technology are evolving quite quickly right now, and a variety of energy users are interested in procurement. It is not clear that a DOE initiative aimed at identifying a couple of “winning” players will make a big difference in this rapidly evolving market.
- It is hard to determine from the presentation, but progress to date versus the time and money spent seems lacking.

#### Recommendations:

- This project represents a great opportunity to bring in utilities, especially those who are interested in quantifying behavioral savings. This is a tough market to reach, and one in which utilities have had few successes. This reviewer strongly encourages bringing them in sooner, rather than later. Their input in what they need to substantiate savings is critical to offering incentives.
- The bigger opportunity is submetering built directly into the equipment by original equipment manufacturers, particularly for any new equipment that is rapidly evolving with power electronics and digital control. Increasingly unitary equipment incorporates microprocessor control that would allow direct access to control commands and monitored points. One effort along these lines is the Consumer Electronics Association 2045 standard.
- If there is a good response to the challenge from industry, this should be continued; otherwise, it is likely that the private sector (through utility and other efficiency programs) can move more quickly and nimbly than government in this type of market development activity.
- A follow-on project to encourage use of the meters and the supporting tools will maximize the benefits received from developing a lower cost submeter.
- One reviewer did not enter a response.

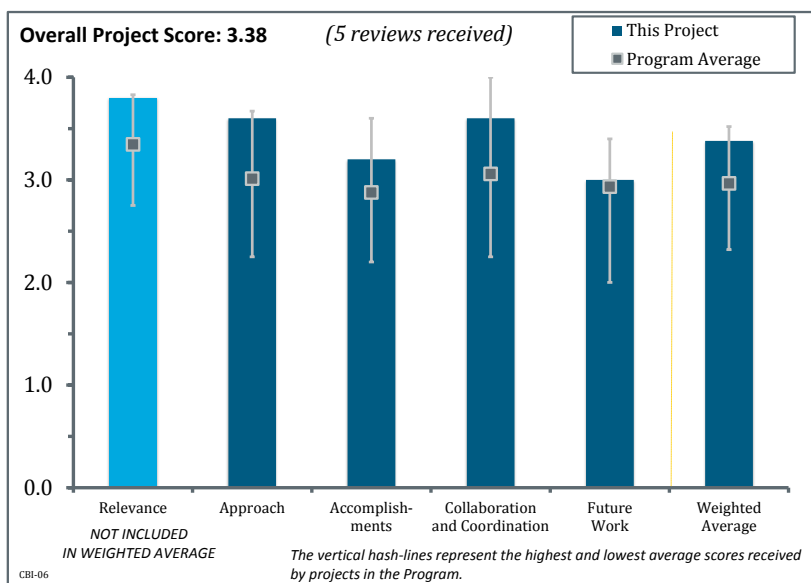


## Project # CBI-06: Better Buildings Alliance

Kristen Taddonio, U.S. Department of Energy, [Kristen.Taddonio@ee.doe.gov](mailto:Kristen.Taddonio@ee.doe.gov)

### Brief Summary of Project

This project brings together the private and public sectors to identify specific barriers and work with the U.S. Department of Energy (DOE) to develop and deploy innovative, cost-effective energy efficiency technologies. The project's objective include making buildings 20% more energy efficient by 2020, saving more than \$40 billion annually in energy costs, and creating jobs in the United States.



### A. Relevance

This project was rated **3.8** for its relevance to Building Technologies Office (BTO) goals and objectives.

- Engagement of the entire commercial real estate community is paramount to success in overall industry deployment and acceptance of energy-efficient products, processes, and educational opportunities.
- This project focuses on persistent barriers, along with key technologies that have the potential for energy savings. The project involves leadership development and segments the market into leaders, followers, and laggards.
- This is a very important activity to draw in important market leaders who can demonstrate what is possible in their own facilities. It will be very interesting to see how much progress some of the leading partners can achieve towards the stated BTO goal of 50% reduction in building energy use by 2030.
- Goals and targets can be addressed via the commercial building retrofit market. This is the largest market for savings potential in the commercial sector.
- The Better Buildings Alliance (BBA) is another key strategy for reaching BTO goals. However, BTO and Commercial Building Integration Program goals will be difficult to achieve regardless of the BBA project.

### B. Approach

This project was rated **3.6** for its approach.

- The approach is well thought out, bringing together industry leaders who are willing to commit to analysis and some level of implementation of efficiency improvements. However, much of the focus seems to be very “technology spec” driven, instead of a whole building, integrated approach. Other work has shown that without significant integration effort, efficient technologies will not result in nearly as much savings as a more holistic approach, especially through integrating the educational and behavioral impacts of occupants and operators.
- This project focuses on persistent barriers, along with key technologies that have the potential for energy savings. The project involves leadership development and segments the market into leaders, followers, and laggards.
- The Better Buildings Challenge (BBC) partnership focuses on leaders who are motivated to demonstrate a high level of data sharing. Replication of this project is possible via BBA participants who readily see

parallels with their facility (e.g., it “looks like me”). The crosscutting structure offers broad opportunity for involvement and segmentation across the commercial sector.

- The barriers identified—lack of demand and underinvestment—and their proposed solutions appear to be working to some degree. The level of effort and focus on some areas, such as highlighting results, are helpful, but the reviewer is not sure that the needle is moving substantially.
- The diversity of approach creates the issue of potentially watering down some of the initiatives because multiple initiatives take resources to maintain the forward momentum for each project. More weight should be placed on recruiting a larger segment of the owners and operators of buildings. However, the team seems to have sufficient funding and resources this year to move each initiative forward.

### C. Accomplishments/Progress

This project was rated 3.2 for its accomplishments and progress.

- The project has made excellent progress on technical specifications by leveraging DOE expertise and real-world industry needs. The project addresses market barriers collaboratively. Split incentive solutions are addressed via the green lease; BBA provides a resource that collects information on all green lease offerings. Public-sector solutions are also being incorporated; these solutions cover a major segment of the market and leverage the department’s role. The fact that membership is growing by referral is an indication of success and ownership by partners.
- BBA is reaching many industries with many solutions that are clearly beneficial. For example, the Lighting Energy Efficiency in Parking Campaign is close to reaching its goal.
- Many partners have been brought on board, including a very impressive listing of major market actors. Similarly, there have been a number of useful publications and case studies developed. There was less information presented, though, about measured energy savings and impacts from the initiative activity.
- Hosting multiple seminars, fostering industry participation, and achieving a significant industry presence with a limited budget in 2012 seems to indicate that the project is on schedule.
- This project is meeting organizational benchmarks and putting all of the right pieces in place. It is harder to determine movement toward performance goals (e.g., 20% by 2020).

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated 3.6 for its collaboration and coordination with relevant stakeholders.

- This project features extraordinary collaborations and high-quality staff and information. It is targeting key technologies with substantial room for energy savings.
- The presence of industry organizations, owners and operators of buildings, and vendors that serve the industry in collaborative campaigns, seminars, and face-to-face meetings indicate active participation of members. Having the Green Lease Library as a reference for members, along with the case studies, shows progress in providing resources to program members.
- As presented, many key market actors have been assembled for this initiative, representing a broad cross section of the commercial buildings marketplace. This seems to be a very useful platform for information sharing and data collection among these important players. The energy savings market impact should follow, though there was no evaluated savings information presented.
- The BBA reach appears to be well integrated with many industries and solution sets, but the depth is still shallow when compared with the program’s aggressive goals.
- Collaborative development of specifications builds off of the ENERGY STAR specification development model and the Building Upgrade Manual. Lots of activities are bundled under the BBA. The project leverages the prioritization tool on an annual basis to scope new opportunities (emerging, innovative, or underutilized technologies), but might need better transparency and visibility to demonstrate a high level of interaction and engagement.

## E. Proposed Future Work

This project was rated **3.0** for its proposed future work.

- Although barriers are well identified, plans to overcome them are speculative—perhaps necessarily so. This reviewer is uncertain about the value of public-sector project teams. Multifamily housing is a good market. The project should recognize the importance of benchmarking.
- Inclusion of utility companies and expansion of the member base to increase deployment of this program’s initiatives is the right direction. Figuring out what creates the “laggards,” or the bottom percentile of the adopters, and finding opportunities to move this group forward initiative by initiative should be a major focus.
- While the goal of attracting additional program partners representing more floor area is laudable, there needs to be some evaluation of the level of real efficiency investment (and resulting energy savings) by the program partners.
- The goal of having at least 300 members in fiscal year 2013 may not be possible.
- Utilities will be integrated into the program. Small buildings scoping will feed into BBA and/or the BBC.

### Project Strengths:

- This project features lots of great tools and solutions that can assist users in reducing their energy use and cost. It also has an excellent cross section of participants—many large organizations with a large footprint of properties. The structure is solid with a focus on various industry sectors, technologies, and market solutions; the reach is wide and diverse. The Green Lease Library is also an area that can have a large application.
- This project’s strengths include active industry participation, integration of vendors with projects, and educational releases such as case studies, seminars, and face-to-face meetings.
- Bringing in major market actors who represent large swaths of the commercial buildings market is a great strategy.
- The budget is substantial.
- BBA is engaging the right players on the right issues around the right solutions.

### Project Weaknesses:

- The project features lots of good tools and solutions, but it can be difficult for end users to fully understand and utilize them. Training sessions and webinars may help to guide industry users to be more aware of and utilize these programs more effectively. The barriers are real, but the savings, if presented and marketed more effectively, can easily outweigh the lack of demand and investment such that companies can move forward more quickly and effectively. A downside is that there appear to be so many similar programs and projects that it is “paralysis by analysis.” If all of these projects can be rolled-up into a single more cohesive program, target markets in many industries will jump in and bring others in with them.
- It is unclear how utilities would be involved. The project team needs to consider their role and define their point of influence in the market before they can count measurable savings. In other words, if the market will do it on its own, the need for incentives is not apparent. Utilities cannot claim savings and cost-effectiveness for projects they did not influence. Utilities can currently be an ally to the BBC, but it is not clear what active role they can take. The biggest challenge seems to be internal resources; the project team is trying to develop them in a way that is responsive to member needs, but the value proposition cannot get lost in the process.
- There are multiple initiatives, so the project team needs to make sure resources and funding fit activities. There is a lack of utility company involvement. To recruit new members the program needs focus.
- The project team needs to understand and push out into the market more. There needs to be more focus on telling the story, packaging the opportunities, and moving beyond proof to sales.
- Just having commitments of “interest and participation” by large numbers of market actors does not necessarily motivate investment in better efficiency or building performance improvement.

### Recommendations:

- It may be helpful to create an overall program that is segmented by industry—government (federal, state, local), education (K–12, higher education), and private sector (office, industrial, retail, etc.)—with case studies and contacts that allow customers to connect and see progress. The project team still needs the ability to roll up all of the projects in a more cohesive manner so they do not seem so disjointed or, conversely, too similar.
- Growing this initiative makes a lot of sense. However, with the desire to bring in more partners in the coming years, it will be important to balance a stronger commitment for activity and reporting of energy use and savings levels to monitor progress toward BTO goals.
- Understanding the role of utilities and how they can impact market adoption, as well as their needs for documented savings and attribution, is key to the challenge models, in particular.
- The project team needs to understand and push out into the market more. There needs to be more focus on telling the story, packaging the opportunities, and moving beyond proof to sales. The utility connection is very compelling.
- One reviewer did not enter a response.

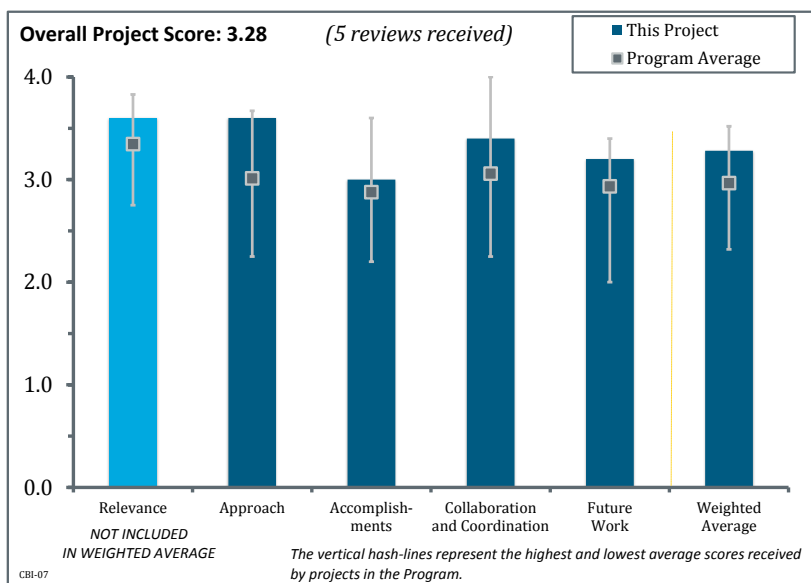
## Project # CBI-07: Lighting Energy Efficiency in Parking Campaign

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### Brief Summary of Project

The partners involved in the Lighting Energy Efficiency in Parking (LEEP) Campaign, along with private and public entities, advocate for and install energy-efficient lighting in public parking lots to foster significant reductions in participants' energy consumption. The project's goal is to install energy-efficient lighting for 100 million square feet of parking space.



### A. Relevance

This project was rated **3.6** for its relevance to Building Technologies Office (BTO) goals and objectives.

- The project has extraordinary potential, with an emphasis on overcoming market confusion. It is a wonderful project because of this clear potential, use of emerging technological solutions, and involvement of industry leaders.
- Light-emitting diode (LED) technology, especially in parking lot lighting applications, can have a tremendous impact on reaching BTO goals.
- Parking lot and parking structure lighting offers a tremendous opportunity for market conversion due to the poor performance of incumbent lighting technologies. Lighting uniformity and controllability offer significant energy savings potential.
- This project reaches the larger commercial building sector through current relationships, such as the Building Owners and Managers Association (BOMA). The energy goal using LEDs exceeds the American Society of Heating, Refrigerating and Air Conditioning Engineers 2010 standard by over 30%. Eight percent of energy use is in parking lots and structures. The project features accessibility to real market data through partnerships.
- This fast payback lighting initiative offers quick wins that fit the “no-brainer” ownership needs in the marketplace.

### B. Approach

This project was rated **3.6** for its approach.

- The LEEP Campaign is an impressive collaboration that features a well-defined scope and metrics.
- This is a collaborative project with BOMA, the Federal Energy Management Program (FEMP), the International Facility Management Association (IFMA), and the Green Parking Council (GPC) that helps demonstrate that improved lighting can be done successfully. The project uses performance specifications for LED parking areas; the market is still very new, so it needs a lot of resources to help identify appropriate sites across the portfolio and possible utility incentives. The project incorporates and repurposes other resources, such as FEMP-designated design vignettes, and is not limited only to LED

technology. The project stresses the importance of establishing a baseline year of 2010 for tracking sites and savings.

- The tools are good. Reporting appears to be lagging, but technical assistance options are key.
- There are two barriers to adoption of higher efficiency lighting systems for parking areas. The first is cost and the second is access to credible information regarding new lighting technology. Because this project involves lighting systems that propose extremely long lives and energy savings that are based on computer modeling, the skepticism over these technologies has to be addressed by rigorous testing and documentation of products in the market. If the DOE takes steps to assist in separating the high-quality product from the low-quality product, that will accelerate adoption. Control systems deserve focus because they can dramatically reduce energy consumption and improve the return on investment of projects.
- Use of feedback from industry members and the LEEP Campaign, driven by industry organizations, works extremely well.

### C. Accomplishments/Progress

This project was rated **3.0** for its accomplishments and progress.

- This project has only been in existence for a short time (it was launched in the fall of 2012) and now has 66 registered participant organizations in 25 states. It has 73 million square feet reported from 17 participants, on its way to its goal of 100 million square feet. Walmart has 260 sites with more than 70 million square feet installed—the driver is reduced maintenance. Walmart requires training for site designers, which represents a good model for replication. This project represents a good forum and conduit to site and usage data.
- Achieving 73 million square feet is impressive even with only 17 participants reporting; much could be done with more participants.
- There is much potential still to be realized. It seems like there is high performance by a small group of 17 participants. This reviewer supports the idea of extending the campaign timeline.
- The implementation stage worked well, with the exception of site selection criteria. This needs review and the data is still difficult to obtain to create market case studies and marketing material for mass deployment.
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.4** for its collaboration and coordination with relevant stakeholders.

- This project features a strong collaborative component and impressive stories from MGM and Walmart.
- The project appears to be focused and widely accepted.
- This project leverages the U.S. Department of Energy's Solid State Lighting program to support BBA members. This is a very visible and inclusive project that is leveraging and encouraging participation by BBA partners.
- Major retail members were the initial drivers; the program should now be expanded to multiple building types. The information deployed from the lighting team supported C-level acceptance of several major companies. The educational seminars seem effective.
- Additional work needs to be done to look at these technologies from a total system perspective, meaning luminaires and control systems.

### E. Proposed Future Work

This project was rated **3.2** for its proposed future work.

- Thoughts for future applications include extending the program if momentum kicks in and providing an opportunity for awards and recognition. The team should explore ways to leverage utility incentives, but it needs to bring them in early enough to be able to influence the projects. Otherwise, the team will not be able to put incentives on projects that have already been completed.

- Bringing in utility supporters is key. It sounds like a good foundation has been built—it needs to blossom. This reviewer will be interested to see what is replicable and what is unique to this project.
- The project should focus on utility program evaluation, measurement, and verification processes to assist in documenting delivered energy savings as a result of the conversion.
- Coordinating more with financiers and utility companies is important.
- Site selection criteria and data collection for study and case study creation are critical to success.

#### Project Strengths:

- This program can have a huge impact because parking structures are fairly straightforward—once the program is seen as successful, it should “sweep the nation.” Strategies have been successful, with more than 73 million square feet impacted already and “marketing/partnering” with key supporters such as IFMA, BOMA, GPC, and large retailers and property management firms. The payback and economics are good, and the technical support offered is a major plus for the project.
- Strengths of this project include the following: it is a “no-brainer” project for quick deployment; it was adopted by the industry leader; and the new technology shows performance improvement versus the old technology.
- This project’s performance toward its goal is high. It features strong collaboration—it has a lot of partners. Another strength is its focus on the market challenges.
- Recognition awards put a premium on the need to capture and report data on usage/savings—if participants do not give enough data, they cannot be eligible for an award. Coordination with the DesignLights™ Consortium’s (DLC’s) qualifications for the same specifications is a great way to bring utilities in early enough. The success with Walmart through the BBA relationship clearly resulted in the company’s early “uptake” on this project.
- The incumbent high-intensity discharge lighting technologies are performing so poorly and this market segment is so large that the potential benefit is very significant once mass adoption begins.

#### Project Weaknesses:

- The focus on working with utilities to offer incentives will be important. Quick implementation should be a “no-brainer” for owners/operators because of the good payback and economics. Technology and unknowns are still out there for many, so case studies and a list of contacts would be helpful. As an owner/operator, this reviewer wants to read about what others in similar facilities did for retrofitting in a particular region or industry, and the reviewer wants to call and talk to someone in a similar position (i.e., another owner/operator), not a salesperson or government resource.
- Utility involvement could really make a difference in the potential for this challenge. The trick is (1) bringing them in early enough before installation to ensure that they can get credit for any savings they incentivize; otherwise, regulators will determine that the companies would have “done it anyway” and (2) making sure they have access to the savings data and site information.
- The primary weakness is the volatility of the emerging lighting technologies. The number of lighting manufacturers in the market and the varying levels of quality need to be managed. Staying up to date on the technology changes will determine the long-term viability of the program.
- One weakness is the lack of data returned for verification. The site selection criteria and selection process need examination.
- The number of participants contributing to performance seems limited. Another weakness is the project’s inability to overcome the market challenges fully.

#### Recommendations:

- It strikes this reviewer that there is a lot of untapped potential—continued work is encouraged.
- Four reviewers did not enter responses.



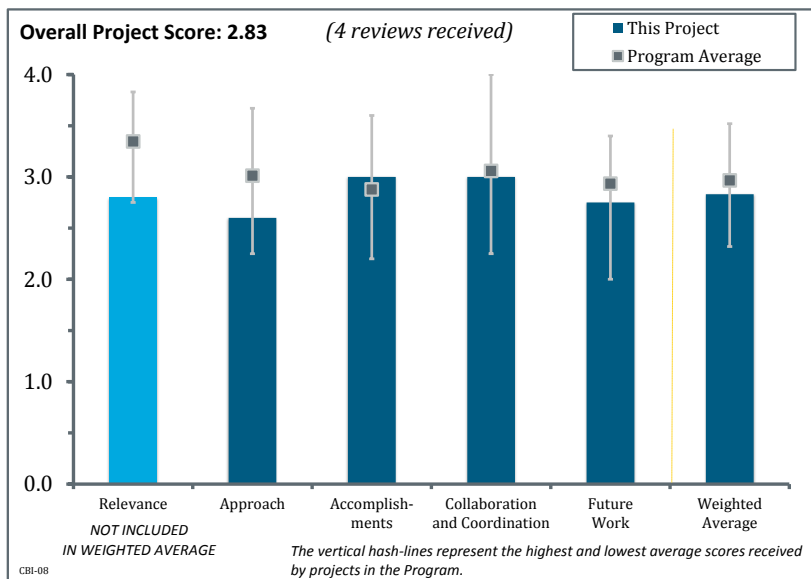
## Project # CBI-08: Commercial Buildings Consortium

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### Brief Summary of Project

The Commercial Buildings Consortium is working with the U.S. Department of Energy (DOE) to achieve near-term results while charting a path to long-term goals for net-zero commercial buildings. The project's objectives include compiling and assessing information on the performance and costs of current and next-generation technologies, identifying market barriers and potential, coordinating activities, promoting information exchange among stakeholders, and disseminating information to inform and guide purchasing decisions.



### A. Relevance

This project was rated **2.8** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This project is driven by Energy Independence and Security Act (EISA) 2007 net-zero energy goals for commercial buildings. It aligns with the need to develop pathways to net-zero energy buildings via deep energy retrofits.
- This is a reasonable, sound approach toward the challenges of developing marketplace awareness, interest, and eventual motivation toward net-zero building design.
- This project features good potential for savings, but it is unclear how savings will be achieved and attributed.
- This project provides a more advanced look at reaching BTO goals via a net-zero approach.
- This initiative seems to cross over into other programs and does not have a clear purpose with measurable results.

### B. Approach

This project was rated **2.6** for its approach.

- A national framework for collaboration, innovation, and demonstration/deployment makes strong sense to overcome imbalances in regional perceptions, attitudes, knowledge, and motivations.
- The approach involves capturing market feedback.
- The approach involves sector-specific engagement of members to address market and technical issues and policy solutions. This reviewer has seen the model replicated in the standard data format (taxonomy) of the Better Buildings Alliance (BBA) Building Performance Database. The project seems to be dragging on with no clear need at this stage. It was scheduled to be completed in fiscal year (FY) 2012.



- It is unclear how BBA specifications will address cost and other barriers. The reviewer wonders if these will be for integrated building design, building construction, or developing a skilled work force. Using a test bed is a good approach, but it is not clear how this will be accomplished. There is good steering committee membership.
- This reviewer did not see the necessary approach to the marketplace or determine what initiatives are effective for the members.

### C. Accomplishments/Progress

This project was rated **3.0** for its accomplishments and progress.

- There have been a good amount of accomplishments since the project's inception in 2009. The project team has effectively utilized and leveraged the relationships between the states and commercial building owners/businesses. State and local technology demonstrations expanded the reach of the Commercial Buildings Consortium (CBC); the publication of net-zero energy costs and features and disseminated findings have been well received. The process seeking input from Building Energy Performance Taxonomy stakeholders is delayed.
- The project has demonstrated clear progress on tasks and accomplishment of milestones.
- The project's accomplishments are impressive and targeted.
- It is unclear to this reviewer how BBA projects will be marketed or accomplished within the project timeline.
- There are no tangible results apparent to the industry through the stated purpose of market feedback or providing a bridge between government and utilities.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.0** for its collaboration and coordination with relevant stakeholders.

- The collaborative process identified in this program design is vital toward eventual consideration and acceptance by large portfolio managers and building operators.
- Outreach has been successful, with representation from more than 700 members in 400 organizations.
- The team collaborated with New Buildings Institute to prepare publications and leverages the National Association of State Energy Officials member base to engage the public building sector. The distinction or collaboration with BBA was not clear.
- This project features good steering committee membership. However, it is unclear to this reviewer how utilities are involved.
- There is a broad swath of members, but this reviewer cannot see the thread of interest to focus successful outcomes.

### E. Proposed Future Work

This project was rated **2.8** for its proposed future work.

- The project provides a clear demonstration of how tasks align to future work.
- The goal of adding at least 40 state representatives is positive.
- The main issue that would differentiate this initiative would be working with the mandatory vs. voluntary, vs. regulated industries, such as government/industry/utility companies.
- There is a lot to accomplish in FY 2013; the project's technology transfer plans are unclear.
- It seems like the project does not really have a future because funding ceases at the end of FY 2013, so this reviewer is not going to rate this.

### Project Strengths:

- One strength of this project is its ability to focus on outcomes and results, including publications. Other strengths include how it keeps EISA's long-term goals in mind, and how it understands financial barriers and works closely with those who can afford to make the leap or are required to meet future goals. Publications have had success—this reviewer recently presented at a Society of American Military Engineers conference and net zero was a big topic for military bases as a major challenge for the future.
- This project was clearly initiated in response to a legislative mandate, and it was appropriate for the time. It represents a good start to building a coalition of commercial building end users to leverage specific demonstrations and data gathering. The collection of good data on net-zero energy is critical to understanding the market.
- One strength of this project is its opportunity to cover a broad base of members and focus the members on large goals.
- The detailed list of partners, subcontractors, and collaborators (slide 12) clearly indicates the depth of engagement so far that will help move the program toward the desired goals.
- This project features good steering committee membership.

### Project Weaknesses:

- This reviewer believes the project has no significant weaknesses.
- The project is relevant for the future, and aside from the net-zero focus, other tools appear to overlap and could be consolidated with other programs. There is a need to create an overall structure showing how the various projects interact and relate to each other—and how they can be combined and/or structured to work with each other more effectively.
- The lack of tracking does not allow for attribution to the CBC, and messaging of some of the analysis reports has been an issue with DOE. This project was appropriate for its time and probably set the stage for the BBA, but it seems to be somewhat duplicative in terms of goals and does not have any clear direction at this point.
- There do not seem to be any large goals that the member base can rally around. Not making the partnership opportunity of mandatory vs. voluntary is another weakness. The main focus of having the members debate the opportunities and how we can determine goals that will help members agree require mandatory rules and initiatives that can be accomplished voluntarily.
- It is unclear how utilities are involved.

### Recommendations:

- This reviewer's recommendation is to sunset the project and not look for ways to continue it.
- This project needs better collaboration with utilities, including program resources.
- Three reviewers did not enter a response.

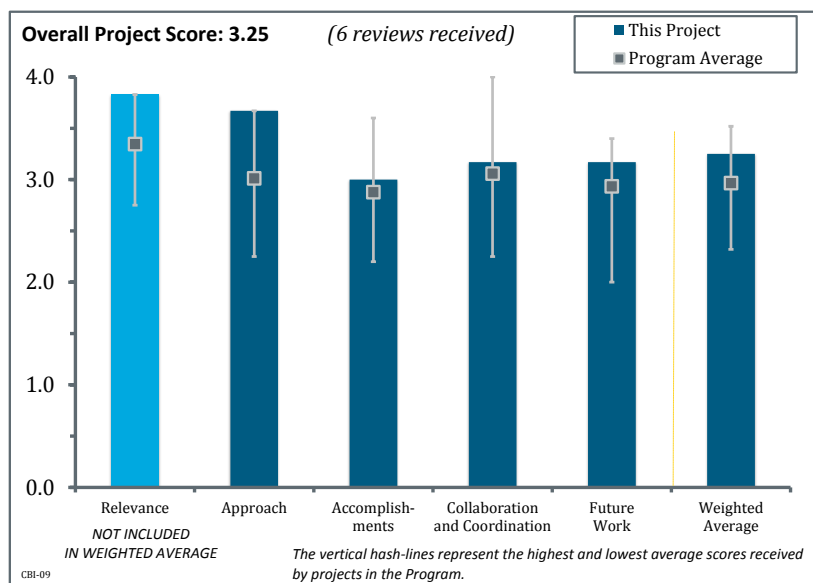
## Project # CBI-09: Building Performance Database

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### Brief Summary of Project

The goal of this project is to provide public access to high-quality building characteristics and energy consumption data to incentivize, analyze, and validate energy efficiency investments. The project's objectives are to construct a database and analytical tools, demonstrate the tools to stakeholders, and complete the data cleansing and data specifications.



### A. Relevance

This project was rated **3.8** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This is one of the more important projects in the portfolio because it addresses one of the more frustrating efforts at the interface of archeology and anthropology to ferret out the information needed from building owners.
- Decisions start with having access to data. Although the goal is to have the best information possible, it is important to act now and continue to improve on the process. The project has wide use and standards are sorely needed. Focusing on the greatest opportunities first, forecasting project performance, and then reducing investor risk will pay dividends. This project is critical to BTO and its objectives.
- This project fits in very well with BTO's objectives and has the potential to be the basis to drive much of the funding and focus for years to come. It will also be an outstanding tool to show the success (or where things may have fallen short) of BTO and U.S. Department of Energy (DOE).
- It is important to have better information about building energy performance in the public domain, though it is not clear that just setting the data exchange specification for sharing information will be successful toward motivating efficiency investments.
- Developing a decision-making matrix based on empirical data will support the deployment of technology that meets certain filters for the financial industry.
- This project seems to directly address the "transparency" objective, and it should facilitate awareness of energy-efficiency benefits among the commercial building owner/operator community. It can be a powerful tool for energy-efficiency project planners, financiers, and building owners if the database can be made comprehensive enough and accurate enough to ensure adequate sample sizes for the likely "cell sizes" needed for specific inquiries. If it stays too general, either through small cell sizes or through excessive "data cleansing," its utility will be greatly diminished.
- One reviewer did not enter a response.

## B. Approach

This project was rated **3.7** for its approach.

- The project team understands barriers and appears to have reviewed and addressed alternatives such as pulling data from other sources. It is good that information is “anonymous.” The project could be more transparent about the criteria for “cleansing protocol and data validation” and how mapping rules are defined. It would be beneficial to see what application programming interface (API) tools and algorithms have been created and used to date (if any). The project team seems to understand legal/privacy/disclosure. Maintaining maximum flexibility is important.
- The “taxonomy” effort seems to have been useful toward getting to a better building energy performance “data exchange spec.” However, it is not clear how many sources for the desired data are willing to share that information publicly. A number of private-sector actors are already compiling the data, potentially more successfully than what DOE will be able to assemble.
- After 40 years of applied building science, we still largely run open loop, with almost no feedback from real buildings to the larger research and design communities. This work is totally inadequate, but it is the best start this reviewer has seen. It would be preferable to see a request for proposal for large-scale “big data” studies, with a pay-for-information quality that would attract some of the big actors in the “MUSH” (Municipalities, Universities, Schools and Hospitals) and commercial office sectors, but that does not seem like it is in the cards.
- The nationwide effort may be overly ambitious. The data cleansing and standardization effort is critical to avoid “over-homogenizing” the data. As a national benchmarking database for building energy performance, this tool could be extremely useful if it proves easy to use and truly comprehensive in scope.
- This concept is analogous to the old axiom of “herding cats.” In this case, using other “cat herders” to help bring together a lot of information that has already been collected to build a comprehensive database is the right approach.
- Work with utilities to provide databases would support completion of this project; the way data is collected by different utilities is the barrier.
- One reviewer did not enter a response.

## C. Accomplishments/Progress

This project was rated **3.0** for its accomplishments and progress.

- The project only started in January 2011, so progress is good with data collection on 70,000 buildings, even with limited system data. The project could stretch more to higher-space users/managers and share data exchange specifications. Commercial buildings should have multiple categories—education, office, retail, etc. The project makes good use of climate zones, and dynamic tools with charts and metrics help sell. The development of a retrofit tool (slightly behind schedule) is also valuable.
- With more than 73,000 buildings already incorporated, and by bringing in some major property databases, this project is already developing very quickly. Other potential contributors will see the names on this list of sources and want to be part of the effort.
- This project has made progress faster than rationally could be expected, given the complexity of the issues. Enron may have been the best possible foundation for “getting” the interface between building science and finance sectors.
- Establishing the data exchange specification is a significant accomplishment. It is less clear that there is substantial progress in populating the database, and with a number of competing efforts, this needs close monitoring. If large numbers of data “compilers” are not sharing their data through the exchange, and this is only a platform for existing public sources, the value of the effort is pretty limited.
- Progress toward a national buildings database appears to be good, especially given the complexities of developing a comprehensive, useful taxonomy for all of the factors that affect building energy performance. However, it appears that progress will be slow, and it will be difficult to expand the database to all relevant technologies. If this database does not prove itself useful in the short term, interest and support from the participants/partners may wane in the long term.

- Progress has been made; it seems like support is needed to move forward and complete the goals and objectives.
- One reviewer did not enter a response.

#### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.2** for its collaboration and coordination with relevant stakeholders.

- The sheer number of active and pending stakeholders indicates that collaboration is extensive. However, the presentation did not provide much detail regarding the makeup of the stakeholder population. There is concern that there might be some type of “selection bias” in the mix, although it is probably much too early in the database development to worry about that.
- BuildingEnergy partner is key if open protocol and not overly proprietary. Connecting buildings (inclusion, awareness, financing) is good, as is moving from the built environment to the designed environment. Communication is fair and could be more widely expanded to share innovations and learn from others.
- The Data Exchange Spec was an important collaborative activity that should allow for better “apples-to-apples” sharing of energy performance data and comparison of relative performance. It will be important to continue to closely track other related efforts because the market impact of the Building Performance Database (BPD) versus other data initiatives is not at all clear.
- This project could eventually be the basis for much of BTO and DOE’s research. In addition, the benchmarked information gleaned will have an impact on how many investors will direct their funding. The results could be huge, on par with recognized and established programs such as ENERGY STAR.
- The interaction with multiple agencies, both public and private, has been phenomenal, but the conversion of data is one of the barriers that needs support.
- This question is not fair. There needs to be another response option that does not reduce the score for situations in which it could be too early to judge outcomes. The project team is doing a fine job on collaboration (but has not yet been successful with the Building Owners and Managers Association [BOMA] and its experience database) and designing for tech transfer, but it is too soon to even speculate about the market impact of the results, as opposed to the need for the results.
- One reviewer did not enter a response.

#### E. Proposed Future Work

This project was rated **3.2** for its proposed future work.

- The proposed future work seems to be primarily a continuation of past efforts and is probably appropriate, considering the massive nature of this project. A concentration on making the database suitable for easy benchmarking is probably a good idea because that seems to be the aspect of the program that is easiest to implement.
- This project has a lot of potential to help benchmark and use a lot of information. The approach and future time line is in line with the mission. However, there may be some need to distinguish this project as either an enhancement of or a distinct program from another federally sponsored program, ENERGY STAR. There is quite a database in there (though with less systems information), and much of this is part and parcel to that information. There does need to be some clarification as to how these two match up, and the team should make it known that this project is not a duplication of effort.
- The budget has been significantly increased in fiscal year (FY) 2013 (\$264,000 to \$343,000 to \$1 million in FY 2013). Continuity is paramount. The project did not describe how the standard data specification will be promoted.
- The proposed data-sharing tools look interesting, though they have not yet been tested by intended practitioners. It will be very interesting to see the level of population of the tool in the coming year or so.
- Much more effort is needed in this area. A recommendation is to build an outside advisory committee with some institutional members from American Society of Heating, Refrigerating and Air Conditioning Engineers (Owning and Operating Costs), the International Facility Management Association, BOMA, and others as the project gets into more specialized buildings sectors.

- The conversion of data and a common taxonomy still require focus to define the acquired data. The retrofit analysis tool will help owners and managers determine retrofit criteria.
- One reviewer did not enter a response.

#### Project Strengths:

- This project is one of the most important in the overall BTO portfolio. Having useful and actionable data is needed to meet energy-savings goals. Putting the effort into a single and robust database that could be used by nearly all who manage energy for the built environment can have a tremendous impact for both the short and long terms, with a continuous improvement focus. Focusing on a standardized effort while remaining flexible is difficult but necessary—and the efforts to encourage API development are encouraging.
- The potential from this project is great and could be a driving tool for future investments, as well as a database to help decision makers determine state-of-the-art technologies in buildings. The presenter was well prepared and delivered one of the best overviews of the gathering. If it is managed as well as it was presented, this project should be a good use of resources.
- It appears that the project staff is trying hard to build an information technology foundation that will be extensive in terms of information content and flexible in terms of access and filtering. This effort is extremely commendable.
- Efforts to develop common taxonomy/data exchange specifications are a valuable addition to the energy performance market.
- A sophisticated approach to taxonomy and data cleansing is critically important to the success of this program, and it appears that that is what is being done. Using existing databases is a sensible approach.
- Multiple databases have been acquired and integrated to the BPD.
- One reviewer did not enter a response.

#### Project Weaknesses:

- There are no major weaknesses, but the scope of this project is vast and should be tightly managed by those in charge to ensure the overall focus is not lost, and that it does not simply become a quest for numbers.
- The project could be more successful if it (and this limited peer review form) thought more about ways to use positive feedback and “nudge” concepts from behavioral science to encourage deeper efforts by participants. For example, Portfolio Manager uses some recognition methods for those who do well. Exact analog would not work, but it warrants deep thought and some experiments. Until there is greater granularity and/or public (but aliased) forensic studies of the good and bad cases, there will not be information to guide owners, developers, system designers, architects, and facility managers.
- The project could be more transparent on how information is normalized. This is such an important project that a more focused approach needs to be made to push this as the one standard for all energy data—and the project team needs to brand it as such. The team may be missing the opportunity to utilize this database as the centralized system to collect and utilize data from all other sources from all other projects.
- There are several competing “tools” that seem to be gaining more market traction, and unless the BPD is generously populated, the other tools will be more widely used and BPD will not add any value.
- The sheer scope of the project is a weakness because it will take a long time to populate the national database with enough clean data to enable reasonable sample sizes for all possible inquiries (cell sizes).
- Several delivery dates for usable data have been presented and not achieved; focus on data formatting is required.
- One reviewer did not enter a response.

#### Recommendations:

- This presentation was probably one of the best of the event. The presentation and the presenter were very informative and the information was well prepared. The researcher and the team seem to have this project coordinated well. The only recommendation is to be careful about how deep the data is drilled down; at some point, the utility of the information is overshadowed by the effort required to get it. Data miners have a desire to acquire information, and it needs to be focused so that the resources are aligned with the “big picture.” It is obviously valuable to get the large system information for these buildings, and an idea of the

percentage of space that they cover, much as a database such as ENERGY STAR does (and this could probably be improved upon). However, getting into the microcosms of what is in the building beyond those major systems could divert useful energy away from the prime directive of this effort. There was no evidence that this is currently an issue, but it does need to be remembered by those overseeing the project as it evolves. The distinction(s) between this program and ENERGY STAR also need to be made clear so that there is no perception of a duplication of effort.

- The project team should work closely with “owners” of key data sets to be certain that as much data as possible is shared with the BPD, so that the original intent as described in the “problem statement” in the slides can be realized.
- The team should better utilize private-sector marketing and operational teams to help target users to expand its use.
- One reviewer recommended the project to “get bigger and go deeper.”
- Three reviewers did not enter a response.



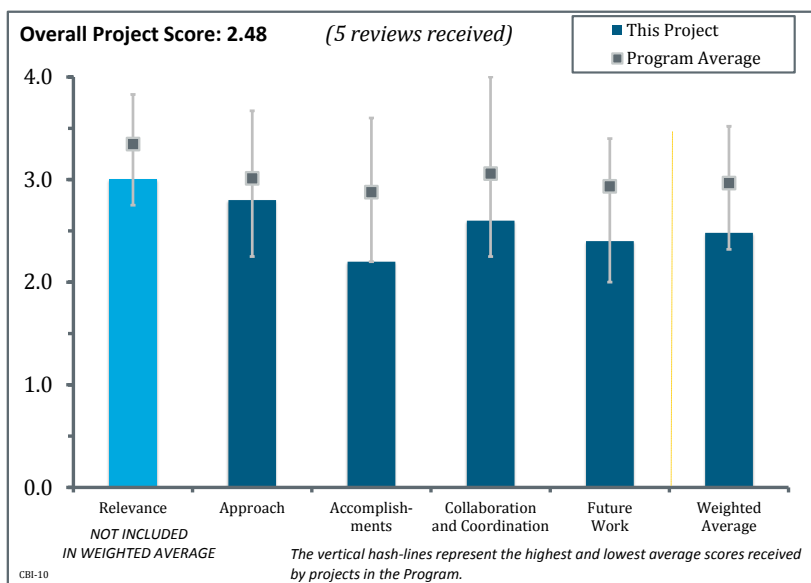
## Project # CBI-10: SEED (Standard Energy Efficiency Data)

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### Brief Summary of Project

Standard Energy Efficiency Data (SEED) endeavors to develop a standardized U.S. energy data infrastructure to improve consistency in building energy measurement. The project's objectives are to 1) identify constituents' needs in managing high volumes of data, 2) define a data aggregation/cleansing approach, 3) complete final structure of an application programming interface, and 4) transition to user community ownership.



### A. Relevance

This project was rated **3.0** for its relevance to Building Technologies Office (BTO) goals and objectives.

- Establishing a standard database and reporting platform that can be used by states and cities in their energy performance disclosure programs is an excellent way for the U.S. Department of Energy (DOE)/BTO to support building energy efficiency across the nation. It is a great example of the federal government enabling state and local implementation of existing building energy-efficiency regulations.
- Transparency of data/information is key for comparison of energy-efficiency opportunities. Organizations with multiple buildings can face hurdles when trying to aggregate data. This program attempts to address these issues.
- This area is important toward understanding building energy performance and improvement potential, but the relevance and need for government activity was not clear relative to the large amount of private-sector/nongovernmental organization (NGO) activity currently happening on this topic (e.g., Green Building Information Gateway and Honest Buildings).
- This program would seem to be a subset of the Buildings Performance Database program. As such, it is less critical to the achievement of BTO's overall objectives, but it could be a useful tool for some parties.
- One reviewer did not enter a response.

### B. Approach

This project was rated **2.8** for its approach.

- The focus for SEED seems clear enough, as does the idea that data exchange is currently difficult to do and is a significant barrier. However, it is unclear whether this project meets a real need of the intended users. If this project is top-down, driven by an idea that users need a DOE-provided standardized data structure, then that is less compelling than if this project is more bottom-up, driven by specific user needs. The goals and scope may be too broad and vague to begin with, and even more so now that the scope and budget have been increased so early in this project. Perhaps a better approach might be to start with some small subset of this project and try for some earlier small successes. In any event, working closely with the intended users is a strength.



- Yes, data aggregation can be a challenge; however, there may be existing systems/programs that already address a large portion of this issue, and thus it would be more efficient to build off of an existing platform. An additional concern is that the local governments had to give little commitment up front to implementing the platform once completed. Currently, most have still yet to make a commitment. Further analysis is necessary to determine if this product will be used once completed and that the local governments will take ownership. Ownership and open source is good, but the cost for cloud and application programming interface (API) design may be out of reach for many governments. This issue must be addressed. Due to the short period of time for the presentation, it was not clear if major hurdles were overcome or will be overcome. For example, it was mentioned that issues had arisen with the upload of data; however, it was not clear if those were resolved. Nonetheless, the idea of open source that allows for a dynamic environment with a controlled data access has many potential upsides.
- How the SEED effort fits with other DOE building energy data efforts (Building Performance Database, Technology Portal, etc.) was not made clear through this presentation or others, and there seemed to be real confusion about how these efforts support or complement one another. Unless there is a clear, well-articulated idea for how these projects fit together, it may be better to work on some “data standards-making” activities, attempting to define data fields for a limited number of building performance characteristics.
- Using a small, focused group of initial users may help ensure a realistic timetable and scope of capabilities while still allowing for considerable customizing and development of user-specific applications. There are some concerns over the lack of control over user-generated inputs.
- One reviewer did not enter a response.

### C. Accomplishments/Progress

This project was rated **2.2** for its accomplishments and progress.

- SEED is already being used by local governments to implement their energy use disclosure regulations.
- It appears that the major cause for the delays and cost overruns in the program involved problems with the initial software contractor, and that these problems are now being overcome. Given that, and the fact that the program is currently limited in scope to the six cities, the program seems to be back on track. However, it is still behind schedule and over budget.
- This project is behind schedule and the budget has more than doubled. It was reported that the scope has been expanded to meet user requirements. Expanding features and scope in a software project is a troubling sign. Confidence in the project’s success would be greater if the scope and focus had been tightened up, along with the project being broken up into smaller, achievable segments with Stage-Gate decision points added.
- It is not clear what has really been accomplished to date through the SEED effort—part of this uncertainty comes from confusion about how SEED fits in with other data efforts. Unless there is a clear articulation of how SEED fits in with other data development activities, there is real risk of different projects going in competing directions, not really adding value to what is already happening in the marketplace.
- Due to the additional budget request and lack of firm commitments from the local governments, it seems as though the project may be struggling. Yes, the local governments face a funding challenge in the implementation and API development; however, it is also not clear if the governments even see the platform as meeting a need. That is also a central issue that needs to be examined.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **2.6** for its collaboration and coordination with relevant stakeholders.

- This project has collaborated with and provided direct assistance to all local and state governments that have expressed an interest in using the SEED platform. By establishing an API for SEED, there has already been adoption of this technology into private vendor software applications.
- It is hard to tell from a short presentation, but the collaboration with users appears to be in the good-to-outstanding range.

- Given the limited number of initial users, it seems that collaboration could be improved. It seems like there were a number of surprises and unexpected developments in the earlier stages of the program that might have been avoided with better communication between the participants.
- Yes, the project is working closely with the local governments, but there does not seem to be strong buy-in from these organizations. The governments have yet to make commitments to implementing the platform once complete. In addition, closer collaboration with other programs such as DOE's Building Performance Database may have been beneficial.
- Very little was presented about the level of collaboration or market impact. Given the number of competing energy data sharing activities, SEED seems to be playing in a crowded field, without a clear demonstration of the value.

### E. Proposed Future Work

This project was rated **2.4** for its proposed future work.

- Because of the good collaboration with the industry, the plans for future work are focused on the key issues with the current tool and the market needs for this database platform.
- A large projected budget was presented, without a clear demonstration of the value. It will be important to closely monitor how widely the intended audiences are using the SEED platform to determine whether there is commensurate value relative to other BTO activities.
- The presentation mentioned that a business plan addressing user ownership will be developed; however, this plan was not described in detail, making it difficult to evaluate. However, it is clear that there are major challenges, such as whether the target market sees the value of the product.
- There was not much description of future decision points and consideration of alternate pathways. Definition in these areas seems important in light of expanding scope and budget.
- It was not clear from the presentation that all of the barriers will be overcome.

### Project Strengths:

- Free, open-source data structure and limited scope (six large cities) should encourage third-party development of specialized applications. Coordination of taxonomy and data with the Buildings Performance Database should standardize input data formats and help populate the platform, while making it more useful for various types of specialized applications.
- Many local governments face new reporting standards and aggregating this data can be a challenge. Even when data is consolidated, analyzing the data produces another set of challenges. Local governments definitely need assistance with energy management, and there is a growing internal awareness of this need and the opportunities that come with it. The idea overall is good.
- The project's close collaboration with municipalities is good. The project seems to have identified some significant barriers and relevant solutions.
- Moving toward comparable, standardized building energy performance information is important to understand realistic energy savings potential and progress toward savings goals.
- One reviewer did not enter a response.

### Project Weaknesses:

- It is not clear how this project fits in with (or really supports) several private-sector/NGO efforts to develop and provide building energy performance information. In the presentation, a slide was shown using the Honest Buildings NY State platform, but Honest Buildings has quickly evolved separately from SEED and is getting fairly significant market traction. It is also unclear whether the assumption that "jurisdictions will carry the bulk of implementation costs" is valid, given that most of the jurisdictions that are implementing the policies that SEED is targeting do not have budgets allocated for data services, and it is not clear that they will provide extra funds to participate in a national database.
- It is unclear if the local governments see the value in the platform. In addition, they have not been required to make any real commitments to implementing it once completed. Absence of their commitment raises many concerns. Most likely, the governments would need significant assistance in implementing the

platform, along with developing the APIs. It is unclear if DOE plans on closely guiding them through these steps. Finally, there may be other programs/systems that can be slightly changed, instead of building a new program from the ground up. This technique may be more efficient and cost effective.

- The open architecture and user-supplied data may make it difficult to ensure accuracy and consistency. “User ownership” may make it very difficult to maintain the database and platform over time.
- One weakness is the expanding scope and budget.
- One reviewer did not enter a response.

#### Recommendations:

- It is unclear if collaboration with the portfolio manager was investigated, and whether it is possible to enhance that program with SEED’s lessons learned and meet the needs of the local governments. Perhaps DOE and the U.S. Environmental Protection Agency should focus on getting more utilities to allow for automatic upload into that software. It is unclear whether the DOE Performance Database can be used on a programmatic or operational level, and whether SEED’s work can be integrated into that database’s work. Before proceeding with scope expansion, the team should work with customers to determine if their needs will likely be met with the expanded program, as well as the likelihood that the local governments can and will implement the platform. Consider requiring some level of commitment before additional investment. Finally, it is important to note that businesses may have a slightly different set of needs. Thus, those elements will need to be examined and addressed before SEED can be effectively expanded to other markets. Due to the complexity of the SEED program and potential overlap, more discussion is really required in order to give a deeper level of feedback.
- The project team should consider adding some explicit decision points in this project to avoid scope creep. It should also consider ways to narrow the scope in order to achieve complete and timely delivery of some subset of features, as well as continue to assess whether this more standardized approach is in fact best suited to address users needs, particularly in light of the many dynamic, rapidly evolving commercial information technology providers.
- The project team should closely monitor how much the pilot users are adhering to the SEED data platform and whether there is really any value from government support to tie these data sets together. If pilot users are “going their own way” without changing toward the SEED common data taxonomy, it is not clear how this project is a good use of limited government funds.
- Two reviewers did not enter a response.

## Project # CBI-11: Commercial Building Partnerships

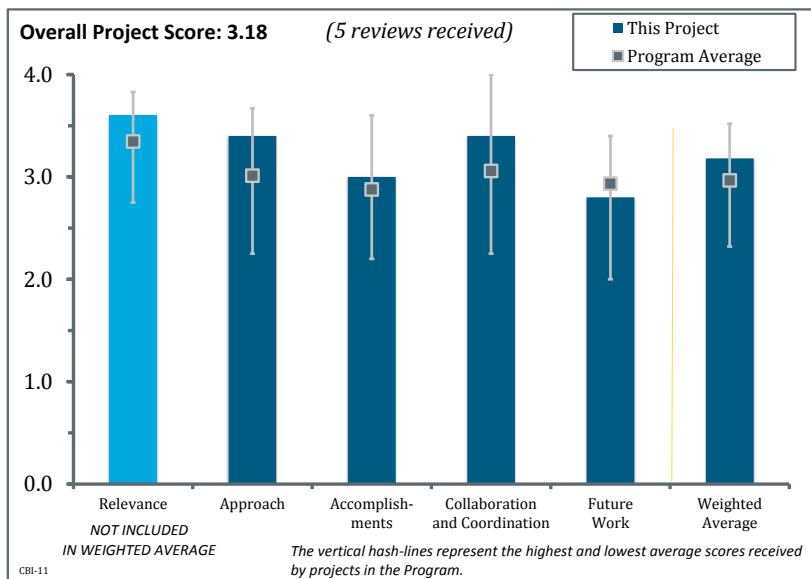
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### Brief Summary of Project

The Commercial Building Partnerships (CBP) initiative is a cost-shared effort through which organizations team with the Building Technologies Office (BTO) and others to improve energy efficiency in new and existing buildings. U.S. Department of Energy (DOE) national laboratories and private-sector technical experts provide energy analysis support and engineering expertise to explore energy-saving ideas and strategies. The 42 CBP partners represent many of the nation's largest and most influential commercial building owners and operators. Partners implement energy-efficiency strategies that meet their business

criteria in specific building projects, and the resulting energy performance is measured to ensure it meets expectations. Partners commit to replicating low-energy technologies and strategies from their successful CBP projects throughout their building portfolios, which represent nearly 4 billion square feet of commercial real estate. Further replication occurs as other organizations take advantage of lessons learned and as private-sector technical experts incorporate CBP innovations into other projects. Publicly available CBP case studies, developed as the projects advance, contain project data and a wide variety of resources to help building owners and managers save energy.



### A. Relevance

This project was rated **3.6** for its relevance to Building Technologies Office (BTO) goals and objectives.

- The Commercial Building Partnership seems to be the necessary precursor to some of the other programs discussed in the BTO Peer Review. It is a hands-on, experience-based program that can provide real-world feedback to inform other, more comprehensive programs that are designed to increase the scale of commercial building energy-efficiency implementation. Its comprehensive, collaborative approach should generate a wealth of valuable lessons regarding policy, as well as actual data for the metrics needed to evaluate such programs. The case studies that emerge from this program should stimulate substantial awareness of and interest in comprehensive energy-efficiency measures on the part of commercial building owners and operators, and should further the objectives of BTO in many ways. The “how to” information gathered during the planning, analysis, design, and implementation of the various projects, and the data generated by analysis of the results, should be extremely helpful in spreading the gospel of energy efficiency to the target market.
- Design assistance is a good area for DOE/BTO to allocate resources.
- This project is committed to goals and driving energy savings.
- This program is all about getting technologies into buildings.
- One reviewer did not enter a response.

## B. Approach

This project was rated **3.4** for its approach.

- The logical, systematic program design based on a pilot constituency of motivated, multiple-building owners and operators was a good start. The results feed directly into the Better Buildings Challenge and should also support the Buildings Performance Database, Standard Energy Efficiency Data, Open EIS, and the Technology Performance Exchange. Looking at specific energy-efficiency projects in their entirety, from opportunity identification to performance evaluation, seems to have been a very effective way to obtain information that can provide useful guidance not only at each stage of a project, but also on the relationships between the various factors at each stage and from stage to stage. As a laboratory for evaluating commercial energy efficiency, this program should generate a wealth of practical “how to” information as well as hard technical performance data, all of which should help to inform decisions by building owners and operators regarding potential energy-efficiency projects.
- The program seems to have been designed well with key elements, including enrolling a number of customers and setting up the system so that there were off ramps if the program was not the right fit for a certain company. The program also increased the likelihood of successful participation by enrolling companies through competitive solicitations. This process demonstrated that companies had real commitment from the start. Other elements of the program, such as the laboratories providing technical support, can be replicated by industry through utility-funded energy audits. Overall, there seemed to be a good balance between meeting both technical needs and boasting the strategic planning process. By providing guidance through a step-by-step approach, participants should be able to replicate the process in the future.
- There are many barriers to achieving deep energy savings and the comprehensive approach seems to be successful. It is not surprising that a strong focus on deep energy savings backed up by considerable resources is bringing good results. Working with national accounts appears to have the potential to lead to replication at a wider scale. There appears to be general advancement toward instilling higher efficiency design choices in the commercial sector. It appears that the cost per completed project is quite high, so a question for this approach is if there is successful high replication across the partners’ portfolios from this initial seed funding. The presentation has a diagram showing a relationship of the 5 million square-foot pilot, expanding to 80,000 million square feet in the commercial sector. The reviewer wants to know how it is expected that any replication will happen, and what a metric to track this would be.
- This project is moving fast to make an impact.
- One reviewer did not enter a response.

## C. Accomplishments/Progress

This project was rated **3.0** for its accomplishments and progress.

- The results are not only a convincing demonstration of energy-efficiency technologies, but the holistic evaluation of the projects from the standpoint that all relevant stakeholders should produce information and insights that greatly facilitate the “marketing” of energy-efficiency benefits to the wider commercial community:
  - An opportunity to validate and quantify many long-standing assumptions of energy measures.
  - A deeper understanding of interactions between measures and building systems through modeling and improving design integration.
  - An understanding of the magnitude of indirect savings.
  - An enhanced design process beyond traditional “design day” calculations to include yearly operation profiles.
- The program already has seemed to produce several deliverables, such as high-quality case studies, and implemented energy-efficiency measures. Plus, all projects will be measured and verified for an accurate reading of kilowatt-hour and therm savings. However, free ridership should be analyzed. Due to the selection of large customers with numerous similar sites, there is a higher likelihood that savings could be compounded across portfolios. Of course, the bigger issue will be if these types of savings are actually

implemented across the participants' portfolios and if a more broad and cost-effective program can be run to target many more companies.

- It is good to see that 30% improvements in current practices are achievable in existing building retrofits.
- The case studies, projects, and industry reach are all good.
- It is difficult to relate accomplishments to spending from the information provided. It appears that at most 35 projects will be done, at a total cost of more than \$33 million. This works out to close to \$1 million per project for design assistance, which does not seem plausible. So the reviewer assumes that these numbers and assumptions are not correct. In any event, the cost per project seems quite high. The reviewer wants to know if the level of spending per project is needed to get the intended results, and how one would know. The reviewer also wonders if there are lower cost approaches. Timelines are driven by owners' design and construction schedules, so that is a given. The reviewer does not see any metrics for project cost versus savings accomplished. The reviewer also does not see any metrics for measuring replication across a portfolio, or any metrics for replication to the wider commercial sector.

#### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.4** for its collaboration and coordination with relevant stakeholders.

- The involvement of a wide variety of stakeholders from the inception of the project appears to be one of the major strengths of the approach. The sheer number of reports, presentations, papers, and case studies indicates a high degree of collaboration among the partners, and the explicit coordination with the Better Buildings Challenge shows a focus on active coordination with other teams.
- The program was able to recruit a number of strong participants that appear to be actively engaged. In addition, the project team pulled high-quality resources from the laboratories and made sure to engage the greater industry through groups such as the Better Buildings Alliance.
- It appears that all of this work is done in close collaboration with the commercial partners. The integration with the Better Buildings Alliance seems productive.
- This project features a good mix of partners/collaborators.
- It is difficult to see how the results of this work will trickle down to the other parts of the small-medium commercial building market not represented by the market leaders that participated in this well-funded program.

#### E. Proposed Future Work

This project was rated **2.8** for its proposed future work.

- The "next steps" discussed at the BTO Peer Review clearly describe a process for evaluating the results of the program and communicating the lessons learned in a useful, understandable way to the commercial buildings community at large.
- It seems like the program is set up to finish in a strong position. The main challenge will be to determine how to capture lessons learned and ensure this program's findings can be replicated to a broader audience.
- Three separate funding cycles were described, with a total project duration of 6 years. Follow-on work to assess replication success and market impact was described. This appears to be a one-time intervention. The reviewer wants to know if that is the end of it, or whether this program should continue on an ongoing basis. The reviewer also wondered if constant operation of this program is needed and whether it is cost effective. The reviewer also wants to know if this program should be done with different partners, or whether it should never be done again.
- This reviewer does not see solid plans for technology transfer to the rest of the small-to-medium commercial building market.
- One reviewer did not enter a response.



### Project Strengths:

- One of the major strengths of the program appears to have been the absence of preconceived ideas regarding the expected results and the specific intent to challenge conventional wisdom in all aspects of project planning, design, and implementation. A conscious effort to involve all stakeholders in the process has clearly contributed to successful project completion. Finally, an approach based on using a relatively small number of motivated, interested building owners provided a manageable, yet reasonably comprehensive, sample of business and building types for the pilot activity.
- The program recruited a strong group of participants that committed to financing and installing energy efficiency measures and had a centralized decision-making process, managerial support, and a large portfolio. This criterion made excellent candidates. By the end of the program, many companies will have completed a full cycle of identification and implementation of projects. This will be an empowering experience for them and should set up long-term success in energy management. The presenters stated that major learnings were on process (soft side), not technical in nature. This falls in line with what many in the industry would expect. The program's challenge is to now educate a wider audience about these process learnings and how they can be implemented.
- Strengths of this project include its success at getting deep savings, its capability building and advances in practices, and its success at replication across partners' portfolios.
- A strength of this project is how it focuses on the entire process from predesign to validation.
- One reviewer did not enter a response.

### Project Weaknesses:

- The only weakness is the potential distortion caused by the high level of subsidies to partners. This is an expensive program, and in the current climate of cries for government austerity, it cannot be scaled up directly.
- Major learnings were on the soft skills, which are some of the key barriers across the industry for getting projects implemented. However, it is yet to be seen how the decision-making process can be influenced without a lot of one-on-one guidance (through a similar program, which is expensive). There is the remaining question of whether this program will end up being an investment in only these companies/participants or whether the larger market can benefit.
- There was limited success and impact for a 3–5 year project, albeit there were difficulties with the downturn in the economy and uncertainty with funding.
- Weaknesses include the (1) apparent high cost per project, (2) lack of metrics to assess the extent of replication across partners' portfolios, (3) lack of specific actions and metrics for replication to the wider commercial building sector, and (4) lack of an articulated long-term vision and decision framework for ongoing DOE and national.
- One reviewer did not enter a response.

### Recommendations:

- The project team should focus on a good transition at the end of the program for participants to ensure they continue forward with the process. It should also determine if adjustments should be made to address different needs of medium-sized companies or run a similar program for that sized market. The team should also work with utilities to accept a whole building measurement and verification approach. This will help save money and time with the verification of EEMs. The presenters noted that some customers' management teams were much more likely to approve projects because they had been stamped by the laboratory. The team should also identify what the customers will need in the future when the laboratory's stamp is not available. The project team should try to get participants' buildings enrolled in the Building Performance Database. The team should follow up with the companies that completed the program at 1 year, 3 years, and 5 years in order to document results, demonstrate self-sufficiency, or provide additional follow-up resources. This could be a great way to check sustainability and perhaps help sure up the initial big up-front investment with follow-up resources.
- The project team should develop and use metrics for project savings versus spending. It should also develop and use metrics for success at replicating EEM across partners' portfolios. The team should also



undertake a process evaluation to learn and apply lessons related to which program components are effective and which are not. Three national laboratories are involved. This reviewer wants to know if there are various approaches here that provide lessons learned.

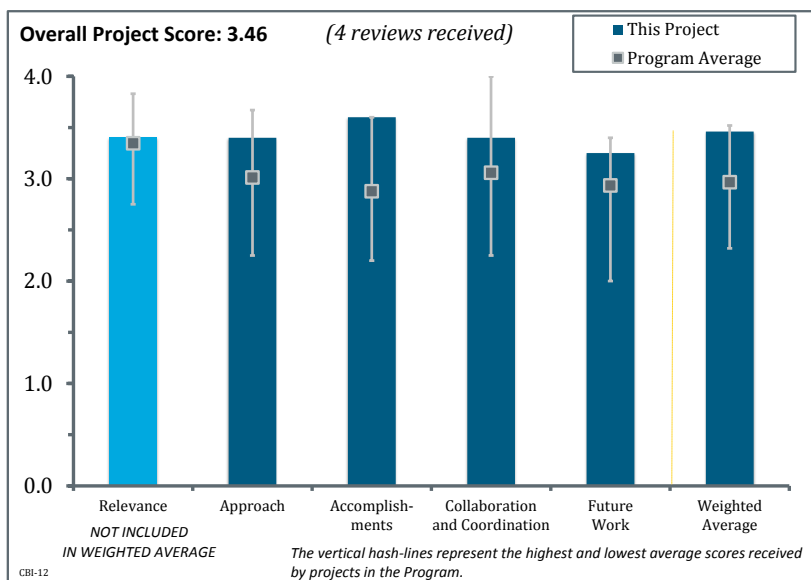
- This program was extremely well funded, so it may not be appropriate to compare its results/scores to other BTO projects that did not have ample or sometimes even adequate funding.
- Two reviewers did not enter a response.

## Project # CBI-12: Advanced Energy Retrofit Guides and Advanced Energy Design Guides

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### Brief Summary of Project

This project's goal is to provide technical guidance to building owners and managers for building design and operation/maintenance to reduce the energy consumption of new and existing buildings. Specific project objectives include assembling a team of experts in retrofit technology and modeling, drafting general guidance for retrofit processes, defining a life cycle cost analysis methodology, identifying highest priority retrofit measures, and performing energy modeling analysis examples.



### A. Relevance

This project was rated **3.4** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This is a terrific project and was one of the best-presented projects at the meeting. The availability of information and the statistics regarding the number of downloads show the impact that this program is already having in the industry. This project fits well within the BTO ecosystem and will be a major help in meeting the 50% “uber-goal.”
- Per <http://www1.eere.energy.gov/buildings/about.html>, these are the four outward-facing goals for BTO: (1) saving money while maintaining or improving comfort, (2) supporting the economy, (3) improving energy security, and (4) protecting the environment. Of these goals, success of this project has direct impact on (1) and (2), with indirect impacts on (2), (3), and (4).
- It is good to target barriers to energy-efficiency measures in the marketplace, and there is good provision of market support through engineering teams developing best practices.
- The country needs more programs similar to this one, which looks at the whole building, uses an aggregated approach to energy savings using the real world, and uses current technology to achieve its goals.
- While Advanced Energy Design Guides (AEDGs) are a well-established product with a broad application for private and government sectors, Advanced Energy Retrofit Guides (AERGs) need to be defined better, establishing specific targets and assessing synergies of energy-efficiency measures. Levels of savings resulting from recommended measures are similar to those currently achieved using business-as-usual methods and do not support BTO objectives.

### B. Approach

This project was rated **3.4** for its approach.

- Much of the approach so far has been driven by market demand in terms of determining where the needs are and then developing the documentation to fulfill those needs. By hitting both design and retrofits, this approach helps managers who are designing facilities as well as those looking into renovating new spaces.

Experts are gleaned from the “real world” and provide a variety of small-scale and larger-scale options. The information is well presented and readily available.

- The technical approach of the project appears to be strong. The approach for deployment to consumers by leveraging technology (information technology) could be improved. For example, energy models could be shared with the broader community using DEnCity, the Building Component Library (BCL), Open Energy Information (Open-EI), etc.
- Partnerships with the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), the American Institute of Architects (AIA), commercial building alliances, and other professional organizations allow the project team to have good penetration and dissemination of the research, information, and results into the industry. Some work needs to be done to hold the owners’ attention through the operations and maintenance phase of the building’s life cycle.
- The AEDG approach is good and the AERG approach is fair.
- One suggestion is to focus more on frameworks and methods for analysis, rather than specific technical guidance.

### C. Accomplishments/Progress

This project was rated **3.6** for its accomplishments and progress.

- The number of documents generated over the last several years is impressive. The number of downloads (nearly 500,000) show that this information is reaching its intended audience.
- The projects are timely and are providing information to the industry on schedule.
- The progress was good for the AEDG and fair for the AERG.
- The measurement system (for gauging measurable progress) is currently highly dependent on counting the number of downloads and purchased products. While these numbers are indicative proxies (and increasing in magnitude) for usage, they fail to address the basic unit of measurement—the designs/retrofits of how many individual buildings (regardless of size/complexity) were affected by individuals who consumed information contained in these guides.
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.4** for its collaboration and coordination with relevant stakeholders.

- Technical collaborators are “top notch.” Deployment collaborators could be improved by leveraging organizational networks that include key (owner side) stakeholders in the building design and retrofit process, such as the Building Owners and Managers Association, REBNY, CoStar, etc.
- This program has an impressive portfolio of partners: ASHRAE, Leadership in Energy and Environmental Design (LEED)/U.S. Green Building Council, Illuminating Engineering Society, American Institute of Architects, and a number of others. There are significant commercial partnerships and peer reviewers along the way. The outreach to young engineers was also impressive.
- One concern is that the project team is not allocating enough effort and resources to evaluating the overall project approach, success of technology transfer, and impacts. This project targets a specific type of actor in the industry, but it is unclear whether the project team is doing enough to understand this “customer’s” needs and constantly improve its “product” to create more value for that customer. The team should get more feedback on non-technical aspects—format, media, delivery system, integration with other tools, etc. There may be potential to better integrate AEDGs into the common tools of practitioners.
- One reviewer did not enter a response.

### E. Proposed Future Work

This project was rated **3.3** for its proposed future work.

- The continuation of using industry partners to help determine the need for new guides is a good approach. There is a lot of success from which to build, and this program is taking advantage of that. The expansion

of interactive tools and spreadsheets will only enhance its utility. Working toward a “net zero” guide is a terrific goal.

- The team should go straight to a combination prescriptive and performance guide that offers affordable net-zero energy design, construction, and operation and maintenance guidance.
- The project team needs to expand the AEDG for additional facility types and develop a more aggressive AERG for a broad spectrum of facility types.
- N/A—there is no fiscal year 2014 funding planned.
- One reviewer did not enter a response.

#### Project Strengths:

- This is a fantastic use of resources. The number of downloads and the collaborations demonstrate the project’s effectiveness and influence. By differentiating between the type of work to be done (major retrofits, component replacements, and new design) and the industry it is intended to serve, the guides are relevant to a large audience.
- These guides represent a new, dense collection of sector-specific “expert system” technical guidance for new construction and retrofit projects that present large leverage opportunities for design practitioners and others to quickly increase their knowledge base.
- These guides have the opportunity to transform the energy use and indoor environmental quality in buildings. The guides are valuable to owners and the technical support documents are invaluable to modeling professionals.
- This project has a reasonable approach for provision of technical support to the industry.
- One reviewer did not enter a response.

#### Project Weaknesses:

- No major weaknesses were noted. It would be advisable to fully include the cost of expected maintenance as a component of system cost so that designers and managers would have a better picture of the full impact of specific measures.
- The overall effectiveness of the project could be significantly improved by providing a mechanism for sharing the seed energy models used to generate the recommendation for both the AEDG and the AERG. Such a mechanism may already exist, through either the DEnCity energy model database or the BCL, which is hosted by the National Renewable Energy Laboratory.
- Several comments were made cynically in reference to a concept they call “value engineering.” Cynicism is very troubling here because value engineering is what this industry calls “staying in business.” The U.S. Department of Energy (DOE) is significantly limiting its potential impact if it does not provide solutions and support that appreciate the risks and constraints of private actors in the industry.
- Many design professionals understand all of this. Owners need good, well-documented proof that these recommendations are cost effective and meet the needs of business.
- One reviewer did not enter a response.

#### Recommendations:

- The project team should keep up the good work and DOE should continue to fund these kinds of integrated efforts.
- There are no additional recommendations. The team should keep up the good work.
- The project team should focus on the customer and put more effort into improving the project’s approach and products.
- Two reviewers did not enter a response.

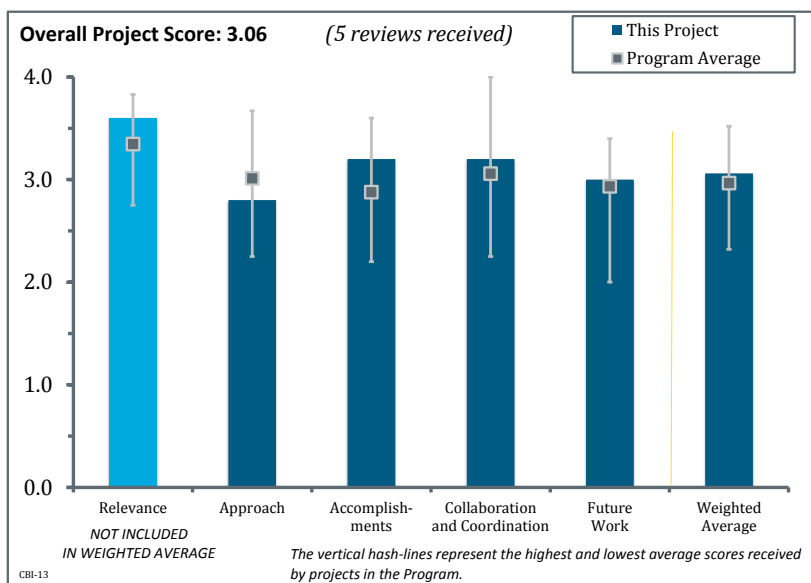
## Project # CBI-13: Whole Building Energy Performance Training

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### Brief Summary of Project

The Whole Building Energy Performance Training project seeks to properly train building owners and managers in the energy efficiency technology procurement process. Project objectives include creating a how-to guide outlining the entire acquisition process, describing the request for proposal (RFP) and contract language to define efficiency requirements, training pilot partners using the how-to guide, and partnering with industry training organizations.



### A. Relevance

This project was rated **3.6** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This approach to construction is transformative. It addresses the needs of owners and business, as well as allows the industry to be innovative and use its creativity to meet the owners' project requirements for a fixed price and schedule.
- A project that attempts to encourage building projects that utilize less energy from the start (rather than reducing ongoing consumption) is key to meeting BTO's goals. Addressing the traditional building process and providing alternative means to meet energy goals within a project's original budget parameters is a key building block toward reaching the ultimate energy usage goals for buildings.
- Documenting successful high-performance building construction projects and training others to do so is a worthwhile effort because there is a disconnect between projecting and achieving high-energy-performance buildings. It is unfortunate that this project appears to limit this process to design-build (D-B) techniques, because the plan-spec-bid process is widely used and many will be reluctant to change in the short term—and some for good reason.
- This project features a good, holistic view of building performance, but it has somewhat limited application in the "real world." It has potential for significant energy conservation where it is used, and it does align with the BTO ecosystem in at least two of the three principles, if not all three.
- One reviewer did not enter a response.

### B. Approach

This project was rated **2.8** for its approach.

- This project team's tactic of attempting to bring a systems approach from the start of the acquisition process is a good one. By mandating the requirements as part of the procurement process, there is essentially a contractual requirement to ensure long-term building efficiency.
- Many aspects of energy efficiency are lost through the traditional design/bid/build process utilized for most new building projects. The D-B process, when used effectively, offers a means of establishing performance criteria for all aspects of a project, including energy efficiency. Ideally, this approach should allow the D-B team to provide the most cost-effective solutions that accomplish the owner's energy goals. Owners

frequently struggle with how to implement this approach, and the team has created a multiple-step process for educating owners so that they can replicate what the National Renewable Energy Laboratory (NREL) has achieved: (1) outline of the process from start to finish, not just the bid process; (2) description of RFP and contract language; (3) training for pilot partners; and (4) utilizing industry organizations to publicize the approach. These steps cover important steps in the process, many of which are often overlooked by those who are unfamiliar with the D-B approach. The training of project managers, contracts staff, and others will increase the understanding and improve the flow of a project. By taking the message out to the general community, it reinforces the approach of utilizing performance objectives in lieu of hard specifications. This educational process will build a foundation for future participants in these efforts.

- The idea of working to develop performance procurement for buildings is a very good one, but the process being developed appears to be missing much-needed intermediate steps to ensure success. The experience of some of the efforts has shown that without intermediate steps (beyond simulation at the design stage and accountability for final performance), the result can end up less than fully successful performance-wise without a good track on who is really accountable. A lack of accountability can lead to finger pointing and lawsuits instead of success. Some of the intermediate steps include performance requirements in equipment specifications along with a review of actual performance of the energy-consuming equipment and systems, conducting a review and oversight of controls, and adding an element of performance testing in the commissioning process. Some or all of these elements are likely necessary to mainstream effective performance-based procurement because many contracting teams—even D-B consortiums—are only loosely affiliated and do not really act as a single entity.
- The project team should think of a major consulting firm attempting to provide a new category of service in this industry. A rich understanding of these transactions and the various stakeholders is needed to design an offering. For example, McKinsey & Company or a similar firm could evaluate go-to-market strategies. Training may not be the right keystone to achieve the team's objectives.
- There is a need for more nongovernment pilot projects to see where the pitfalls are in private-sector construction.

### C. Accomplishments/Progress

This project was rated **3.2** for its accomplishments and progress.

- The process of working with a large number of organizations and potential partners in training is an effective means of making progress. If the listed testimonials are representative, it appears the project is having a positive influence where it has been applied.
- The project proves that new construction can be delivered to meet energy-efficiency goals while maintaining indoor air quality and indoor environmental quality standards and respecting the owners' budget and all stakeholder business needs.
- A significant number of training sessions have been held and supporting documents have been developed. The information has been disseminated to design teams and to owners, and this process will continue through the end of the project.
- The training appears to have been used in some form with a number of government and institutional agencies. NREL has had demonstrated success as well on its campus. The "ripple effect" slide was a very good visual model for how this is planned for further implementation.
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.2** for its collaboration and coordination with relevant stakeholders.

- The collaboration with prospective users of the performance procurement process appears to be very effective at this point in the project. This collaboration is necessary to ensure that the developed tools provide the necessary benefits to ensure success when applied widely without hand holding. This is a very good start.

- The team is collaborating with industry associations for training, as well as specific groups that own/build/manage portfolios of buildings. The feedback from these groups and from design teams will allow for continuous improvement of the training and the process itself.
- By aligning all members of the design/construction/operation teams toward the same goals, this process should have a significant impact, if it is practical enough to be adopted industry-wide. Eventually, some collaboration is needed to transfer of information outside the government/institutional sector.
- Building alliances could join in to take this project to the next level, e.g., American Institute of Architects; the American Society of Heating, Refrigerating and Air Conditioning Engineers; the AGC; MCA; and the U.S. Green Building Council.
- The criteria for collaboration, technology transfer, or market impact is obviously the core measurement of this project's performance. The project team should be focused on identifying the best means for creating value.

### E. Proposed Future Work

This project was rated **3.0** for its proposed future work.

- The remaining work consists of additional training sessions. The team has developed a significant amount of training materials that can be used independently or in conjunction with presentations or pilot training. The collaborations developed to date will support the plans for the remaining time in the project.
- Having the Design-Build Institute as a partner in training is very important. While the development of Web pages for documents and related materials will be helpful as a resource, some sort of hands-on training with support will likely be required for some time to come. The future work statement should be clear that hands-on training with support will be needed, and some additional funding should be planned for these activities.
- Future work at market penetration, given the fragmentation of the design and construction industry, and overcoming the need for training all stakeholders in the process will be a challenge. Also, consistently maintaining the standard of care required of design professionals (that is not the case for contractors and equipment suppliers within this process) will be a challenge.
- Using the D-B process toward an eventual goal of net-zero is an admirable, yet lofty, goal. As a fairly newly funded project, the jury appears to still be out on what the future holds.

### Project Strengths:

- The concept of this project is very strong. Using D-B principles, directing everyone toward the same operational goals, and doing it from concept to building turnover is the right way. Providing guidance to the industry by using the success stories is a good way to get these concepts into the market. The use of incentives to make it a long-term partnership is a good approach. All too often, it seems as if designers will create a set of plans, mock up the design, and use it to sell themselves before the first hole is dug. Contractors are often disengaged by the time substantial completion rolls along. By making them long-term partners, everyone has a stake in the ultimate success of the project long after the building is turned over. Long-term partnerships also encourage innovation on a holistic level by all parties involved in the process to help meet the energy goals of the building.
- Developing experience-based energy performance procurement is a potentially critical step to improving the energy performance of buildings in accordance with BTO building performance goals.
- This project delivery process has the ability to overcome the issues related to poor design and construction that has plagued this industry for centuries.
- The project set out a clear set of objectives and has nearly finished achieving them. The premise is strong, supports BTO's goals, will have a direct effect on energy savings in buildings, and leaves little or no residual issues that remain to be addressed in order to actually achieve savings.
- It is a fine intention to understand "how NREL achieved these goals and how can we help others do the same."



### Project Weaknesses:

- The process of training owners and their preliminary design teams to engage in energy-performance-based procurement should be expanded so that it can be applied to other project types such as plan/spec-bid-type processes. To be effectively applied in the industry, the process also should have some very specific intermediate steps such as equipment performance specifications and pre-turnover testing and/or performance testing during commissioning at a minimum. Finally, there needs to be some agreement on exactly what is required to verify that performance criteria have been met. These critical items for success were not addressed to the level needed to ensure this process will succeed when more widely applied.
- There are concerns that this project could have a very limited sphere of influence. For one, it would only seem to apply, in its current structure, to large institutions and government-type agencies. For industry adoption, concepts also must be broken into some smaller elements (almost in a step-by-step basis) to make it seem more achievable/less unwieldy. Because so many buildings are not part of a large portfolio, medium/small building owners will need translation to make it practicable for them and maximize the potential market impact. In addition, major retrofits should also be considered as a future evolution of this process (beyond just new construction).
- There is not enough introspection or case study of how and why NREL was successful. It is unclear whether their success was really because the project partners were “better trained.” There may be more factors that are not being fully appreciated in project design and implementation.
- Owners are often overwhelmed with the construction process. Being able to spoon feed this information in small, understandable bits at each phase of the project similar to an airplane pilot’s checklists would be beneficial.
- One challenge is that the project is measuring itself by training delivered, but the true measure of success will be the number of projects that adopt the approach.

### Recommendations:

- Energy-performance-based procurement could play a very important role in reducing energy use in buildings. It is recommended that this project be continued to evaluate projects that use the program to test their success rates and to tune the program to improve its success in the future as it becomes more widely applied. Also, the program should be expanded to incorporate other types of project processes, such as plan/spec-bid.
- The project team should keep up the good work and the U.S. Department of Energy should keep funding this effort. It can have a major impact.
- This project has many more strengths than weaknesses.
- The project team should hire an industry specialist to focus this project. What this reviewer would call “strategy development” is not a core skill of the national energy laboratories. What is needed is a business model to create value for parties in these transactions; that will require deep knowledge and skills in areas such as organizational theory and economics, among others, and these types of knowledge and skills are typically held by strategy and other management consulting firms.
- One reviewer did not enter a response.

## Project # CBI-14: Transforming the Commercial Building Operations

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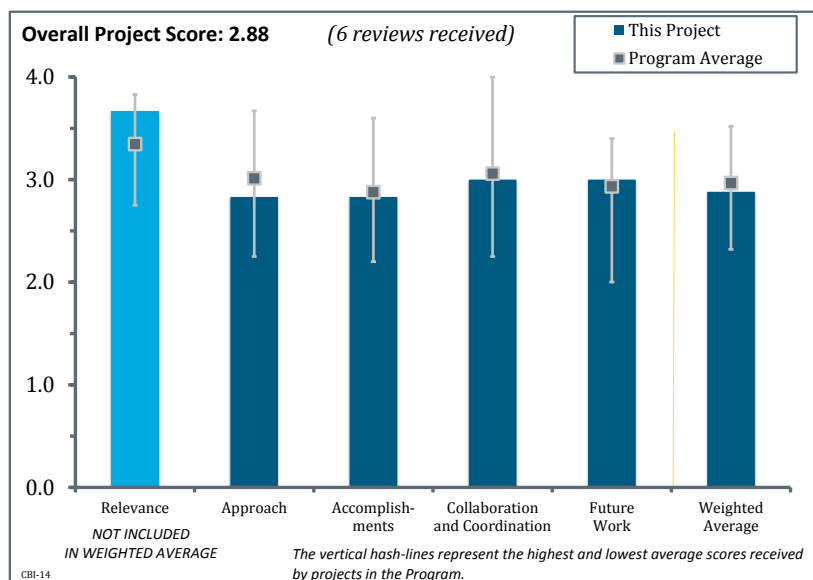
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### Brief Summary of Project

The overall goal of this project is to train building operations staff and service providers in a systematic process for identifying and correcting no-cost building operational problems that lead to energy waste. The project's objectives are to establish regional training centers and transfer training tools and materials; enhance/update training materials, including Web-based training; and work with other stakeholders to expand the project's audience.

### A. Relevance

This project was rated **3.7** for its relevance to Building Technologies Office (BTO) goals and objectives.



- This is a terrific project that addresses a long-neglected aspect of building performance: maintenance, and the people who perform it. This project could have a significant impact on the 50% “uber-goal” by virtually eliminating “wasted” energy due to inefficiencies, poorly implemented design technologies, and malfunctioning equipment. Eventually, by empowering the workforce to have a gold standard of maintenance personnel, it could have significant market impact and possibly even affect future codes and regulations as far as building operation. By engaging the workers and getting feedback on the systems that work, the systems that do not, and which technologies provide the best long-term “bang-for-the-buck,” this project could help direct future research and development as well.
- The problem is well defined and captures the need for a more robust workforce. Having a talented group of mechanics and technicians that are aware of their influence on the efficient operation of heating, ventilation, and air conditioning equipment and controls is immediately needed. There is a need to establish a profession that is focused on the actual maintenance, operation, and repair of technologies that provide comfort and lighting in the nation’s facilities. Members of this profession will need to be trained and experienced in the relationship between sophisticated building automation systems and the actual operation of installed mechanical and electrical systems.
- This project is critical to reducing energy consumption throughout the United States. Having a practical training program that allows individuals and organizations to have a process to take existing building stock and work toward making it as efficient as possible through low-cost or no-cost actions is incredibly logical and should be the first step in any comprehensive program of energy use reduction. If properly implemented, a building retuning program will reduce the energy use in buildings. On another note, BTO’s goals and objectives were not easily found on the BTO webpage (<http://www1.eere.energy.gov/buildings/>). BTO should consider making a tab that specifically references the goals and objectives. It makes it hard for someone to know what it is that an organization is trying to do if the organization does not make it clear and readily available to anyone who looks for it.
- Existing building energy consumption is where there can be the most immediate impact. Much of that can be realized through good operations and maintenance (O&M) practices. This project is a great start toward that goal. There is a need for greater focus on best practice sequence of operations.
- Building O&M is a good focus area.

- Training programs that provide building operations staff and support groups with tools to operate buildings more efficiently without specific targets and without accountability have a very low likelihood of making a difference, especially over time because building operations staffs' primary concern is always keeping occupants satisfied. Many operators want their buildings to be more efficient, but ultimately lowering chilled water temperature or supply air temperature to make people more comfortable will not even be second guessed, especially when the energy penalties are not brought to their attention. U.S. policy as stated as an introduction to this exercise is to cut building energy use in half by 2030. Any training program should start with building operations staffs gaining a perspective as to where their buildings are operating with respect to others of their type (their ENERGY STAR rating), and where they are operating with respect to the 2030 target. Monthly and even weekly or, in the future, daily reports on building energy performance using utility data in comparison with targets must be integral to any such program. Building management must be involved so the operations staff understands that building management expects certain progressive targets to be met and maintained. This aspect of targeting and verifying actual building energy use needs to be added to this project for it to have a chance of making a noticeable difference in the industry.

## B. Approach

This project was rated **2.8** for its approach.

- The current approach to addressing the issues is technically sound and the blueprint to achieve success is well defined. There is a need to more specifically identify the target audience for the proposed training. The makeup of the proposed workforce should be defined. Defining whether or not the proposed workforce is made up of an improved existing segment or freshly defined and developed is important. It is understood that buy-in at higher levels of target markets is needed. Yet, it is enthusiasm at the workforce level that can guarantee success. The new workforce will have to have a greater interest and understanding of data and the relationship to actual operations. Training should also include showing how systems can and have been circumvented in the past. These practices should be discouraged and considered to be an affront to the profession.
- The reviewer loves almost everything about this project. The project material is fantastic. The project intent is possibly the best ever. The idea that people who will actually be where the rubber meets the road will be involved and that the best practices from an academic and research perspective are being transferred into action is stupendous. There is only one real stumbling block that has not been addressed. There are a few assumptions made in the process of implementing the retuning process. One of the assumptions is that the building plans, operations manuals, sequences of operation, and/or other documentation will be available, but this is not a reasonable assumption. In fact, one of the main problems that building owners and operators have when trying to maintain and operate buildings as efficiently as possible is that the documentation is often lost or incomplete. A major improvement in the project would be to create a troubleshooting process for when the documentation is not there. Clearly there is a way to move forward if documentation does not exist, but at this point a person participating in the retuning training would be on his own at that point and could easily get distracted; the goal of accomplishing the retuning could get lost before it ever gets underway if the documentation is not available. Individuals that have performed many building retunings know that there are plenty of things that can be done to improve building performance without ever referring to building documentation of any kind. While it is not impossible to perform a retuning without documentation, the documents are essential for the retuning process to be optimized. Addressing this issue as a future plan is a good idea and strongly recommended.
- By engaging the maintenance personnel, training them on the new technologies, and getting their feedback on the actual operation of the systems once they move beyond concept, this project has the potential for a very significant role in the future operation of buildings. The shift from reactive maintenance to proactive maintenance is very important, and removing the perception that implementation is expensive could break the barrier that many operation managers have toward more aggressively pursuing retro-commissioning and preventive maintenance (and reaping the future savings).
- A very brief discussion of energy use comparison was included in the presentation (the Energy Charting and Metrics tool), but it appeared to be limited to comparison only with the same building at different times more as a fault detection tool. Comparison to other buildings of its type (via ENERGY STAR) and with improvement targets over time should be employed to make this a useful improvement tool. The element of

comparison appears to be missing from this approach. Energy use comparisons and targets need to be developed automatically and be provided monthly or weekly to operations staff to show whether or not the building is meeting the progressive targets. If consumption appears to be increasing, there needs to be some advice in the report as to what is the likely cause. Tools available to the operator need to be highly automated so that the operator need not spend much time in evaluating building performance each week or month.

- The project team needs to identify the target audience. Partners should lean heavily on technical schools. Barriers are going to be that no one knows what the project team is doing. The team needs a good marketing and media strategy beyond just throwing this up on a website.
- Training the trainers may not be the best strategy for achieving goals.

### C. Accomplishments/Progress

This project was rated **2.8** for its accomplishments and progress.

- The identification of need, creation of a training program, and deployment of project goals and objectives is well underway. Sites that are candidates for employment of retuning graduates need to have established benchmark programs for utility commodity. Establishment of clear metrics on specific buildings is necessary to ascertain the success of workforce training. Fine tuning the establishment of the proposed trained workforce is needed. Specific careers need to be identified and targeted.
- The major partners are well identified. However, how the technology will be transferred to owners, technicians, etc., would be beneficial to know.
- This project is behind schedule. There are still some obstacles to overcome. The “train-the-trainer” sessions are not completed yet. It appears that the collaboration between BTO and the National Institute of Standards and Technology (NIST) continues to develop as time goes on, but that there is still some synergy that is lacking. In order to analyze the success of pilot programs, the trainers must be in place and the training sessions must be underway.
- Everything is moving along nicely and whatever difficulties may exist will be overcome very soon. However, the project’s progress was not as clear from the presentation and the materials. It does appear that there has been some delay with the scheduling of actual classes via NIST, but there does seem to be a track record of success with the limited number of centers that have been working with this project. Because this is early in the process, it was hard to mark this part of the project beyond “good” (though the reviewer would like to have given it “outstanding” marks across the board).
- Operator training using more or less conventional tools—as appears to be the basis of this project—will generate a very low return on investment because the efforts are subject to very rapid deterioration over time. Training has and is already taking place in the industry and it is assumed lessons are being learned. It was not discussed, but it is very important that training programs such as this directly engage the building management so that the operator understands that energy efficiency is a management objective. Just focusing directly on the operator is problematic for that very reason. To get and keep building management involved, the benefits of more efficient operation and/or the need to comply with present or expected codes must be explained, and the process needs to keep management abreast of how the building is meeting these challenges. If energy use is instituted into the building operation policy—through management—then there is a chance for a program to succeed and for the benefits and impacts to continue over time.
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.0** for its collaboration and coordination with relevant stakeholders.

- Current efforts to deliver the program from the top are well underway. The nation needs to know and understand that this project is necessary. There is a need to drive the appetite and need for retuning training from both the owners’ perspective and the workforce. The workforce has to want to be a part of the solution and needs to have a vested interest in why its participation is necessary. Work should be done to ensure that information technology (IT) experience is sitting at the table. IT is driving the automation of

building operations and this is surpassing the technical expertise of mechanics and technicians in the field. A focus should be put in this area.

- The project managers have made contact with and reached out to some excellent institutions and agencies to get feedback, train personnel, and track the results. It would be advisable in the future to try to diversify some of these partnerships (such as with different institutions, different types of facilities, and various sizes of building portfolio operators). Despite that statement, this project does appear to be planned and implemented very well.
- There are many good collaborations on this project. It seems that everyone who has participated is fully integrated into the program.
- The project is engaging a number of operations clients—it is not clear how and at what level they are in the various organizations. These associations and feedback from them is essential in shaping a successful program.
- Collaboration needs to be expanded to large and small K–12 schools and municipal owners. Another suggestion is to conduct pilots for owners with lots of small buildings such as banks, pharmacies, convenience stores, etc.
- It is unclear whether the industry really needs this project.

### E. Proposed Future Work

This project was rated 3.0 for its proposed future work.

- This project is fantastic.
- This project appears to be headed in the right direction by working toward the private sector and expanding the training opportunities. The development of guides and interactive tools will become more practical to all. While there is a lot of focus on the process, it should not be forgotten that the people served by the training are the key to the project's success. If the training has value by being relevant to their needs, presented in a practical manner, and personally useful in their careers, there will be sufficient buy-in, and the model/project will flourish. The idea of expanding this training to custodial staff on a smaller scale is also a good one, as it will only enhance the value and make it more of a holistic approach. Often times, custodians know a building better than even the maintenance staff (if they are even different people).
- Complexity is already making it difficult to keep current building technology operating at peak performance. Creation of automated systems to keep an eye on the operation of automated systems doubles the complexity of operations. Although online training will help the workforce gain knowledge, the workforce will have to have practical repair skills that are refined and developed through practice. The program should continue its focus on the development of a highly qualified workforce that can keep existing systems operating at peak efficiency. This workforce is the answer to establishing and maintaining highly efficient, low-cost operations. "To attain and sustain highly efficient buildings, nothing beats a well-trained and conscientious energy user who implements decisive actions in both operations and repair of their systems." The project team should consider improving the benchmarking and performance measurement process over time.
- Training does include development of unspecified automated tools, but these tools need to be a higher priority for success. A focus has to be on engaging building management, not just on fault detection and repair, but also on improvements. These aspects should be added to the project.
- The project team should focus on whole building, technicians, managers, documentation, integration, etc. The presentation should be modified to point out some of the great features of the project that were not highlighted until the question and answer session.
- Technology roadmap toward better automation of feedback, diagnosis, operations, maintenance, and so on.

### Project Strengths:

- This project addresses a real need (existing buildings are often able to be operated in a more efficient manner). This project also potentially creates jobs (people should be able to find employment performing retunings). In addition, this project includes good partners (government, research, industry, etc.). Furthermore, this project actually has good information that can be put to use (the online training tool is pretty good).

- This project has a number of strengths. By taking a long-term approach toward the people that actually work in these buildings and keep them running at (hopefully) peak efficiency, there are enormous opportunities for avoiding unnecessary energy consumption and showing that the program can pay for itself. This approach could shift the industry paradigm more from reactive maintenance to proactive maintenance.
- Building retuning training is a clear need and has the potential to significantly contribute to the overall goal of energy use reductions throughout the United States. In addition, the potential to create a new workforce with specialized skills can be found within this project.
- Operations staffs do have a great impact on building energy performance, and it is helpful in attempting to meet building energy performance goals to have programs that include improving operations expertise.
- The project's focus is spot on regarding the operations and maintenance of buildings, which is where much of the ability to control and contain a building's energy use intensity exists.
- This is a good barrier to focus on.

#### Project Weaknesses:

- No major weaknesses were noted. There may be a need to diversify the training source if there are issues with scheduling classes through NIST. Perhaps other partnerships could be used to help move the process along and still maintain the intent and integrity of the program.
- The only weakness is the assumption that a building's documentation is always available, which is not reasonable. The lack of documentation may be more the norm than that documentation actually being available. Not providing tactics, troubleshooting, and a process for dealing with the very real and probably quite prevalent lack of documentation is a project weakness.
- The Building Retuning project will be enhanced by establishing a clearly defined target student. Enthusiasm for the retuning project should include driving interest from the workforce. Current efforts appear to focus on the trainers. Ensuring that they have a viable and interested student population can improve success.
- Comments were made during the session indicating the low priority of energy efficiency and paucity of time/attention available for retuning. Thus, training would only have an impact for those rare individuals with both. Instead, technical solutions could address the fundamental barriers—analysis, automation, etc.
- The project does not appear to focus on new approaches to operator training. Building operators today have generally less background in mechanical/electrical energy issues than decades ago, and that trend is continuing. Meanwhile, building systems and equipment are becoming more complex. Similar to the changes that have occurred in supporting auto mechanics over the last several decades, tools to improve the operation of buildings need to be made more automated and procedures far more regimented. These aspects are minimal or missing from the description of this project.
- Weakness is going to be in the project to reach a large number of consumers and get their attention. Case studies and cost benefits in real-world applications, along with a good marketing plan, will help overcome this weakness.

#### Recommendations:

- This is a great project. Several recommendations that could help make it even stronger include the following:
  - The project team should develop meaningful certifications that will encourage personnel to attend the training, improve their own marketability (which would help with promotion potential, taking those skills to higher levels of management), and demonstrate an understanding and knowledge above the “average” maintenance worker. In addition, adding a continuing-education-unit-type requirement will encourage them to keep the knowledge current and to network with other similar professionals.
  - The project team should find a way to work this training into all levels of technical education programs, starting at the 9–12 grade level (most school divisions have a technical/vocational career department), as well as those that move into the field after high school. This approach will ensure that the new generation of workers will eventually understand the long-term investment of maintenance, as well as reinforce the value and importance (and uniqueness) of their work. There



is a severe shortage of qualified new maintenance workers coming into the market on some of the more critical building systems, particularly mechanical.

- The team should work this training and education into programs regarding preventative maintenance and asset management. A three-pronged approach to facility maintenance could really move the industry toward proactive maintenance as the standard of care. The resulting cost avoidance, wasted energy reduction, and overall energy efficiency will have a profound impact and reduce the “Band-Aid” approach toward addressing maintenance issues.
- Technology is moving quickly and complexity can cause problems when the workforce is unprepared to cope with the speed of change. The retuning project should be infused with updates and students must be encouraged to stay abreast of enhancements. Even though the mechanical and electrical equipment remains the same, the automation available can be intricate. Students need to be interested and aware of these updates in order to keep the equipment running properly. Stressing that the students are working on the entire system and that it includes a working knowledge of the relationship between mechanical operations and the signals from building automation is critical.
- The project team should consider restructuring this project to focus much more on coordinating operator training with the development of fully automated building energy performance, targeting, and diagnostic tools. The process should start with engaging building management, and the first order of business is to identify an ENERGY STAR rating and annual/monthly performance targets. The training should be a very regimented process that requires operators’ (and managers’) time sparingly and provides access to support for meeting elusive use targets.
- This project should eventually find itself incorporated into vocational and technical programs within the public education sector. If this integration appears practical, Loudoun County Public Schools in Virginia may be a good partner with which to work—[www.lcps.org](http://www.lcps.org).
- High-quality training materials that are easily accessible in small bits and pieces should be developed. Online certification of managers and technicians at low to no cost would also be beneficial.
- One reviewer did not provide a response.

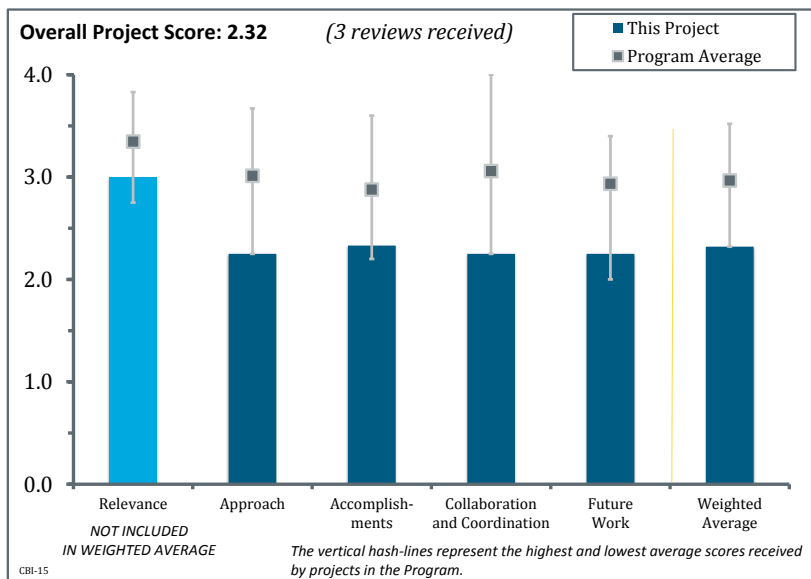


## Project # CBI-15: Financing Turnkey Efficiency Solutions for Small Buildings and Small Portfolios

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### Brief Summary of Project

The project's goal is to enhance the adoption of energy efficiency technologies and techniques in the small buildings and small portfolio (SBSP) sector by reducing financial risk of small building efficiency projects. The project's objectives include identifying energy efficiency financing programs, compiling a draft plan for national laboratory contribution to support identified programs, and producing a final technical product that mitigates financial risk for clients in the SBSP sector.



### A. Relevance

This project was rated **3.0** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This project's relevance is good and addresses a segment of the building stock that needs support. The scope does not address the full problem statement. For non-technical barriers, the project team should consider the appropriate agency to intervene here, whether it is federal energy laboratories in direct partnership with financiers or some appropriate "devolution" of activity to other federal, or state and local government, agencies. The reviewer wonders if the National Renewable Energy Laboratory (NREL) is the right entity to lead this work. NREL does seem appropriate for tasks related to technical analysis.
- This project has a good target focus, given that the small buildings sector is a key target, has an aggregated high energy usage, and is hard to reach. Access to capital is a key barrier addressed by this project. This project has a strong logic model that supports reduction of investment risk. Very little work has been done in this sector, so this project may be "low-hanging fruit."
- This reviewer loves this project concept! It starts from the needs of the decision makers and decision influencers, rather than from some analysis concept with a list of hypothetical benefits.
- This program appears to overlap with much of what the Buildings Performance Database is doing. It is unclear whether the basic premise of developing standardized "packages" of energy-efficiency measures and forecasting costs and savings for "typical" small buildings will be perceived by the financial community as having a significant impact on risk. Certainly, anything that reduces performance risk for a project is desirable, but it seems that there are other programs that will reduce risk for specific projects.

### B. Approach

This project was rated **2.3** for its approach.

- This project leverages the core competency and expertise of a national laboratory as technical analysts to make an independent justification of value for capital funding. It is not clear how the results will translate to the financial community. Engagement with the financial community is critical to the success of this approach; it is not clear how that engagement will happen. No partner(s) have been involved yet. Even

though the laboratory would be creating packaged solutions that are customized for the different building types, it seems like this customization should be done in concert and with input from the financial partner.

- This reviewer would love to rate the project as outstanding, but it is too soon to tell. The project has a great focus on real barriers (e.g., transaction costs and risks).
- This project does not appear to address the full problem statement. More integration of stakeholders is encouraged—for example, of financial interests and operation of electricity grids—in determining an appropriate set of activities for BTO. Allocation of effort to non-technical barriers may be critical to achievement of this project. To borrow an analogy, the approach here seems “modular” as opposed to “integral.” This project focuses effort on development (and implicit validation) of specific, investment-grade packages of energy-efficiency measures. An alternative, integral approach might look more at capacity building across the range of actors and analytical requirements, without specificity to measure packages. The latter would empower more customization and perhaps counterintuitively lead to deeper retrofits than a suite of packages that are limited in their appropriate application.
- It is unclear how a performance model based on a “turnkey” standardized package of energy-efficiency measures, using supercomputers yet, will appreciably affect the underwriting criteria for financing these projects.

### C. Accomplishments/Progress

This project was rated **2.3** for its accomplishments and progress.

- This section does not apply to this program.
- One cannot evaluate progress for a project that is just started and has been delayed by some perceived interaction issues with BTO.
- The timeline was not well articulated, so progress is uncertain. Delays happen. It is not clear whether the delay is problematic for related efforts of BTO or other parties.
- The team is 10% into the project; two months into the project, the direction changed; little bit of gap. The team has already completed the SBSP Roadmap (scoping study/gap analysis, sector characterizations) via the National Trust for Historic Preservation, Preservation Green Lab, which is expected to be completed end of May; another scoping study and gap analysis of financing solutions is needed. The roadmap informed a recent funding opportunity announcement. No financial partners have been identified yet; but this needs to happen soon, as it is critical to the outcome.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **2.3** for its collaboration and coordination with relevant stakeholders.

- The project leverages internal BTO program resources such as Open Studio software, which reduces cost and time to audit. There are not a lot of other tangible collaborations or market interactions. The team is still looking for a financing partner for the project. It is not clear if partners are being reviewed or assessed.
- A better, more explicit survey of all stakeholders across the value chain is needed to identify the full range of barriers, needs, etc. There also needs to be better articulation of financing requirements and both technical and non-technical bases for a solution. These items may be an outcome of SBSP roadmapping, although only if the right groups of stakeholders are convened and surveyed. Many utilities invest directly in markets or contract with third parties to invest in building upgrades. Those utility programs often pursue the same technical validation of measures or bundles of measures that this project is proposing. The project team should either involve them early on or make clear how it intends to transfer to them the value of its work.
- Early involvement of the financial community is critical, but care must be taken to talk with the right types of lenders. A large national bank may have no interest in small building projects, but a local credit union might.
- The need for partners (such as an advisory committee) has been recognized, but not much has happened to engage folks yet. The team is only 10% into the project.

## E. Proposed Future Work

This project was rated **2.3** for its proposed future work.

- This project features a well-laid-out work plan.
- In addition to duplicating efforts that seem to be further along in other programs, this program seems to be focusing on a relatively minor factor affecting the high cost of financing energy-efficiency projects for small buildings. Transaction costs (as a percentage of a total loan) and borrower creditworthiness may far outweigh concern about technical risk.
- This project may be replicable if it achieves the desired outcomes. It may also be too early in the project to develop a future plan. The migration path toward scalability is not clear. It might be possible to export the outputs of this project to other U.S. Department of Energy (DOE) laboratories as resources for local financial institutions and credit unions.
- The plan for finishing this project and distributing the value of its outcomes were not well communicated.

### Project Strengths:

- This innovative, creative, and important project is being done by people who seem to understand finance, as opposed to the usual suspects rooted in engineering, physics, etc. This project is very worthwhile.
- This project's strength is its focus on the key barrier of independent, objective analysis and information about the value and savings associated with energy-efficiency upgrades in small commercial buildings.
- The basic thrust of the program (addressing the financing obstacles to energy-efficiency measure adoption in the small commercial market, which is an underserved area of energy-efficiency activity) is good.
- The problem statement is good, but it may need further research and articulation to determine the right course of action for BTO.

### Project Weaknesses:

- The small buildings sector is hard to define and segment in terms of needs. There are also some unknowns related to whether the financial lenders will really unlock financing if they do have this level of confidence. Small businesses and owners of small commercial buildings still need to be creditworthy, whether or not the return on investment is more defined and substantiated.
- The context is understated—the full scope of industry requirements may exceed the scope of this project, even given its intended outcomes of characterization and roadmap building.
- This project has a simplistic approach that seems naïve in its underlying assumptions. Development of “turnkey” modeling solutions assumes a “one-size-fits-all” type of market. The modeling seems to duplicate other DOE program efforts.
- This project should feature a stronger emphasis on getting early and continuing advice from people who are intended to be its beneficiaries.

### Recommendations:

- It is strongly recommended to bring in utility or energy-efficiency program sponsors to collaborate with this effort. They need much of the same substantiation of savings and cost-effectiveness as the lenders need, and if they are partners, they can bring greater assurance of incentives to offset the financing.
- There needs to be more explanation and detail of the business case leading up to a decision to fund this project, as well as the project's position in the context of other BTO and Office of Energy Efficiency and Renewable Energy activities. This general comment on format applies for this entire peer review.
- BTO should have more projects of this type, as opposed to incremental widget improvement.
- One reviewer did not enter a response.

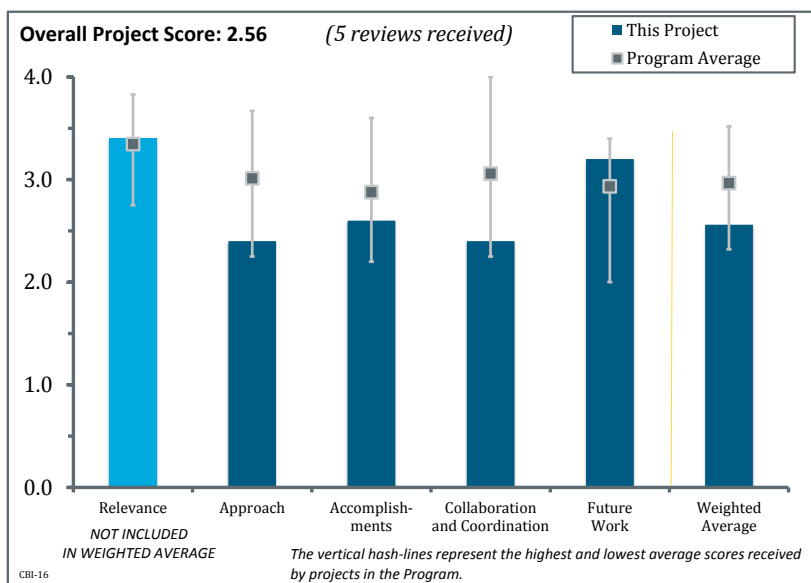
## Project # CBI-16: Small Building Energy Management System

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### Brief Summary of Project

The primary goal of this project is to develop packaged, highly “commoditized” energy management systems for small commercial buildings that can be delivered with sufficiently low transaction costs, resulting in site energy savings of 5%–10%. The project’s objectives include analyzing market need and potential, developing a technical and business approach, creating the energy management system package, demonstrating the pilot and tracking impacts, and disseminating results.



### A. Relevance

This project was rated **3.4** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This project is critical to achieving the BTO goal of reducing energy consumption. The small business community will greatly benefit from the project because finding conservation methods that fit in a short payback period will greatly improve the rate at which the measures are implemented.
- Enabling installing and servicing contractors to provide “entry-level” energy services is very relevant. It is likely that only a small percentage of lead users will make use of this material. However, it will create differentiation for those contractors that over time will help influence others to raise their performance to this level.
- The program logic is reasonably sound for addressing BTO goals, along with the alignment to the Commercial Building Integration Program’s strategies and priorities.
- This project is not very well defined and has an uncertain outcome. It appears to be aimed at providing — for a very low cost—certain energy use data and other information to outside contractors to help them assist small buildings improve their energy performance. However, the contracting business model is to sell equipment and installation services. It is not at all clear—and it is of concern—whether this approach would be used just to gain access to new customers, and the energy aspects of the actual work largely ignored, as they are ultimately by contractors today. It is not certain whether success would require a new non-contracting or limited contracting entity that is primarily focused on helping small buildings meet energy code requirements as they may develop. It would have made this project more relevant if these issues were addressed.
- One reviewer did not enter a response.

### B. Approach

This project was rated **2.4** for its approach.

- This project features good use of contractor input. The principal investigator has realistic goals.
- The overall approach, for the time frame already in progress, is satisfactory, but it can be improved by expanding the pilots. Using only two contractors from one location without the diversity of other areas of the country may be an issue.

- Barriers of transaction costs, low skill, and limited time all ring true. Additional barriers include limited interest of owners, limited interest of contractors, conflict of interest of contractors, and difficulty (transaction cost) of ever verifying energy savings. Choosing small commercial HVAC contractors as the main delivery approach is problematic. There is a big conflict of interest here. Contractors can claim that maintenance activities save energy, but the likelihood of an owner having the time and expertise to verify 5%–10% energy savings claims is very low. If the contractors are tracking the success of their own work, there is a big conflict of interest. The approach relies on savings from the low-cost measures such as lowering set points, deepening setbacks, adjusting combustion efficiency, installing occupancy sensors, etc. All of these measures are difficult to verify and have typically demonstrated low persistence of savings. The approach greatly underestimates the gap between contractors' typical abilities and the sophistication needed to perform this type of analysis. The great failure of many of the suggested energy savings measures is in poor installation and maintenance practices. Increasing the quality of work is a major change needed in contractor practices, yet this seems inconsistent with the idea of doing all of these functions at very low costs. Persistence of savings is another issue for this approach. This project is really a performance-based approach, which is hard enough in large commercial facilities with larger savings supporting better analysis. The project team should clarify how it is dealing with persistence of savings, and whether it is credible for the contractor delivering the service to track the success of the service. Scaling to 5% of buildings in a few years seems unrealistic. It is unclear how many buildings that is per year. In short, this approach seems to be aiming to close some very large gaps at unrealistically low costs.
- The program logic is based on the premise that HVAC contractors will have a predisposition to be engaged for learning, and then using the packaged walkthrough approach for identifying, and then presenting, good energy-efficiency opportunities to small commercial accounts. Utility and state program experiences with HVAC contractors reveal that, apart from the approximately top 10%–20% of contractors in a given region, most contractors are caught up with day-to-day challenges and issues in running their businesses and selling services. It takes significant time and effort to engage these contractors in utility tune-up programs and equipment replacement programs where the program connection to their economic motivations is already clear and simple. The program premise here that contractors will want to use this packaged approach to create and deliver building assessments, where there is a longer term correlation to their economic motivations, will need to be further tested. There are two other elements that will need further testing and refinement to demonstrate a practical program approach. The first is the ability for HVAC contractors to understand, and then of course document and assess interval load data. It may be that the top performers within a given region are already cognizant of how interval load data works and can readily embrace the data collection and documentation element. Other utility- and state-level HVAC program experiences reveal that most contractors have difficulties understanding utility data and bills. The other element that will benefit from further research is the assumption that HVAC contractors will have the motivation and interest to collect and assess building energy use for non-HVAC equipment, such as lighting and building envelope measures. While the logic of giving a contractor the means to present HVAC equipment or repair opportunities to customer accounts is sound, the assumption that those beyond the top 10%–20% will be interested to take these responsibilities on is less clear.
- The presentation did not address the potential for abuse by contractors in the approach, nor did it focus enough on evaluating the actual performance of buildings first in order to focus on those most in need of energy upgrades. An ENERGY STAR rating should be a prerequisite.

### C. Accomplishments/Progress

This project was rated **2.6** for its accomplishments and progress.

- For a project that only started in October 2013, the selection of pilot program participants is excellent. But there should be a broader reach to other areas of the country.
- The progress is good/outstanding, but it is still a bit early in the project. The project features clear evidence and plans to overcome barriers.
- The demonstration of accomplishments and program progress to date is clear and appears quite appropriate.
- It is early in this project and all tasks seem to be on track.
- The process to date is reasonable, but it would have been helpful to look more into other BTO project activities and merge some of them into this process as part of the business approach. For example, it could

be useful to consider the use of Open Studio to benchmark each building and provide areas or systems in the building that appear to be underperforming.

#### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **2.4** for its collaboration and coordination with relevant stakeholders.

- The collaboration with demonstration partners seems good. A number of relevant tech transfer partners have been identified.
- Coordination exists; however, there are many opportunities for further collaboration opportunities: (1) industry trainers and (2) industry contractor associations, which are hungry to develop similar canned training programs, such as Air Conditioning Contractors of America, Mechanical Contractors Association of America, etc.
- It will be helpful to the program design and success if further research can be undertaken (as budget and time allows or can be expanded) to test the program concept and package with other HVAC contractors in other parts of the country apart from the small group identified in the presentation. It could serve a dual purpose if a regional organization (e.g., Western Performance Alliance, Consortium for Energy Efficiency, or Northwest Energy Efficiency Alliance) could be invited to review this program and in turn invite members to assess or test the package concept with individual contractors.
- This project is not too far along, so it is difficult to assess how effective it could be; however, the experience with contractors is that they will not be reliable partners in such an approach and not the ideal partner with whom to collaborate. It may be better to encourage cities and/or utilities to provide these services as well as providing some oversight or performance assessment of the contracting of improvements.
- The project's presentation at the BTO Peer Review is allowing more participation in the project. Expanding to additional contractors outside of the California Bay area will improve the project and its acceptance throughout the country.

#### E. Proposed Future Work

This project was rated **3.2** for its proposed future work.

- There is a clear path demonstrated on project activities to date, and how the activities relate to future tasks and products.
- This is a relatively short project, and future plans are laid out well enough at this point in time.
- Progress is moving forward with the tools to review potential energy savings with specific contractors. The general methods of selecting new contractors will overcome the issues of initially using a small location segment.
- At this early stage, the approach to mainstreaming the program is correct, but whether or not it can be effective is in doubt.
- One reviewer did not enter a response.

#### Project Strengths:

- Strengths include the following: (1) there is a significant need for a credible toolkit for contractors serving smaller, unaffiliated commercial buildings; (2) this project is a relatively low-cost way to create a tool that industry can use as a starting point for "Energy Expert" curriculums for the contracting base; (3) no new technology is required; and (4) there is no/low risk.
- The approach has identified a good opportunity and some relevant barriers. Tools and techniques identified are appropriate and effective. Conceptually, without regard to cost, much of this project's objectives could be achieved.
- The fundamental concept is good—to find a way to provide an energy management/improvement program to small buildings that cannot justify supporting one on their own. Standardizing analysis and benchmarking of small buildings would be very helpful in moving this segment of the building sector into more energy-efficient operation.



- The strength is the use of existing HVAC contractors to identify the potential energy savings. They are in the small commercial buildings often through their maintenance agreements.
- The project design is an effective mix of publicly available resources, and it intelligently leverages them into a single, meaningful package.

#### Project Weaknesses:

- This project has some weaknesses. (1) The robustness of the tools intended to be used was not clear, along with what exactly this package is going to be. (2) The project may be too ambitious in terms of contractor expectations. People work very hard to market the Database of State Incentives for Renewables and Efficiency (DSIRE) website, but few contractors ever use it. It will be a stretch to expect a significant percentage of non-design-build contractors to do much here. However, if 5%–10% engage over the next few years, it will be impactful. (3) There will be much more opportunity for industry collaboration when it is time to roll out and train contractors. This project was not as clearly thought out as it could have been.
- The package delivery mechanism through HVAC contractors is an unknown, and the premise will benefit well from further research and incremental testing. The following observation is a minor quibble, but it has enough merit to point out—project materials should avoid the use of incandescent bulbs in their graphics (e.g., as shown in the “Energy efficient checklist for small businesses” on slide 7 of the presentation). Respectfully to the project designers, this issue is a minor quibble in the bigger view, but the use of a compact fluorescent lamp or other graphic of an advanced efficiency technology further reinforces the messaging that the program is seeking to promote.
- The barriers addressed are just a subset of all of the important barriers. The approach greatly underestimates the barriers. The approach greatly overestimates the ability of contractors to improve enough to deliver the required level of service, or it underestimates what it will take to improve average contractor performance. The approach underestimates the drivers of contractors’ business that conflict with the goals of the approach.
- There are concerns about whether the approaches taken can be effective. Contractors may not be the right vehicle to implement such a program. The program should be more highly automated and perhaps regimented so that it can be supported by others who are more incentivized by performance outcome than by looking for work.
- The project’s weakness is using only two contractors for the pilot, which may not give enough data to determine the viability of the project.

#### Recommendations:

- This concept is great. The project team should offer support to original equipment manufacturers training departments to help rollouts. The team should not get hung up on trying to impose strict measurement results at the building level; if it gets a contractor to consider energy at a basic level in its proposals, that is a success.
- The team should consider revisiting Task 2 and redeveloping technical and business approaches. It should also consider a strong alliance with ENERGY STAR and Open Studio to assess actual performance benchmarks and provide preliminary (automatically) expected energy use targets and directions for improvements. Then the team should rethink who would be the appropriate partners.
- If budget and timing will allow, it could be useful to assess the merits of setting up the program delivery mechanics through distributors, wholesalers, and/or lighting vendors. While there are market challenges inherent with HVAC contractors, these market actors may possibly have deeper motivations and an equal/greater ability to offer a value-added service that the program premise suggests for HVAC contractors.
- The project team should expand the contractor base to at least four other geographic areas of the country with at least four contractors in each area.
- It is hard to envision the success of this approach. Going after all of the small energy saving opportunities in small commercial facilities is inherently a high-effort, low-return endeavor. Relying on on-site human labor to do customized analysis and fixes to inherently low-quality systems for small savings appears fundamentally uneconomic. At the conclusion of this project, the ultimate feasibility of this approach should be examined. The project team should consider an alternative approach that fundamentally



eliminates the need for on-site human labor doing customized analysis, fixes, and tracking of results, which will likely be a long-term effort involving (1) improved HVAC and other equipment, (2) improved building design and construction practices, and (3) highly automated smart systems that can maintain performance over time with minimal human intervention. (A good analogy is the vast improvement in automotive performance in the last 30 years that came from building quality in at the beginning and monitoring and maintaining performance with automation, not from training mechanics to become better at tuning carburetors.) This approach is inherently longer term, but perhaps with a better chance of success.

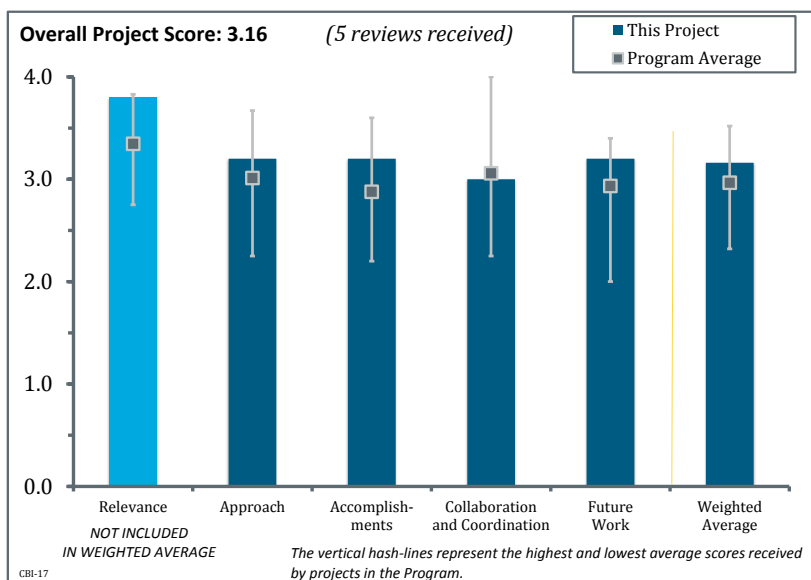
## Project # CBI-17: Rooftop Unit Suite

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### Brief Summary of Project

The purpose of the Rooftop Unit (RTU) Suite project is to improve the efficiency of packaged equipment using three targeted approaches. The project's major objectives are to develop a highly advanced energy efficient RTU, estimate the potential savings and field tests of advanced control strategies, and demonstrate a field-tested remote diagnostic tool for RTUs.



### A. Relevance

This project was rated **3.8** for its relevance to Building Technologies Office (BTO) goals and objectives.

- The RTU Suite seeks to embrace the technical barriers for reducing energy use and coincidental load by commercial rooftop package units. Increasing efficiency of new systems while simultaneously addressing the maintenance and energy efficiency of existing, older units is relevant to the BTO goals. The RTU Challenge may be one of the last final pushes toward pushing RTUs to the final tier of possible optimal performance. Richard Lord of Carrier Corporation had discussed at the American Council for an Energy Efficient Economy Market Transformation Symposium that single technology efficiency of commercial air conditioning has reached “max tech”; that is, it is wringing out the highest possible technical savings on units. Hybrid systems combined together that create a higher system-level energy efficiency ratio are likely the next technological goal. RTU Advanced Controls targets well on the significant amount of time when units are operating under part load, and leveraging BTO resources for moving this element of the marketplace forward makes strong sense. RTU Smart Monitoring and Diagnostics is a good path for introducing and configuring automated fault detection into the marketplace. The opportunity for such a system to expand into other smart grid applications makes it a viable investment for research resources.
- BTO made the case, well and often, about the role RTUs play in the building energy space. Similarly, the Office did a good job of explaining how the three efforts under RTU Suite each address different elements of the energy issue for RTUs; taken together, they are a cohesive response to an array of problems.
- With more than half of all cooled commercial buildings using RTUs, the project can clearly support BTO goals.
- Data is clear that rooftops have a strong influence on energy use and energy savings potential.
- This project features a good potential for savings, but there are uncertainties about the 2020 and 2030 predictions and the 3–5 year achievable potential. It would be helpful to better understand what the key variables are that affect the wide range of Advanced RTU Control savings indicated on slide 13, and the uncertainty on slide 16 to better explain why some sites saved 85%, while others only saved 20%. This explanation would be very useful for utility programs and to ensure cost-effective installations for owners. The 30% SMDS savings seem high—even the assumed 15% savings seem high and would be difficult to achieve in every RTU. It was unclear why deployment was across eight climate zones, especially when the savings will be focused on cooling savings. The reviewer wants to know if there is a plan to extend SMDS

to fans and cooling. It is unclear how field savings will be verified, and what the measurement and verification (M&V) plan is.

## B. Approach

This project was rated **3.2** for its approach.

- The RTU Challenge and Advanced Controls program designs appear to have clear, effective approaches toward achieving BTO goals and addressing market barriers. RTU diagnostic testing and tune-up has been a core business area for advanced handheld diagnostic tool vendors for a significant number of years, as has air conditioning industry use of the American National Standards Institute/American Society of Heating, Refrigerating and Air Conditioning Engineers/Air Conditioning Contractors of America Quality Maintenance 180 standards. Both elements will be helpful to investigate and assess for fit, as appropriate, within the SMDS program design.
- First, the fact that BTO brought together a few distinct initiatives under a single header is a great move. A common frustration for Ingersoll Rand, and industry more broadly, is the degree to which so many government efforts have overlapping areas of focus but are fundamentally disconnected. Here, not only are these efforts connected, but they are clearly meant to work in concert with one another. Many of the technological barriers were identified but other barriers remain.
- The RTU Challenge approach is outstanding; it clearly influenced industry product development. The advanced controller retrofit approach is fair/poor; field retrofitting variable frequency drives (VFDs) is a known technology. People are already doing it, and it is essentially code on new equipment. The value in the U.S. Department of Energy (DOE) developing a control/VFD package is uncertain when it already exists in the field. It is unclear what is new. The SMDS approach is good; there is definitely a need to create a low-cost, open-protocol, stand-alone device that can link information to the “cloud.” There are devices available already, such as Regen Energy’s add-on product. However, there is very little awareness of opportunity and a key enabler will be the open-source cloud technology presented in another project.
- It is easy to understand that cost is the most critical factor with RTUs, and the project team understands the challenge.
- Savings should be based on an RTU performance metric that can be field verified. The potential cooling, heating, and fan savings should be broken down for each climate zone to see if the integrated energy efficiency ratio focus is appropriate. The RTU Challenge lab test and field M&V plans should be made public. This reviewer is not sure DOE promotion should be done prior to the field demonstration; a PNW Rebel demonstration had an 86-year payback. The long-term plan for the RTU Challenge was unclear. A guide to EnergyPlus modeling of Advanced RTU Controls should be developed, and the EnergyPlus models should be made available. It is not clear how the Center for Energy and Environment work will be included. The reviewer wants to know if the field M&V plan, costs, and data will be made available in a form that can be useful for evaluation in other climates, and whether all of the products will be compared. The Advanced RTU Control costs are very low, resulting in very quick paybacks; it is unclear whether these are total costs, including Web-hosting.

## C. Accomplishments/Progress

This project was rated **3.2** for its accomplishments and progress.

- There is clear evidence of progressive, meaningful performance toward stated program goals across each of the three efforts.
- It seems that solid progress has been made to date. Ultimately, market penetration is the only target that matters. It is only in this way that true progress toward BTO goals occurs and can be measured. A path toward this end exists, but the RTU Suite has not really begun that journey in earnest yet.
- The RTU Challenge has made outstanding progress; it has met its goals, although the concepts of DOE-provided technical support are minimal/lacking and never really came to fruition. The Advanced Controller work has demonstrated fair/good progress. The progress of the smart monitoring diagnostic system (SMDS) is yet to be determined.
- It is unclear how the three projects are interconnected. It would be helpful to develop a guide—including how an owner, HVAC technician or utility should prioritize each of these RTU projects for a given RTU—

and an RTU performance metric that can be field verified. The progress and future of the RTU Challenge progress are unclear. Fiscal Year 2013 funding is very low for all three projects.

- One reviewer did not enter a response.

#### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.0** for its collaboration and coordination with relevant stakeholders.

- This project features great collaboration with manufacturers.
- There are certainly collaborations, but it is unclear whether they were all appropriately inclusive. First, the RTU Challenge specification had minimal industry input. Second, the controls and diagnostics elements do not incorporate the voice of the customer sufficiently. Lastly, while contractors were part of the collaboration for some areas, similar to diagnostics, it is uncertain whether the Challenge really considered whether contractors are interested in pushing energy-efficient products. That is an issue because DOE's own numbers state that approximately 82% of the market is to designers/contractors, not original equipment manufacturers (OEMs) to end purchasers. OEMs want to push energy-efficient products, but the motivation for contractors is less significant. Unless some of that 82% is brought onboard to push, there will be questions on how great the penetration will be by pull alone.
- The RTU Challenge features unprecedented collaboration. Well done! The Advanced Controller collaboration is fair/good. There are significant industry stakeholders around retrofitting VFDs on older equipment, which can lead to premature motor bearing failures. Perhaps DOE testing and analysis can eliminate that concern. The strength of collaborations on SMDS is yet to be decided.
- There is clear evidence of collaborative, market-based approaches across all three programs. An inquiry and further research, as appropriate, toward potential integration of the SMDS with vendors who currently produce, sell, and support handheld RTU diagnostic testing tools will be an effective contribution toward greater marketplace acceptance and adoption. Further research and investigation will be helpful to better understand the degree of acceptance and adoption by service vendors and building owners for the SMDS. The model, as presented, appears logical and sound. From practical experience, both vendors and building owners make day-to-day business choices that appear to run counter to economic logic, so any behavioral research on acceptance and use of these systems will be valuable.
- Better utility collaboration could help with the success of these RTU projects. Determining results, guides, and information from these RTU projects would be useful for utility programs and could significantly improve the tech transfer and market impact. The project features excellent ECAM use and enhancement.

#### E. Proposed Future Work

This project was rated **3.2** for its proposed future work.

- Clear evidence was given in the presentation of how the program design will address goals within the budget and forecasted timeline, and how these efforts are visualized to be eventually integrated into the marketplace.
- The comprehensiveness and logic of the plan are very strong. However, the project team should think through more of the market implications that are non-technical.
- Now that an Advanced Controller and SMDS are "available," the presentation was not really clear on what the specific plans are to do with them. It is unclear how they will be deployed, if they will be open source, if it will be licensed, who will be approached, etc.
- Project integration and tech transfer plans were unclear. It was unclear how these RTU projects integrate with the RTU Network project. The team needs a plan for future ECAM training and support.
- One reviewer did not enter a response.

#### Project Strengths:

- One strength is how the team is focusing on low-cost improvements (controls) with challenging manufacturers to produce a more efficient and affordable RTU.

- The degree to which the overall approach touches on a number of obstacles and approaches the market accordingly is impressive. This holistic approach should be a guide to future BTO efforts.
- The program presentation clearly revealed a logical, systematic approach toward achieving BTO goals; addressing known market barriers for cost-effective replacement of older, existing RTUs; and achieving effective control and optimization of existing systems.
- Strengths include good potential for savings, use of laboratory resources, and ECAM support.
- RTU Challenge was a refreshing, collaborative approach that appears to be getting good traction.

#### Project Weaknesses:

- There are two main weaknesses: (1) **Cost:** the Challenge specification has no cost-effectiveness criteria. While many OEMs will bring products to market as a result of the Challenge, it is unclear how the market will react. The fact is, there are premium efficiency products today and they hold a very small share. It is unclear whether the goal is to have more efficient products hold that same small share or grow the share. The goal should be the latter, but cost is a factor and should be treated as such. On the diagnostics, the costs were misrepresented. Saying the device is \$250 is great, but the device without the service has little value. If the service is \$50/month, that significantly impacts the return on investment and payback period. If this question had not been asked during the peer review, that fact would not have even come out. The project team needs to acknowledge the true cost and look to overcome whatever barriers may be associated with it, not obfuscate it. (2) **Non-technical barriers:** Contractors are critical players to get onboard; without a strategy to secure their buy-in, widespread market relevance will be hard to achieve. The community is diffuse, which makes collaboration difficult, but it is too important to ignore. Also, financing energy efficiency, specifically for the light commercial space, is tricky in large measure due to split incentive issues. While it is unfair to say this effort should fix this issue, the fundamental disconnect between who pays and who benefits will continue to hamper the uptake of efficiency, especially efficiency as a service, for these building types.
- The Advanced Controller and SMDS “feel like” technology programs that DOE really wants to get commercialized, but there does not seem to be much pull from industry. It begs the questions of what is missing and why there is not more pull.
- The technical applications within each program design are sound. Further research into both the current market situation for diagnostic testing and vendor/end-user market behavior for the application/integration of SMDS will be useful and beneficial.
- This project needs to do more to get beyond manufacturers and work more closely with end users to achieve results.
- This project needs better integration, a better tech transfer plan, and better utility collaboration.

#### Recommendations:

- This project features great intentions. There is good talent thinking about this, and the project has made great progress. The approach to industry collaboration is very effective, i.e., Retail Alliance. Hopefully there will be more of this collaboration going forward.
- In many ways, DOE is working to bring new technologies and approaches to market. DOE should work with industry to consider how new business models could emerge from this suite of technologies. There are questions on whether this approach can get around split incentive issues, and whether RTU efficiency as a service can be a sub-market on its own. There is great potential with what RTU Suite is doing, but it will not just get incorporated into standard business practice because it is good. Basically, a host of parties need to see how they can make money off of this approach. If DOE can aid in that effort, progress will happen more quickly.
- The team should develop guides and information from these RTU projects for owners, HVAC technicians, and utility programs. There needs to be a better understanding of the key variables that affect savings. Savings should be based on an RTU performance metric that can be field verified. Future ECAM training and support are also areas of need.
- Two reviewers did not enter a response.

## Project # CBI-18: Rooftop Unit Campaign

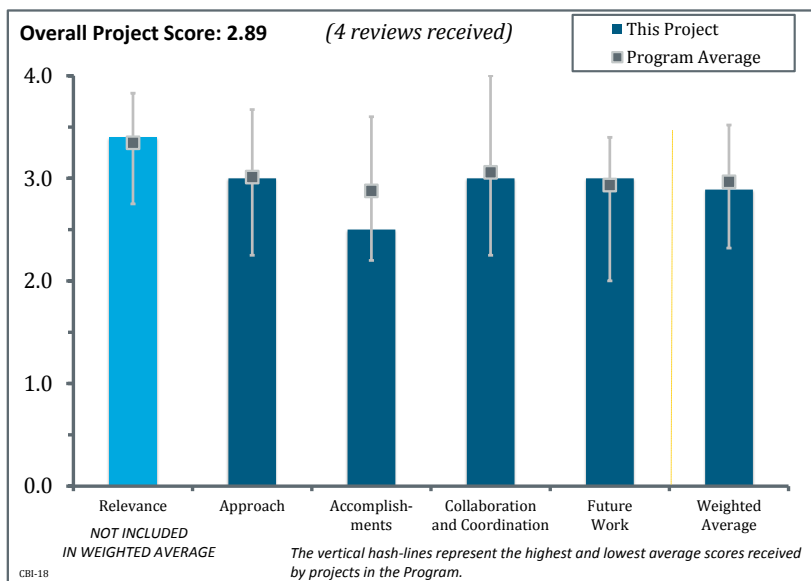
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### Brief Summary of Project

The project's goal is to recruit building owners and operators to deploy high-efficiency rooftop unit (RTU) technology in the market. The project's objectives are to design the campaign; recruit stakeholders for participation; develop the program, finance, and measurement/verification plans; and report results of the installations to stakeholders.



### A. Relevance

This project was rated **3.4** for its relevance to Building Technologies Office (BTO) goals and objectives.

- Given the large number of RTUs in this country that are ripe for replacement, this project is potentially critical for BTO objectives to be achieved.
- The project makes a very compelling case for rooftop early retirement and has very good intentions.
- The market deployment element is a key final link in the chain for the RTU Suite. The partnerships formed to date bode well. However, the absence of the contractor community is a key defect.
- A national RTU initiative is needed, but this initiative is very confusing. This reviewer had the following questions: Does it only address cooling savings? Is it the RTU Challenge? Is it advanced control retrofits? Is it Consortium for Energy Efficiency tiers? How can retrofitting or replacing one unit provide the scale of savings needed? Will savings be verified? The Rebel unit is shown in the first slide screen shot, and one Rebel field test showed an 83-year payback. How can cooling savings achieve 50% RTU savings? More than 70% of advanced control retrofit savings are due to fan savings.
- One reviewer did not enter a response.

### B. Approach

This project was rated **3.0** for its approach.

- The multi-prong, multi-partner approach is a good one. There is little integration with other efforts at this time beyond others under the RTU Suite umbrella. The team should consider how this effort could link to others to maximize visibility. Also, technical/financial barriers are mentioned, but are addressed only in general terms.
- The approach is well thought out and conceived, but expectations should be clear. This project will only build awareness, but it is uncertain whether it will actually drive any incremental behavior in the short term. The approach of providing “Good Citizenship” recognition for replacing units is noble, but it is not an economic motivator to drive behavior beyond people who will do this anyway. It can be effective at calling attention to the opportunity, but that is about it.



- The project has created campaign resources to clearly address both technical and market barriers. Critical success will depend on the degree of market awareness and acceptance (i.e., demand). It was unclear as to what level of production commitment popular RTU manufacturers have suggested they would support (to create stock units), at least initially.
- This reviewer does not recommend launching this effort until it is well thought out. It was unclear whether this project involves only cooling savings, if it is the RTU Challenge, if it involves advanced control retrofits, and if it involves CEE tiers. It was also unclear how retrofitting or replacing one unit can provide the scale of savings needed, and whether savings will be verified. It is not reasonable to expect owners to sign up on the website because it would be design engineers that may look for resources, not owners. It was not clear how the awards will be conferred; including whether there will be a certificate for retrofitting or replacing one unit. It was also unclear why heating, ventilation, and air conditioning contractors are not being targeted. (The installers of the Rebel unit with the 83-year payback needed a better understanding of optimizing the settings for energy savings.) Launching in May does not give much time for replacing RTUs—only emergency retrofits are done during the cooling season or winter, and if they are replaced in the fall, that does not give much time for successful case studies. It is not clear what successful case studies will consist of, whether it is just that someone signed up or did they verify savings? The reviewer also questioned how cooling savings can achieve 50% RTU savings.
- One reviewer did not enter a response.

### C. Accomplishments/Progress

This project was rated **2.5** for its accomplishments and progress.

- N/A—this project is just kicking off.
- This event has not launched yet. A good rating is appropriate, given where it stands, but meaningful feedback cannot be provided about the project just yet.
- This project is just starting; time will tell.
- This project does not seem thought out very well—the comprehensive participant recruitment plan was not well explained. The project team should specify whether this will be marketed nationwide, even though there will be limited financing resources.
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.0** for its collaboration and coordination with relevant stakeholders.

- In addition to large portfolio owners (e.g., Target and Walmart), the project has demonstrated successful engagement with several RTU manufacturers, organizers, supporters, and participants. These engagements form a foundation for success; it remains to be seen if the market will respond accordingly.
- There is a high level of collaboration here; this is good because the initiative is predicated on this. However, the market impact is ultimately about decisions. While there is a “retrofit/retire” focus, the overall “ask of the initiative” needs to be better defined. It is unclear what the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE); RILA; original equipment manufacturers (OEMs); and the U.S. Department of Energy (DOE) will ask building owners to do. It is unclear if these entities are asking them to replace/retrofit, or to examine their systems. There needs to be a simple, coherent message for all parties to deliver any time the initiative is discussed.
- ASHRAE, RILA, and the Building Owners and Managers Association (BOMA) seem like good partners, but this reviewer is not sure they will drive retrofits. All utilities need to be included for a nationwide campaign.
- Because the program is launching next month, more collaboration with OEMs would have been expected by this point, particularly RTU Challenge members. OEMs have big incentives to accomplish this goal, as well as tools and structures in place to sell and promote high-efficiency planned replacements. The project team is encouraged to leverage OEMs.
- One reviewer did not enter a response.



## E. Proposed Future Work

This project was rated **3.0** for its proposed future work.

- The project's proposed future work plan addresses monitoring and feedback for anticipated project barriers.
- This project receives a rating of "fair" only because right now it is all future work, really. The effort could benefit from thinking about how to leverage successes early on to speed information sharing on what works and what does not.
- This effort should not launch until it is well thought out. There were questions about whether the project involves only cooling savings, if it is the RTU Challenge, if it involves advanced control retrofits, and if it involves CEE tiers. It was also unclear how retrofitting or replacing one unit can provide the scale of savings needed, and whether savings will be verified. The expectation that owners sign up on the website may not be reasonable because it would be design engineers who may look for resources, not owners. There were questions about how the awards will be conferred, including whether there will be a certificate for retrofitting or replacing one unit. Launching in May does not give much time for replacing RTUs—only emergency retrofits are done during the cooling season or winter, and if they are replaced in the fall, that does not give much time for successful case studies. It is unclear what successful case studies will consist of, whether it is just that someone signed up or verified savings. It is unclear how cooling savings can achieve 50% RTU savings. More than 70% of advanced control retrofit savings are due to fan savings.
- Two reviewers did not enter a response.

### Project Strengths:

- The strengths are the high degree of collaboration and focus on rounding out the RTU Suite efforts at the implementation level.
- This project addresses a very compelling need, is well documented, and is a huge opportunity.
- ASHRAE, RILA, and BOMA seem like good partners.
- Two reviewers did not enter a response.

### Project Weaknesses:

- The project has the right intent; it just stops short. Perhaps this shortcoming is all that can be expected in this budget environment. To really move the needle, this concept needs to be coupled with policy-driven economic incentives.
- Two main weaknesses were identified. (1) **Contractor involvement:** approximately 82% of RTU sales are to designers/contractors. They are the face to the customer, not the OEM, not the Retail Industry Leaders Association (RILA), not ASHRAE. If some of the people actually making the sales are not brought on board, all the other parties can push their hardest, but traction will be hard to come by. There should be consideration of working with OEMs to have them provide tools to the contractors they work closely with, specifically those that are most able and interested, to help them capitalize on this effort. (2) **Customer segmentation:** The high-level statements on barriers are fine, but no one disagrees with them and they have been around for a very long time. The trick is being able to identify, early in the sales cycle, which of the barrier(s) is applicable to the potential customer, as well as having the right response to address the barrier. This reviewer calls this concept "customer segmentation" because applying some heuristics could help this along. For example, if there were data saying retail customers tend to be more concerned about realizing savings than financing (hypothetically), then sales people and others approaching that space should be armed with information on case studies and empirical data on success. The point is, stating all of the barriers is only useful if clever ways to overcome them are devised and the tools needed to do so are provided.
- This project does not seem to be thought out very well. There were questions about whether the project involves only cooling savings, if it is the RTU Challenge, if it involves advanced control retrofits, and if it involves CEE tiers. It was also unclear how retrofitting or replacing one unit can provide the scale of savings needed, and whether savings will be verified. The expectation that owners sign up on the website may not be reasonable because it would be design engineers that may look for resources, not owners. There were questions about how the awards will be conferred; including whether there will be a certificate for

retrofitting or replacing one unit. Launching in May does not give much time for replacing RTUs—only emergency retrofits are done during the cooling season or winter, and if they are replaced in the fall, that does not give much time for successful case studies. It is unclear what successful case studies will consist of, whether it is just that someone signed up or verified savings. It is unclear how cooling savings can achieve 50% RTU savings. More than 70% of advanced control retrofit savings are due to fan savings.

- Two reviewers did not enter a response.

#### Recommendations:

- This project features a great team, good collaboration, and great alignment across all stakeholders on the need and opportunity. One suggestion for further/complementary work: there is a big opportunity to leverage utility rebates. The Database of State Incentives for Renewables and Efficiency (DSIRE) site is a good step, but rebates are still so confusing and inconsistent that it is impossible to drive a national (or even regional) marketing message around them. DOE could add a lot of value by creating some kind of a rebate “clearinghouse” with a rebate calculator into simple building software tools.
- A national RTU initiative is needed, but it needs to be clear, focused, include all utilities, and longer than a year and a half to be effective in transforming the market. The project team should consider targeting HVAC contractors, who would be the “boots on the ground” for selling and installing energy-efficient RTUs and retrofits. The campaign could be “save now with utility incentives, save later on your energy bills, and save the earth.” Certificates could be provided to the contractors, similar to Leadership in Energy and Environmental Design (LEED) ratings—platinum for achieving more than 95% energy-efficient RTUs and retrofits, as a percent of all of their installations; gold for more than 90%; silver for more than 80%, etc. Similar to Portfolio Manager, they would have to hire a professional auditor to verify the percentages.
- Three reviewers did not enter a response.

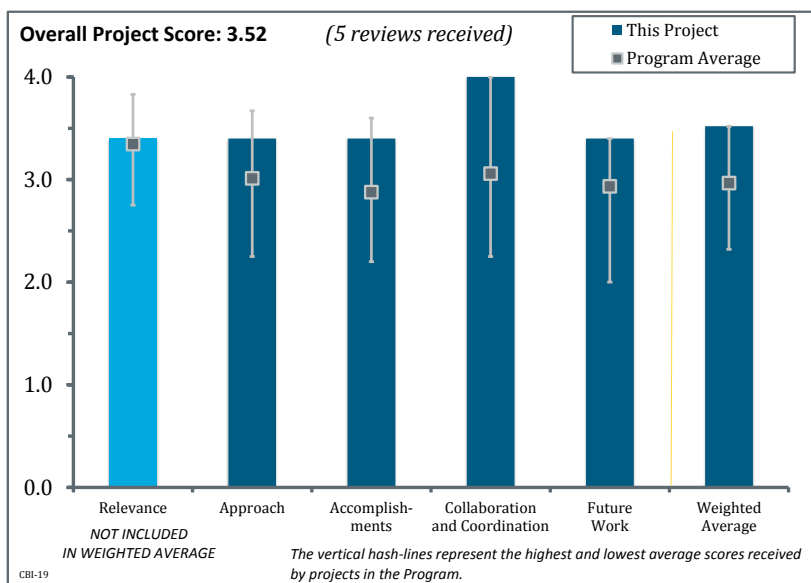
## Project # CBI-19: Retrofitting Doors on Open Refrigerated Cases

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### Brief Summary of Project

The primary goal of the project is to encourage retrofits in open commercial refrigerator cases to reduce energy consumption and increase consumer comfort in retail locations. Specific objectives are to develop and disseminate best practices guides, demonstrate cost/performance benefits, and promote the technology and practices through multi-party collaboration.



### A. Relevance

This project was rated **3.4** for its relevance to Building Technologies Office (BTO) goals and objectives.

- The Retrofit of Medium Temperature Doors project is highly relevant to the goals of the Commercial Building Partnership (CBP). The intent of this program is to enable the members to share and collaborate on best practices with the overall goal of saving energy. Retrofitting of medium-temperature doors has a large impact on energy of commercial refrigeration savings as well as the environment. The adoption of medium-temperature retrofit doors is worthy of support, and the 2.5-terawatt-hour annual energy savings potential seems valid. Future funding of additional retrofit guides similar to the Door Retrofit Guide would be very valuable for the industry to share the best practices of those who have already adopted the technologies with those who may not be utilizing them yet.
- The projected load reduction of 50%–80% by adding doors to open refrigerated cases is extremely relevant to the overall BTO goal of encouraging energy savings.
- The project is relevant in that it is focused on research and results for addressing barriers to implementation of a mature technology, not research for improving the technology itself.
- The presentation clearly presented energy opportunity.
- Good project with good savings potential.

### B. Approach

This project was rated **3.4** for its approach.

- The approach for this project was very well executed. The refrigeration project team was able to invite collaborators and contributors from the end user, design, and original equipment manufacturer (OEM) communities to collaborate on the most effective strategies to retrofit doors and save the most energy, all on an unbiased platform sponsored by the CBP. The CBP forum allowed the project team to meet regularly, discuss differing points of view, and incorporate concerns or ideas from all stakeholders. The quality of the retrofit guide is very good. The guide incorporates sufficient technical and practical information so that it can assist a door retrofit novice in the decision-making process with the best facts and best practices. It is highly feasible that this project could have a huge impact on energy consumption.

- The project plan includes an extensive description of how key stakeholders are being engaged. Collaboration with these stakeholders (and measurement and tracking and resolving of issues) is a component of the approach.
- Barriers to the technician population retrofitting the doors on open cases are perfectly addressed in listing all of the potential component issue and then detailing the ways to review and implement the installation of the new doors. The project's design feasibility and integration is illustrated in the full November 2012 report.
- The approach is well thought out. There is good stakeholder input; stakeholder feedback appears to be very supportive.
- This project features good collaboration with Better Buildings Alliance, RSES, ACHR, and manufacturers. The guide and calculator will be helpful. The project team should combine with light-emitting diode (LED) case lights and occupancy sensor control with case door retrofit.

### C. Accomplishments/Progress

This project was rated **3.4** for its accomplishments and progress.

- Successful publication of the November 2012 Refrigeration guide document represents a key milestone accomplishment. Careful dissemination of the guide document (by collaborating with RSES, utilities, and other efficiency organizations such as the American Society of Heating, Refrigerating and Air-Conditioning Engineers [ASHRAE]) will improve exposure.
- The accomplishment of this project was to publish the design retrofit guide. This goal was achieved in a timely manner and the quality of the deliverable is very high. It would be interesting to see a quantitative report on how many downloads of the retrofit guide have happened since it was released, and also how many end users have effectively used it.
- The report published in November 2012 is still in the distribution stages through refrigeration industry publications and trade associations. Moving forward, the distributed information will become an invaluable tool for the refrigeration industry to properly evaluate the potential of door replacement and the proper installation of the doors.
- It appears that content development is essentially complete and the project is moving to the adoption stage.
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **4.0** for its collaboration and coordination with relevant stakeholders.

- The project staff did an outstanding job of collaborating and coordinating with industry on this project. They invited the key stakeholders that manufacture, install, and promote the doors to participate. The team also included design engineers and end users who often have different motives than the OEMs. The development of the guide was completed by considering input from all of the stakeholders and selecting the best ideas for incorporation. Because this guide was released under the CBP program, it has more credibility than other similar guides that have been released by industry. Because many stakeholders were involved and not just OEMs, the end users are much more likely to accept the information and incorporate it into their retrofit plans.
- The project presenter did a very good job of explaining how key stakeholders are being engaged to support the project. A key implementation method may be the (pending) approval of this technology as a deemed savings measure attributable to savings aggregated by San Diego Gas & Electric's energy efficiency program.
- The November 2012 report will be reproduced and used to develop articles for trade journals. The report will also be distributed to refrigeration companies by trade associations and labor unions to enhance the quicker use of the guide. The project features good use of retail alliance members. Large stakeholders clearly had significant input.
- The project features good collaboration with BBA, RSES, ACHR, and manufacturers. A webinar for utilities would be helpful.

### E. Proposed Future Work

This project was rated **3.4** for its proposed future work.

- The proposed future work includes promoting the guide to industry and key users of the guide that were not original members of the CBP team. This is an outstanding plan because the avenues that have been selected for marketing of the guide are the main channels where the industry looks for new ideas. The plan also includes working with utility companies to implement incentives on a prescriptive basis for this technology. This work will further aid the rapid adoption of the technology for consumers with financial barriers.
- The guide will be used as a vehicle to explain the benefits of installing doors on open refrigerated cases and to develop programs that utilities can implement to achieve the BTO goal of saving energy.
- The case study will be helpful.
- The future work is limited, focusing mostly on getting utility approvals to include the measure in designs for incentive programs. The success of this distribution model will have a significant effect on market penetration.
- One reviewer did not enter a response.

#### Project Strengths:

- This project's strengths include (1) its highly collaborative partnership with industry, government, end users, and OEMs; (2) its effective and streamlined communication to influence best practices in design to capture energy savings; (3) that it is a reliable and trustworthy source of information, not a "sales pitch"; and (4) its effective marketing plan to convey the information to stakeholders beyond the CBP team.
- The project drew upon a number of supermarket case system manufacturers to develop the knowledge necessary to project potential savings. The supermarket industry has known for an extensive period of time that open case systems use extensive amounts of energy. The original open cases actually used three systems to control product temperature: the refrigeration system to maintain product temperature, the air curtain to restrict the influx of air into the refrigerated system, and a heating system to keep case aisles at comfort levels for the customer. Doors on cases remove two of the systems and reduce losses by the product cooling system. Case manufacturers have known of this advantage for years and now are assisting in its implementation.
- This effort is a well-documented savings opportunity substantiated by common sense and science. The project has clearly demonstrated progress toward its goals and features strong stakeholder engagement and support.
- This project is a good measure with good savings potential.
- One reviewer did not enter a response.

#### Project Weaknesses:

- There are some barriers that need to be overcome by industry for wide-scale implementation of the technology, such as misperception about the impact on sales. The project team could further develop an analysis on sales impact due to door retrofits to provide data to the end users. The project really only addresses door retrofits and should include a bit more information on promoting ordering of new systems with doors vs. open.
- The only weakness of the project is the minimal use of contractors and technicians from the construction/service field. A suggestion is to add additional field technicians to any future work.
- This project features good collaboration with BBA, Refrigeration Service Engineers Society (RSES), Air Conditioning, Heating and Refrigeration (ACHR) News, and manufacturers.
- It kind of seems like the work is done. It is not clear exactly what is left to do other than cheer it along.
- One reviewer did not enter a response.

### Recommendations:

- Great work by the team; further adoption of door retrofits is anticipated to save both energy and the environment.
- The presentation noted that supermarkets are driven by a few number of very large chains, such as Walmart, Target, etc. It begs the question of why they cannot drive the adoption of door retrofits on their own, if the need is so important. If one of the large players makes an aggressive move to install display doors, the rest of the industry will move in that direction. It is unclear why DOE efforts are really required if this is such a compelling business case.
- A webinar for utilities would be helpful.
- Two reviewers did not enter a response.

## Project # CBI-20: Technology Specification Deployment

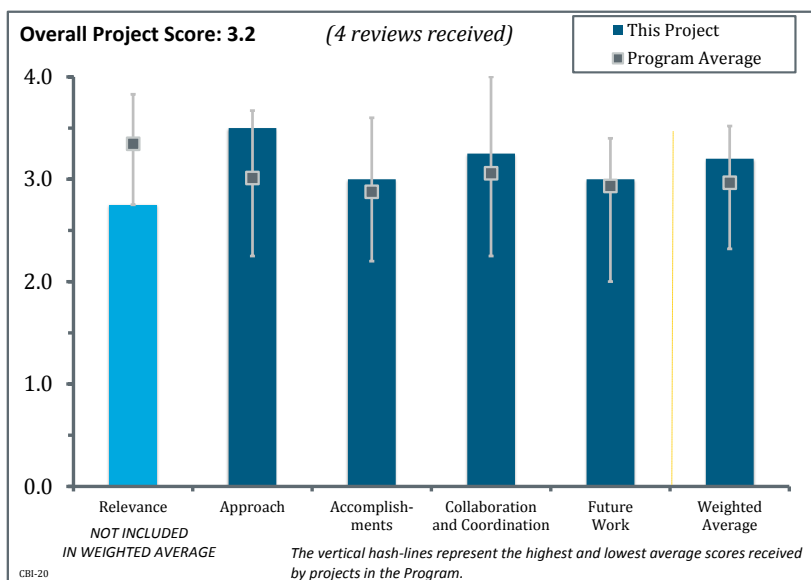
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Kristen Taddonio, U.S. Department of Energy, Kristen.Taddonio@ee.doe.gov

### Brief Summary of Project

This project seeks to reduce commercial appliance energy consumption through the development of performance specifications for appliances that currently have none. Specific project objectives include identifying commercial building technologies with high energy savings potential, developing performance specifications, conducting field demonstrations, and collaborating with stakeholders to ensure technologies are of interest to end users and manufacturers.

#### A. Relevance



This project was rated **2.8** for its relevance to Building Technologies Office (BTO) goals and objectives.

- The strategy of identifying key energy efficiency technologies that are unclassified (or under classification) is solid. Creating standards around technologies that have not been addressed helps to create a holistic approach to building efficiency and fills gaps in areas where potential load reduction exists.
- The project provides a focus on non-major building system components and serves as an adjunct for ENERGY STAR.
- These specifications do not seem to be measures with large nationwide savings potential, but they fill gaps.
- One reviewer did not enter a response.

#### B. Approach

This project was rated **3.5** for its approach.

- The project features a good approach in terms of defining a baseline, qualifying products, and savings, and aligning with utility programs. It would be good to have a webinar for utilities on these resources. Also, it is unclear how technical the case studies will be, or how rigorous the measurement and verification (M&V) will be, or whether best practices or lessons learned will be included.
- The approach features a targeted focus on specific equipment and options (e.g., advance vs. challenge specifications).
- The approach to identify the product categories that could deliver incremental energy savings potential is good. However, there appeared to be very little information or knowledge of the installed base or the costs associated with some of these retrofit opportunities.
- One reviewer did not enter a response.



### C. Accomplishments/Progress

This project was rated **3.0** for its accomplishments and progress.

- This project has good Web resources, and the case studies will also be positive.
- The project features a limited reach, but it has been effective.
- The project has made fair progress on stated benchmarks for the program. However, this reviewer questions if the benchmarks were set correctly.
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.3** for its collaboration and coordination with relevant stakeholders.

- Major manufacturers were listed in each of the five product categories that are targeted. However, no information was presented on the percent of the installed market that those companies represent.
- The extent of utility involvement is unclear; it would be beneficial to have a webinar for utilities on the resources available.
- Two reviewers did not enter a response.

### E. Proposed Future Work

This project was rated **3.0** for its proposed future work.

- Field evaluations and working with utilities for incentives are important to move the needle.
- In order to be effective, the project team has to have a better grasp on the market size, load reduction potential, and costs of retrofit. The team provided \$5,000–\$10,000 in energy savings depending on the refrigerated case doors, but it is unclear if that savings is delivered after a \$20,000 investment by the owner or a \$120,000 investment. Those factors will have a direct impact on the level of adoption of the program.
- The case studies will be good, but it is unclear how rigorous the M&V will be, or whether best practices or lessons learned will be included.
- One reviewer did not enter a response.

### Project Strengths:

- One strength is selecting equipment that is overlooked. Fume hoods can make a huge impact, especially with schools and colleges.
- Potential incremental load reduction is high because these five equipment categories are typically overlooked and appear to be substantial energy users.
- This project has a good approach in terms of defining a baseline, qualifying products, savings, and aligning with utility programs.
- One reviewer did not enter a response.

### Project Weaknesses:

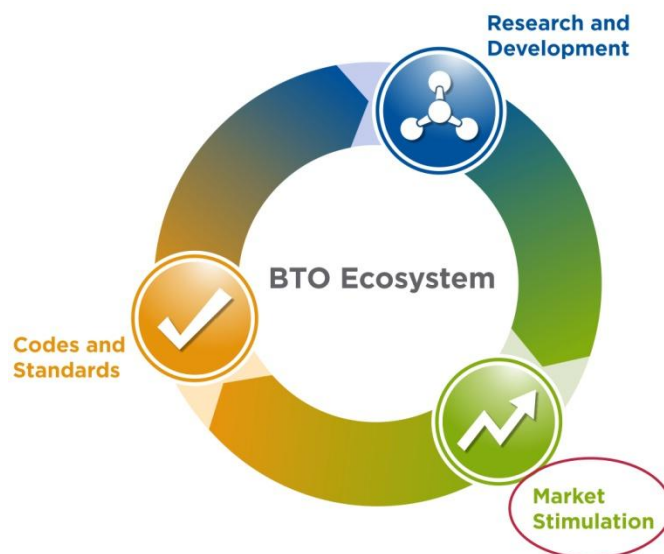
- The project mentioned little about the investment required for these technologies by the end user, or the ripple effect on the buildings' other systems if these programs are implemented. As an example, when installing doors on the refrigerated cases, it is unclear what impact that has on the heating, ventilation, and air conditioning load in a space. It is also unclear what impact that has on the compressor load of the cases. Maybe this reviewer missed something, but there did not seem to be specific detail on the energy impact on these conversions beyond "a lot." The presenter acknowledged that there will be a significant impact, which this reviewer agrees with, but the presenter did not appear to have much quantifiable information past that.
- There should be more focus on working with specific end users, especially with schools and colleges for fume hoods.

### Recommendations:

- The project should develop a webinar for utilities on these resources.
- It would be good to have two types of case studies: one purely marketing and one technical that includes rigorous M&V, best practices, and lessons learned.
- There needs to be specific modeling on the impact of these conversions. In order to invest in this program, “a lot” should not be sufficient. Benchmarks should be used to identify some fairly specific product investment numbers, the existing equipment modifications required, and the energy reduction delivered as a result of the conversions.
- Two reviewers did not enter a response.

## 5. Residential Buildings Integration Program Summary

The Residential Buildings Integration Program collaborates with home builders, energy professionals, state and local governments, utilities, product manufacturers, and researchers to improve energy performance in existing and new residential buildings. To identify cost-effective solutions that reduce energy consumption beyond minimum codes, the Program focuses on research and development activities, as well as innovative deployment approaches to disseminate information and accelerate the adoption of energy-efficient residential building technologies (see Figure 6).



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

By 2020, the Residential Buildings Integration Program aims to demonstrate at convincing scale that is cost-effective to reduce the energy required to operate new and existing residential buildings by 30% and 25%, respectively, using the IECC 2009 as a baseline, while improving overall indoor air quality, durability and comfort. For new homes, convincing scale is defined as 15% of new construction market in all Building America climate zones. By 2030, the Program aims to demonstrate at convincing scale that it is cost-effective to reduce the energy consumption of new and existing homes by 50% relative to IECC 2009, while improving overall indoor air quality, durability and comfort. To track its progress toward achieving this goal, the Program will analyze and evaluate the impacts of program-funded activities on building energy codes and standards, and on the residential buildings' market.

## Project # RBI-01: Building America

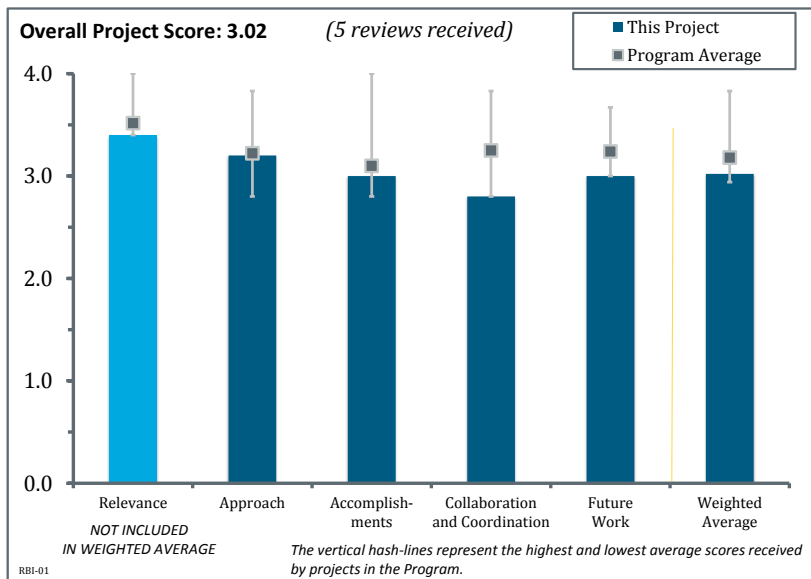
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### Brief Summary of Project

Building America is a unique research program that works and is cost-shared with industry, national laboratories, and research teams to accelerate the adoption of advanced building energy technologies and practices in new and existing homes. The project's goal is to achieve 30%–50% savings cost effectively by conducting critical home performance research with industry partners (including top U.S. home builders and contractors) in real-world homes. Research is conducted on individual measures and systems, new and existing houses, and community-scale housing to validate the reliability, cost effectiveness, and marketability of technologies in new construction

and home improvement projects. Building America innovations demonstrate improvements in home energy efficiency and performance (such as indoor air quality and durability) and have overcome market barriers to accelerate the transfer of building technology innovations to market. Top innovations are highlighted in 32 Building America Innovation Profiles and detailed guidance for implementing innovations are quickly, effectively, and broadly disseminated to building professionals using the Building America Solution Center, which provides expert building science information, guidance, drawings, and specifications. A preliminary project impact analysis suggests that Building America innovations have saved an average of about 5% annually on all homes built since 1995, a cumulative impact of more the \$6 billion.



### A. Relevance

This project was rated **3.4** for its relevance to Building Technologies Office (BTO) goals and objectives.

- There is a well-justified need for this project, based on the lack of industry investment in research and development (R&D), coupled with high potential customer savings and business impact. The project's focus on the business impact is important in today's economy and helps make the case for energy efficiency as a whole.
- Building America supports BTO goals and objectives through effective program management that takes the residential high-performance sector from research to product development to market transformation.
- Building America is a key component in driving improvements in technology and real-world R&D in the field, and the concepts explored through the program often find their way into other national programs.
- Building America has been, and will continue to be, a good investment in advancing energy efficiency through new technologies, building techniques, etc., and it supports the BTO goal of increased energy efficiency in new and existing residential construction.
- Building America stops short of influencing all potential entities and individuals that may be impacted by its work. The R&D projects are very effective for those directly involved.

## B. Approach

This project was rated **3.2** for its approach.

- The project uses a systems-based approach that clearly identifies the challenges and the technology or system gaps and needs. Value is placed on performance and on demonstrating an understanding and appreciation for the systems approach. The project has established a clear goal of reaching 50% savings in new and existing homes. It is impressive that code officials are finding value in the Solution Center—it is difficult to get code officials to embrace tools from outside resources.
- The primary barrier that is being addressed by this program is that industry is only investing in specific products to increase efficiency and is not looking at the building as a system. Building America is filling the void.
- Building America has identified some of the most significant opportunities to save additional energy in buildings, and it has focused on improving these areas through its program. While the focus appears to be on the right goals, the project could be better integrated with other U.S. Department of Energy (DOE) programs seeking the same goals. For example, additional dialogue with both code development as well as code adoption and implementation entities within DOE could bring significant benefits.
- There are two key influences not addressed by Building America that are critical to technology adoption: building officials and trade partners. When thinking of trade partners, it is important to consider all affected by the new technology, not just the trade installing or constructing the products. Both groups have pushed back in the past on new technologies.
- The project did not address the issue of barriers as sufficiently as could be expected. Low industry R&D investments and system-level risks are not the only risks out there. For instance, adding another labeling program (the Challenge Home program) to a crowded market could water down the intended results. Having Building America situated as an energy codes driver is confusing, given that many industry and government programs have been trying to play catch-up to the recent ramp-up of code stringencies.

## C. Accomplishments/Progress

This project was rated **3.0** for its accomplishments and progress.

- Significant progress has been made in developing methods, practices, and technologies that will assist the market in moving closer toward net-zero energy homes in the future.
- The concepts and practices explored by Building America are truly cutting edge. The program itself appears to have made significant progress in the design of more efficient buildings. However, one key barrier that seems to exist is the integration of what Building America does with other federal and private stakeholders in the building industry. Given the level of advancement demonstrated in the presentation, Building America should be part of every conversation about code development, adoption, and implementation.
- The progress to date has been steady and substantial. The path going forward is not so clear. Early improvements were highly cost effective and provided builders with an easy marketing opportunity. Going forward, the savings related to a technology improvement will likely be more costly, making it more difficult to gain widespread adoption. Builders are adverse to risk. When a new technology is shown to work, builders may still not be quick to adopt it because they want to see performance over time. To the extent possible, the Building America program needs to address this concern to accelerate adoption.
- R&D activities, even at this stage of development, are difficult to measure. Qualitative analysis shows that there is good adoption of the products from this program. Demonstrations show potential, but true adoption tends to be measured in other programs. Nonetheless, the progress made in this program has been very good and valuable.
- It is somewhat unclear what has been accomplished. Certainly the claim that Building America drives energy code development adoption is debatable. Overall, the program has been very successful, but it is unclear what was accomplished during this review period. The push toward existing buildings made sense.

#### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **2.8** for its collaboration and coordination with relevant stakeholders.

- The project's collaboration with entities directly involved in research is very good. Outreach and communication through builder-oriented events and conferences is also good. There is a question, however, about other potential stakeholders, building officials, trades, manufacturers, etc. All of these stakeholders can assist or stand in the way of innovation, and this should be addressed. This is a real-world concern.
- The collaboration seems strong. It is unclear whether the initiatives are reaching all of the audiences that they should, however. The program certainly has budget constraints, but there is too much good work here not to share it a little more fully. The five-year approach to selecting teams may limit opportunities, as sometimes things happen that might have gotten better traction if some new partners were allowed in the mix.
- Although the program staff appears to work well with some of the important stakeholders in the building industry, the connection is not yet perfect, and as a result, some of the innovative approaches explored by Building America may take much longer to find their way into the market than necessary. Much of the resistance to energy codes around the country is based on a lack of know-how. Building America could serve an important role in advancing building efficiency by educating builders and manufacturers on the effective use of building products.
- Building America can do a better job of information transfer, especially as it relates to developing solutions for energy code compliance issues. Certainly the development of new websites will go far in getting information to those who are already looking for these resources.
- While there has been movement within DOE recently to collaborate more fully with all industry players, there is still room for improvement in broadening input from relevant stakeholders.

#### E. Proposed Future Work

This project was rated **3.0** for its proposed future work.

- The targeted categories for 2013 should continue to provide solutions for builders to move forward toward net-zero energy homes.
- The project demonstrates a good understanding of the challenges in the marketplace. It is good that the team will do more work on existing homes, as that is where the real savings potential lies.
- As the energy codes continue to ratchet up, the next level of upgrades to reach increased efficiencies becomes increasingly more costly. This is a significant barrier that current technologies alone cannot readily overcome. However, BTO is on target by focusing on mitigating risks by providing alternate pathways. Builders prefer options that allow them to choose a path of compliance in a manner that is cost effective and affordable for how they build.
- Building America appears to be focused on a path toward net-zero energy, but it must work in collaboration with DOE's other code development and code implementation resources, as well as industry, in order to take these ideas into the market. For example, the slide demonstrating six different methods for containing ducts inside conditioned space was a true epiphany for at least one reviewer. The slide claims that "all [methods] are being adopted by builders across the country." This reviewer wonders why these options are not described in a national model or state energy codes. It seems that these approaches could solve many of today's problems if they were effectively communicated and integrated, not just in limited voluntary programs, but also in state and national codes. The path to improved energy performance is getting harder, yet the plan is to spend less going forward. DOE has not crossed the goal line yet and should not let up until the job is done. Market penetration must meet a critical mass to succeed, and that may require more than one geographic area.

#### Project Strengths:

- Building America is extremely valuable and important to the building industry. The typical homebuilder builds fewer than 10 homes per year. Thirty percent of all homes are built by the top 20 builders; the rest are built by mostly very small businesses. The small builder does not (and never will) have the resources to

conduct research. The project provides for a strategic partnership that drives innovation that otherwise would not happen, or that would at best take many more years to evolve. By taking the approach of whole-house impact and systems integration, the industry is learning how important it is to consider all of the impacts of an innovation. There is no other venue for this in the industry, and this is critical new learning for builders. The homes that are currently being built and will be built going forward are complicated and must be built correctly, or they simply will not work. The Building America program is critical to demonstrate this fact—one more reason that the program needs to maintain its overall effort, particularly in new construction.

- Clearly, the program's strengths are the research tools and program support. Providing technical expertise and innovations that actually work in the field are the main strengths in the program. The Building Science Solutions Center has the potential to assist a larger segment of builders directly in moving advanced technologies and practices into the mainstream.
- This is a well-thought-out program that focuses on real barriers. It has good alignment with other programs, and it has made a good impact throughout the ecosystem.
- The project appears to be advancing building energy efficiency in a logical, effective manner.
- Building America does a great job on testing new strategies for advancing energy efficiency, and it is a great investment of DOE funds.

#### Project Weaknesses:

- If adoption of proven technology is a core objective, then the program has missed opportunities to date to be more effective. Building code officials can and do deny the use of technologies that they are uncertain of or are not educated on. Little outreach is built into the program. Trades push back on new technology, especially if they perceive an increased risk. The project should speak with most heating, ventilation, and air conditioning contractors in the country about smaller designed systems and about designing systems based on building specifications. Adoption of new technology is not just about the technology, and all of the concerns from each and every stakeholder must be addressed to ensure success.
- The project could do more with technology transfer. The products of this program could benefit many parties that are currently not in the loop. This is likely due at least in part to constrained resources—which will require more creativity!
- The project must include more outreach and support to the broader building industry. Although voluntary programs may drive technology, state and local code adoption will advance slowly without the technical support of groups such as Building America.
- More outreach must be done to promote Building America innovations to the general builder audience, not just builders that are already building high-performance housing. In addition, more collaboration between Building America and the codes and standards teams must occur in order to start moving technologies into the code and to develop solutions for code issues.
- Building America's efforts to move the codes and standards process forward should be outside its scope, given that it is an above-code program. It would be better to apportion those dollars out of infrastructure development and back into the house as a system business case.

#### Recommendations:

- The project should promote a greater public face. This could include showing everyone the good work that is being done, developing education materials and outreach for building officials that describe proven technologies, and teaching consumers that they will get the best home from a builder that innovates and is constantly working to build a better home.
- The project should do more work with the existing homes sector.
- Three reviewers did not enter a response.



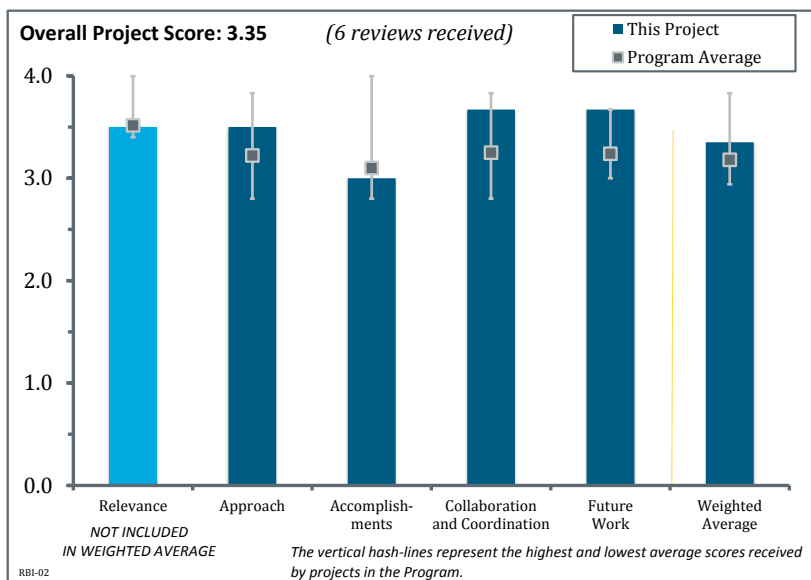
## Project # RBI-02: Challenge Home

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### Brief Summary of Project

Since 2008, the U.S. Department of Energy's (DOE) Builders Challenge program has recognized hundreds of leading builders for their achievements in energy efficiency—resulting in over 14,000 energy-efficient homes and millions of dollars in energy savings. The DOE Challenge Home, an ambitious successor to the Builders Challenge program, represents a whole new level of home performance, with rigorous requirements that ensure outstanding levels of energy savings, comfort, health, and durability. The DOE Challenge Home labeling program builds off of the the U.S. Environmental Protection Agency's highly successful ENERGY STAR

homes program by providing complimentary labels to recognize truly high-performance homes based on top innovations developed and demonstrated in the DOE Building America program. DOE Challenge Homes are verified by a qualified third party (the same verification infrastructure used by ENERGY STAR) and are at least 40%–50% more energy efficient than a typical new home. All DOE Challenge Homes are zero-net-energy ready and are so efficient that a small renewable energy system can offset most or all annual energy consumption.



### A. Relevance

This project was rated **3.5** for its relevance to Building Technologies Office (BTO) goals and objectives.

- Having a branded, defined “higher bar” for the residential new construction market is necessary to make rapid progress toward high-efficiency buildings. Costs of high-efficiency buildings will only come down if more high-efficiency homes are built. Using a systems approach, as this program does, is necessary to ensure incremental costs are justified by improved performance.
- Challenge Home supports the BTO goals and objectives through effective program management that takes the residential high-performance sector from research to product development to market transformation.
- Challenge Home provides an important bridge between beyond-code and beyond-energy use. Whether it could be effectively absorbed by Building America or Energy Star, it is important that at least one program keep an eye toward a net-zero energy future.
- The Challenge Home supports DOE's movement toward net-zero energy homes.
- The program is quite relevant and consistent with the goals of BTO. However, the problem statement identifies only the housing industry to be slow in adopting the new technology. This may not be the entire problem. It is very true that the U.S. housing industry is very slow to adopt new technology, but there are good reasons for this as well. For example, look at the use of solar panels. When this technology goes through ups and downs, the developers or homeowners may not see it as wise to invest in that technology. On the part of developers, distributors, or even some manufacturers, when there is a threat of litigation for any potential poor performance issue down the road, it is unreasonable to expect them to embrace the new technology and accept all the risks. Another example includes the low-e double pane glass manufacturer or developer who uses this “proven product” and is now liable if the reflected heat waves strike other buildings due to a potential convexity effect of the panes, which can cause damage to another building's

siding. In a society that is highly litigious, one cannot expect investors, contractors, and homeowners to quickly accept the risks of dealing with potential malfunctions or litigations. The idea is good, but other issues must be taken into account as well to realistically evaluate the reasons why the new technology is not easily and quickly embraced. Perhaps the issue of less stringent liability rules can be cited with regard to some other countries that quickly adopt the newest technologies.

- Challenge Home states that its objective is to deliver 50% better homes, which is also a stated BTO goal. This is clearly defined. The subsequent presentation clearly lays out how the plan is going to be delivered with very specific milestone/measurements.

## B. Approach

This project was rated **3.5** for its approach.

- The project is well thought out and designed, and it builds on other successful DOE efforts and programs and carries them to another level. Besides the identified key issues mentioned, one can think of other barriers or issues that need to be considered if the ultimate goal of such a program is realistic energy savings in homes. It is true that this program can lead to the incorporation of advanced technologies in certain homes that will qualify to be considered Challenge Homes. However, the real energy savings come about when the end users actually start using the homes as the program envisions, which depends on how well trained the users will be about using such an advanced home. If the users are not familiar and sensitive to the special features that the home can offer, then the result of using the Challenge home will not be as expected. Therefore, one important barrier is the training and culture of the end users in different age groups, etc.
- Integration of new technologies and processes into current best practices provides a natural evolution through the ecosystem. The reviewer appreciates “zero net-energy ready” as opposed to “zero net energy” as the incremental cost of renewables may put the home out of reach for many customers. The reviewer would like to see more emphasis on consumer behavior and building operations, maybe as an extension of the program.
- Challenge Home appears to have analyzed every possible barrier or challenge and has provided a reasonable solution to each of them. The ability to tap into other national programs is key to the effectiveness of this program.
- This project had the best developed marketing and outreach plan of all of the projects that were reviewed by this reviewer during the BTO Peer Review.
- Builders’ reluctance to adopt new technologies is identified as a significant barrier. But this does not speak to building officials or trade contractors, most specifically HVAC designers. Builders are not equipped to educate building officials or convince trades in a large enough number to be effective. Outreach to these segments would improve the effectiveness of the project. The cost barrier should continue to receive attention, as this will be one of, if not the most, significant barrier to adoption. It would be useful to conduct focus group meetings of consumers to better understand their perspective of costs and benefits. If the focus group results are credible, this will carry a lot of weight with builders’ decisions.
- This project does not address the issues of barriers as sufficiently as could be expected. For instance, adding another labeling program (Challenge Home) to a crowded market could water down the intended results. Also, trying to keep ahead of energy code stringencies has been a struggle for ENERGY STAR. It is not all that clear how Challenge Home can effectively surmount those difficulties. Also, the Challenge Home Supply Chain strategy was well thought out but somewhat daunting.

## C. Accomplishments/Progress

This project was rated **3.0** for its accomplishments and progress.

- The accomplishments up to this point are very good as evidenced by the efforts made and reported (such as manufacturers joining Challenge Home as partners, memorandums of understanding, publicizing the program, logo, branding, brochures, training, education, partnerships). Most aspects of the accomplishments have been mentioned quantitatively. Some goals/milestones may not be completely accomplished by the target dates because creating partnerships is time consuming and the speed depends on

the capacity, resources, and willingness of other parties. In particular, because the nature of the program is more based on encouragement/memorandums of understanding and not by contract, one cannot expect the delivery to be as per contracts.

- The reviewer is impressed with the number of homes that have been built through this program to date. There is an opportunity to provide more reach, but it seems that the program may be resource constrained. Since the program also indicated it is relevant to existing homes, it would be good to see how that is being done.
- The Challenge Home program is certainly on the right path, but it must be viewed as a long-term investment. Given the large up-front investment by DOE, the project must gain substantial market share in the years ahead. It is too early at this point to comment on the long-term success of the program, but Challenge Home appears to have achieved the intermediate goals and to have set a reasonable path toward success.
- The initial stages of the program focused on developing the new specifications for the program and launching Challenge Home, in addition to presenting at key conferences to get the word out.
- For the most part, the development of the project plan is outstanding and well thought out. Accomplishments will be measured by the successful enrollment of homes in the program, which is too early to evaluate.
- It is too soon to make any determinations on the measureable success of the program, but the strong “value proposition” argument bodes well for the long term.

#### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.7** for its collaboration and coordination with relevant stakeholders.

- This program is one of those “best kept secrets.” The reviewer is surprised not to have heard more about it. While there has been a fair amount of outreach, it should be noted that the energy efficiency market is a very busy place and perhaps more direct outreach to program administrators is needed. The slide that discusses “communication” is very one-sided (i.e., “presentations”). Communication is a two-way process and the program could benefit from additional communication. Once again, the program may be resource constrained. The reviewer is also concerned that there has not been any real branding research. Even though builders are the primary target for the training and education, it is important to understand how the public may respond to both the brand and how Energy Star may be impacted by this additional brand. The reviewer is not suggesting the current path is not OK, just that it is important to better understand the market impacts related to the branding. “Challenge Home” may sound too difficult (challenging) to some prospective participants.
- The level of effort that the project staff has put in the program is incredible and very impressive. The partnerships that the team has built with other stakeholders and its ability to align collaborators with the program is very good considering there are several other competing programs. One possible problem may be the time factor. This means the housing industry and target partners cannot be expected to have the same agenda with the same milestones, deadlines, and promised deliverables as the Challenge Home program. The pace of others involved in the process should be considered realistically. Once certain technologies are incorporated in built Challenge Homes and promoted or perhaps endorsed by this program, the market will be impacted as others start using those technologies further.
- Greater outreach to other stakeholders will broaden the recognition of the program. The online tool is an outstanding addition and should help especially the smaller builder, assuming they know about it. Perhaps the National Association of Home Builders could help in getting the word out to a broader membership. Outreach to *Builder Magazine*, for example, would be positive. The program stops short by being solar ready. There are locations that make sense today and the technology is advancing rapidly. Some way to obtain recognition if a home is not only solar ready but includes renewables should be considered.
- Challenge Home will stand or fall based on the program’s ability to collaborate and coordinate with relevant industry stakeholders. Drawing on the experiences of the successful ENERGY STAR model should assist in accelerating the movement of technologies or practices into the residential marketplace. To date, the program’s strengths are directly attributable to its ability to speak to builders in a language they understand. Risk reduction and market differentiation reverberate with builders as they struggle in this economy to remain successful and competitive.

- Challenge Home appears to be well integrated with other DOE and privately funded programs.
- Outreach for the program appears to be built on collaboration with stakeholders in addition to getting information out to potential supporters for the program. This is a well-thought-out strategy.

### E. Proposed Future Work

This project was rated **3.7** for its proposed future work.

- Challenge Home has established a very solid business plan and has left no stone unturned. Many of the potential pitfalls have been anticipated and addressed, and the program appears to be well on its way to achieving broad success.
- The project has a clear path to success because it is well thought out with so much attention to the details and pitfalls.
- The future steps are well thought out and should go far for getting the program up and running.
- This program is well designed to build on the success of other programs, specifically ENERGY STAR.
- As Challenge Home positions itself for the future, it is tackling a large efficiency swath: certifying homes in the 50% energy-savings range and at the same time certifying net-zero energy ready homes. Looking at this project from a simplistic energy labeling program stance, builders building to Challenge Home will not have a fixed singular stringency index to reach for. This is a somewhat different angle than the ENERGY STAR model and therefore requires additional risk strategies as Challenge Homes' next steps and future plans involve targeting larger scale developments. Community-scale optimization may be the quickest way to grow the numbers, but may not level the playing field in allowing all interested builders to have access to technologies and resources.
- The reviewer believes in continually pushing the performance bar up and this program uses that approach. The reviewer would like to hear more about plans for the existing homes market as that is where the most energy-savings potential lies.

### Project Strengths:

- The project targets the important goal of incorporating advanced technologies into homes, but goes above the level of other programs. This is the real strength of the concept and the expressed goal. The project has a good plan to accomplish this goal. The other strength of the project is the breakdown of the details that have been well thought out, including strategies that vary with time.
- This project is well designed and, for the most part, fully thought out. Most of the stakeholders identified had their needs addressed. The time frame of the technical project is aggressive, but not overly so.
- This project fills the final gap between an "above-code" program and a feasible net-zero-energy program.
- This project had the best collaboration, outreach, and marketing concept of all the other BTO projects reviewed by this reviewer.
- This is a whole-house demonstration of the next generation. Whole-house concepts showing advanced building practices and products are likely more effective than demonstrations or training on individual practices or systems. As use of renewables grows in the marketplace, the need for net-zero energy ready will also grow. The implication that "after a home is energy efficient it is then ready for renewable" is important and should be a stronger message.
- Challenge Home derives much of its strength from working off the successful ENERGY STAR model. The Supply Chain Strategy is somewhat dizzying given all the various components, but overall it is well thought out, including the program's thorough implementation schedule.

### Project Weaknesses:

- The only concern about the project is the current ratio of dollars to actual homes. Although the program appears to be in its early stages, and although it is important (over the long term) to demonstrate the feasibility of net-zero energy homes, the budget seems very large for the limited number of buildings certified to the program. Many states are operating under outdated, unenforced, or no building energy codes, often because of a lack of adequate funding. There are several options for the above-code or green programs currently available, and Challenge Home will have a difficult time differentiating itself from

these. While the reviewer does not doubt that the plans outlined in the presentation will ultimately lead to growth in the footprint of the program, the investment in Challenge Home needs to show a big return in the coming years.

- Perhaps the most important weakness is that the project should go beyond having the home builders incorporate advanced technologies in the new homes. It could well be that this merits a follow-up project. The ultimate goal should be the culture, training, and sensitivity of end users who live in Challenge Homes to actually follow the guidelines; otherwise, even with the most efficient and sophisticated Challenge Home features, the desirable ultimate goal of energy savings will not be reached.
- The connection to existing homes, where most energy-savings potential lies, needs to be stronger and better communicated. Focus groups or other research should be undertaken to ensure that the brand and brand messages are correctly received and have a positive, inviting image in the marketplace before getting too far down the road with the branding. It is difficult to change an image later if there is a misconception.
- This project is missing the direct involvement of several stakeholders. It is also missing the consumer's factual perspective.
- The funding level seems to be the main weakness of the program.
- One reviewer did not enter a response.

### Recommendations:

- If the ultimate goal is significant energy savings, Challenge Homes should incorporate not only more efficient technologies compared to existing homes, it should incorporate intelligent devices that interact with humans to ensure proper use of the incorporated technologies. Imagine your washing machine telling your teenager that the load she put in the machine is too light and she will be wasting \$X of energy if she runs the washer. Or, what if the central HVAC system alerts the homeowner that they should open a window between such-and-such time. This project has done a good job.
- This reviewer is concerned that the project is not adequately funded. Relying on the industry to provide funding for a DOE program to train potential participants is flawed. It would be a shame to have such a well-designed program that could not be effective for what amounts to a very few dollars additional investment.
- This project needs more publicity and needs to do more with the existing-homes sector.
- Three reviewers did not enter a response.

## Project # RBI-03: Better Buildings Neighborhood Program

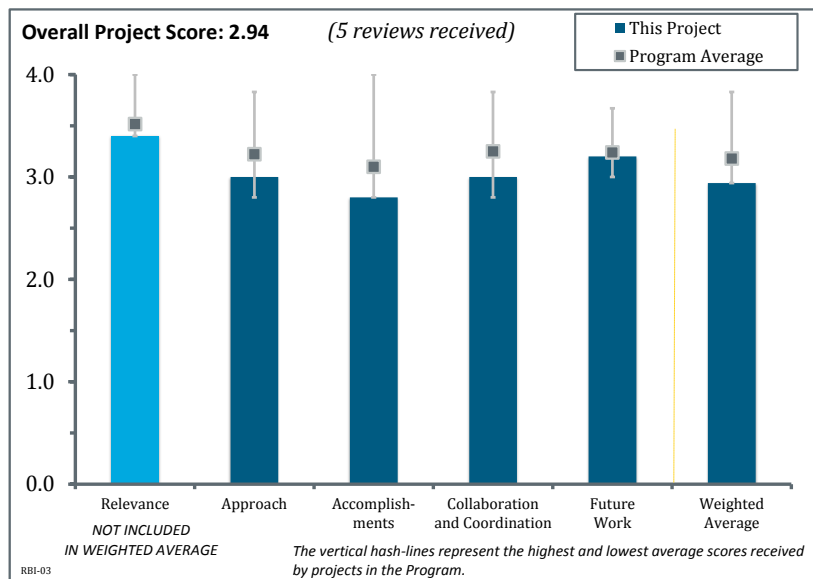
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### Brief Summary of Project

Using funds from the American Recovery and Reinvestment Act (ARRA) and annual appropriations, the Better Buildings Neighborhood Program (BBNP) provided \$508 million in one-time grants to states and localities in 2010. The goal of BBNP was to test and demonstrate innovative approaches to overcome key barriers that have prevented the development of a self-sustaining building energy upgrade market. The U.S. Department of Energy (DOE) plans to analyze data collected from 41 grantees to measure progress, identify successful strategies, and contribute to a national database of residential and commercial building data (BPD) for future study. The

analysis will use empirical data to validate the effectiveness of approaches to program design, driving demand, financing, and workforce development tested by grantees, based on the hypothesis that results will persuade future program managers to use more effective strategies to support a self-sustaining building energy upgrade market. Where appropriate, statistical analysis, which is dependent on a significant quantity of detailed quantitative and qualitative data, will be used to validate emerging lessons.



### A. Relevance

This project was rated **3.4** for its relevance to Building Technologies Office (BTO) goals and objectives.

- Concentrating Better Buildings projects in neighborhoods or other natural communities makes sense in terms of overcoming the barriers to adoption that derive from the unfamiliarity of most homeowners with the benefits of energy efficiency retrofits. Community reinforcement leverages the transformation of “early adopters” into trend setters. The concentrated market that successful programs create also reduces the risk for contractors to adopt the new technologies and sales techniques that energy-efficiency retrofits require. In most places the relative homogeneity of the housing stock in neighborhoods should also reduce the training time for contractors. The difference between being a good fit and an outstanding contribution centers around long-term commitment and a strategy for expansion. These projects were launched mostly with short-term ARRA funding, and plans for continuity are only now being developed. All community-based efforts that survive come to rely on and build ongoing financial support from existing non-governmental institutions, such as faith-based organizations. But more often the adoption comes through the community organization’s goals controlled by a government entity. Schools support and promote the parent-teacher associations (PTA) as much as the PTA supports the schools; neighborhood watch committees link up with the police and public funding; and neighborhood recycling programs feed into and become public recycling programs. Without this kind of ongoing plan, these neighborhood campaigns will be isolated and short lived.
- The program has determined many of the right questions. It will be interesting to see what the answers are to determine how effective it is. The reason this project was not marked as “outstanding” is due to the sub-goal of engaging 10,000–30,000 contractors in work on energy-efficiency upgrades. In practice, many of



these programs (in their early stages) have over-promised what they will be able to deliver for contractors. This leads to contractor frustration and drop out. It is a big step for a contractor to move into energy efficiency. It requires money, time, and adapting to a new business. Many of these programs will end when the funding runs out and that leaves the contractor in a bad place. It was never made clear to contractors from the start that this was a pilot program that hoped, but never intended, for every partner to survive.

- This program does a good job of recognizing the impact existing structures have on energy consumption and targeting them for retrofits. There are a few uncertainties about whether the program is completely addressing the distinctions between small-scale residential and larger commercial structures. The specific goal of reducing the cost of energy-efficiency program delivery is particularly good.
- The goal of the data collection element of this program is to collect as much data as possible in order to build a deeper understanding of effective residential energy-efficiency programs, which seems to directly tie into BTO's greater goals. The program took advantage of a special situation, where a considerable amount of ARRA funding was available, and enabled the team to aggregate a significant amount of data in a cost-effective manner. It has a simple and straightforward goal.
- While the goals of this program align well with BTO objectives, they are very aggressive for a program supported with short-duration funds and targeting new program administrators.

## B. Approach

This project was rated **3.0** for its approach.

- Collecting both programmatic and retrofit building data from grantees, and using statistical methods to analyze this data, is clearly a good approach. The investigators seem to have a very good grasp of the most critical barrier, which is the quality of the data. The statistical analysis consists of multiple linear regressions, a chi-squared test, histograms, and the present value of savings minus the money spent. It is difficult to evaluate the regressions because no specific equations were shown in the presentation. Sometimes it was difficult to tell how many equations were going to be estimated, and there was no specific information on the independent variables in each equation. As a result, it is difficult to see if a good faith attempt is being made to minimize problems like omitted variable bias. In terms of upgrades and energy savings, there is a research question about which estimation methods have been the most accurate in predicting savings. The analysis proposed a vague "comparative of prediction" rather than a formal statistical analysis like linear regression. There seems to be no reason the accuracy of predictions couldn't be analyzed with a conventional regression. Of the many research questions posed, the chi-square test is proposed only for timing a marketing campaign impact interest in the program. The chi-square test does not allow you to control for covariates. This research question could also be analyzed with a regression-type model. The net present value calculations require a number of assumptions. The presentation included no justification of the assumptions used, or analysis of how sensitive the results and conclusions are to particular assumptions.
- Overall, the team has taken a pragmatic and diligent approach. Once the program began implementation, a lack of data health was identified and addressed through increased transparency with the grantees. More consistent feedback, coupled with data sharing on an ongoing basis, seemed to create better buy-in from grantees. What was not addressed, perhaps due to the short presentation time, is if the data collection requirements were made clear from the beginning to grantees. For example, in their request for proposal response, it is unclear if grantees have to explain how they would track and submit data. There was also no discussion as to whether program grantees' needs/issues pertaining to data collection were identified and addressed. It sounded as if data transparency was the only main element in tackling data health. It also seemed that the approach or process for data collection was not altered, instead it was only more transparent. Data collection can add a significant amount of cost for the grantees. Additionally, it takes a specific skill set. Overall, it is unclear if data collection requirements were clear to the grantees from the start of the program, and if the grantees were equipped with tools and training that addressed their needs. If data collection rigor is not set from the beginning, changing behavior and expectations is harder. Nonetheless, it sounds as though the project has been able to improve the data health.
- In reality, the effectiveness of the approach varies from program to program and the reviewer is not familiar enough with the program details to be of much real assistance. The programs with which the reviewer is familiar (Repower Bainbridge and Home Performance in Maine) have been extremely



successful in overcoming a variety of barriers. This was partly the result of good design, but equally or more so a result of flexible and adaptive program management combined with ongoing and flexible public support for the efforts.

- It is unclear if the shotgun approach is really addressing the goal of overcoming “well-documented barriers that have prevented the development of a self-sustaining energy upgrade market.” “Innovative” models implies “untested,” and we already know that residential retrofit programs often take years to get off the ground and often go through many changes to reflect learning. ARRA presented an opportunity and had time limitations attached to it. In addition, nothing could be done to make the funding go farther. However, the very aggressive and disparate goals of this program (through the individual grants being done with funds that would naturally limit the ability to fully explore and exhaust the new ideas), provided little chance of a big win from the start. It is what it is and it is commendable that DOE has done as much as they could with the type of funding opportunity provided. The decision tool sounds like it will be great for new programs. The program is still finding its way to all of the right questions, some notable missing ones include:
  - What happens to close rates when homeowners’ projects fall into the “pay as you save” category (meaning that between energy savings, financing costs, and rebates the homeowner will be cash positive on a monthly basis from their energy savings)?
  - How do contractors feel about the programs (the quality of the training, the quality assurance process, what the programs promised versus what they delivered, etc.)?
  - How can programs provide loans to the people who need them the most and are the most likely to be denied based on financial history?

### C. Accomplishments/Progress

This project was rated **2.8** for its accomplishments and progress.

- Concentrating on the small set of projects that the reviewer knows well, these are very impressive results in terms of cost effectiveness, rallying an ongoing community and governmental support, creation of effective contractor partners, and the more quantifiable results of houses improved, the percentage of residents participating, and public awareness of the programs themselves. The published numbers show that these two programs are relatively high achievers, and that other programs have had difficulties overcoming inertia and other barriers and achieving significant results.
- A reasonable plan is in place to collect data in 2013 and analyze in 2014. But this is still in the early stages and we have only seen a couple of preliminary results based on 2011 data so far. The investigators have a good understanding of the data quality challenges and seem to be making a commendable effort to improve the quality of the data. The presenter stated that they made some progress, but they did not mention anything specific yet.
- It is concerning that the program might not have enough data in the format needed to really understand what was (or was not) accomplished. It is not clear what well-documented barriers were overcome and how the programs are sustainable. It was also unclear what new approaches were used to make that progress. There are a lot of numbers, but little understanding of what those numbers mean so far. There may not have been enough time in this setting to get a good understanding of what was accomplished by so many individual programs. This question will probably be better answered a year from now.
- As the program implementers discussed, they faced major challenges with the quality of data. There was discussion of how they were able to improve the data health through transparency and diligence. Nonetheless, no information was given actually showing this improvement. For instance, on a scale of one to ten, it is unclear what the improvement in quality was. To properly review this category, more information is required on how well the quality of data is improving.
- It does not look like the project will hit all of its goals, but the project reached relatively high and the results can help many states get into better programs more quickly.

#### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.0** for its collaboration and coordination with relevant stakeholders.

- In order to address data health issues, the project team had to work closely with the grantees. Overall, it seems as though the project has been successful at continuing to strengthen these relationships. Perhaps some issues could have been addressed up front with initial awards; nonetheless, the program worked hard with the grantees and solved many issues. In terms of market impact, the program and its grantees have been actively publishing case studies. It would be fantastic to see another round of case studies once the program completes qualitative and quantitative data collection and has a better understanding of results, lessons learned, and recommendations. Overall, the industry and state/local program designers and implementers will be quite interested in seeing what can be derived from the data sets and how this can inform program design and implementation.
- The reviewer's experience with this aspect of the program is limited. On a local level, the CSG indicates projects worked well with other stakeholders and had considerable success moving technologies and techniques to market. In other venues, where CSG is involved as an implementation contractor for local utilities, coordination between the Better Buildings Program and utilities sponsoring similar retrofit programs has varied from extremely close and mutually supportive to competitive and counterproductive. In one case, relations started out frosty as two programs saw each other as competitors for credit of achieved energy savings; but gradually, and with considerable effort on both sides, it evolved into a successful and mutually supported arrangement where house parties organized by a Better Buildings program became the largest single source of leads for a utility program.
- The grants and plans to analyze them involve a good deal of collaboration with industry partners. The plans to analyze the data are, in general, effectively aimed at establishing what works and advancing technology transfer, but it is a little early in the process to assess how effective this has been or if it is likely to be in the future.
- The amount of information sharing that has been done is impressive. Holding regular meetings and discussions with participants is good. Capturing and sharing lessons learned is a great goal. This is likely the most valuable part of the initiative.
- This project must dive deeper into the contractor perspective. This project did have a presence at industry events.

#### E. Proposed Future Work

This project was rated **3.2** for its proposed future work.

- The program implementers seem to have a strong plan and team for collecting and analyzing the final set of data. Due to the complexity and nuance of the questions the program is attempting to address, it is important that they are including qualitative and quantitative information.
- The plans to collect and analyze data are generally good, especially the plans to publish the data so other researchers can use it. This is very important and a key justification for the outstanding rating.
- The subject of planning for the future is quite mixed. The Maine program is transitioning nicely into an ongoing Maine strategy for energy efficiency improvements. Repower Bainbridge is making progress on an ongoing plan for continued relevance and has some prospects for expansion to other parts of the Pacific Northwest. Other projects appear to be headed for phased shut down. The likelihood of future work is closely correlated with program designs that saw the Better Buildings Neighborhood Programs as a niche player in a larger "ecosystem" of public policy at the municipal, county, or state level, and utility ratepayer-funded efficiency programs linking up with vibrant home performance contractor networks. Those that attempted to perform all of those functions look like they are not going to last long.
- This program ends with the funding, so this question is really not applicable. However, it is good to hear that there are plans to continue to collect data where possible from programs that are able to continue.
- The project team should review the additional questions posed by the reviewers, but answers to the questions outlined already in the presentation will help.

### Project Strengths:

- One of the main strengths of the program is that it took advantage of a fantastic situation to collect a national dataset. This data will be consolidated into the Decision Tool that has the potential to be quite robust. The implementers are attempting to address key topics, and the energy efficiency community will be quite interested in the results.
- The strengths are in community mobilization and involvement, integration with more sustainably funded utility and state programs, and providing a training ground for a new generation of program implementers.
- The program effectively targets existing structures. Considerable resources are devoted to collecting and analyzing the data. The investigators have a good understanding of the challenges involved in collecting high-quality data.
- There are probably a lot of lessons learned that can be pulled from what was done in this program, regardless of whether the big goals were achieved. This should make for interesting research and analysis for years to come, pulling apart what was done here.
- This program identified many of the right questions. The projects seem to understand the importance of the contractor perspective in the presentation, but have not found any sound ways to act on it.

### Project Weaknesses:

- The reviewer's detailed knowledge of the project is limited to Repower Bainbridge (and associated projects in Washington) and to the Maine program that CSG implemented. The reviewer has more episodic information on other programs in Oregon, Washington, Illinois, Wisconsin, Kentucky, New York, and Massachusetts. While these are impressions from the outside, and therefore lack depth and nuance, the general impression is that many projects were set up with the implicit assumption that they had to create the entire infrastructure of energy efficiency deployment and market transformation. While that assumption is not wholly off the mark in some parts of the south or Midwest with little history of state-promoted energy efficiency, it could not be more wrong in the states with well-developed programs. In most of New England, New York, the Pacific Northwest, and parts of the Midwest, the Better Buildings programs are not umbrellas, but simply another contending provider of energy efficiency programs, jostling with utility-funded programs, state and regional initiatives, and a variety of private vendors. As most of the Better Building Neighborhood projects lack depth of management experience and deep pockets, many will not survive. This is a fine thing if the project is seen as public venture capital type investments, but a bit discouraging if the goal was a high rate of sustainability.
- There are likely to be substantial differences between small-scale residential and larger scale commercial buildings, in terms of data collection, analysis, and the effectiveness of specific programs. It is not clear that these possible differences are consistently being taken into account. So far, description of the proposed statistical analysis lacks sufficient detail to evaluate it completely. It would be good to see specific regression equations with functional form and description of the variables in each equation. During the discussions, for example, a participant mentioned that climate could be an important explanatory variable. Obviously, data on climate is available and could easily be incorporated into a regression, but the presentations have not yet provided this level of detail. So far, no justifications have been provided for the assumptions used to calculate the Savings to Investment ratio, nor has the sensitivity of the ratio to the assumptions been shown.
- The project tried to accomplish too much in too short a time with little structure. Throwing open the doors to the wind is great if there is a way to collect everything that is flying around and time to clean up before the company comes knocking. But, sometimes it is better to open just a couple of windows in places that can be managed when the winds come whipping through. The result is the project spent a lot of money and the project does not seem to even know what they ended up with at this point. However, if it is true that about half of the programs will continue into the future, it may have been worth it.
- There seems to be too much assumption from the program side on how each of these grant programs are working. The contractor's experience and satisfaction with the various programs must be metricized. The project should have invested more heavily and directly in Babylon, NY's Long Island Green Homes program. In their five-year existence in a town of 70,000 homes, they have achieved 2% market penetration through financing alone with 25%–50% energy savings. Rather than sending the ARRA funding through

the state, it would have been better to directly fund the Town of Babylon, which had already proven they could put it to good use. This was a major missed opportunity to focus on an innovative program.

- Data collection requirements could possibly have been made clearer from the beginning of the program to grantees. Additionally, it is not obvious if the program grantee's needs or issues pertaining to data collection were identified and addressed. Perhaps there were additional tactics or tools, such as forms or iPad apps, that could have made data collection more easily implemented.

#### Recommendations:

- This project should provide complete specification of the regression equations planned for use in the analysis, including a description of the dependent and independent variables in each case. The list of independent variables in each equation should be as comprehensive as possible to minimize omitted variable bias and to be able to claim the project is estimating reduced form equations in case questions about joint dependency arise (for example, if you have a dependent variable in one equation that logically should be used as an independent variable in another). The project should omit the chi-squared test as specified, and analyze both "timing of marketing campaign on the interest in a program" and "accuracy of energy savings estimation methods" within a regression framework using variations like logistic regression or a general linear model if necessary. This project should also perform a sensitivity analysis for the assumptions used in present value calculations, as in the Savings to Investment ratio, especially with respect to the discount rate.
- It was mentioned that data on this scale had not been collected before. Due to the challenges of pulling together a large disparate set of data, perhaps resources from other government entities that have a deep understanding of mass data collection, such as the Census to the National Center for Health Statistics, could have been tapped as a resource. Since several grantees will, hopefully, continue to receive funding, the program should attempt to keep collecting data in order to continue to refine the Decision Tool database. Since these programs should be the most successful out of the original pool, data collected from their work could really help reinforce the best in program decision and implementation. During the presentation, it should have been reinforced more that the reviewers were only reviewing data collection and not the entire program. Also, the presenters should make sure to define acronyms more clearly, such as ACI.
- This project should go to all of the programs and gather the best, average, and worst contractors in those programs. The project should talk to them about their experience, determine metrics from the questions asked in these conversations, and understand how the programs and their various rules have impacted these contractors' actual business.
- The future efforts might try to address specific barriers and have better defined data collection efforts from the start.
- One reviewer did not enter a response.

## Project # RBI-04: Solar Decathlon

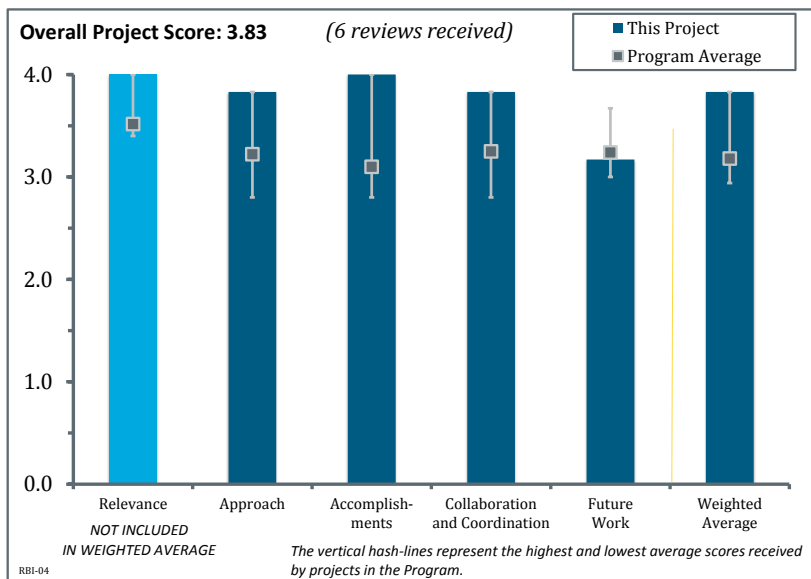
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### Brief Summary of Project

The U.S. Department of Energy (DOE) Solar Decathlon challenges university teams to design, build, and operate solar-powered houses that are affordable, energy efficient, and attractive. The winner of the competition is the team that best blends cost effectiveness, consumer appeal, and design excellence with optimal energy production and maximum efficiency. The first Solar Decathlon was held in 2002; the competition has since occurred biennially in 2005, 2007, 2009, and 2011. The primary goals of the Solar Decathlon are to demonstrate to the public the opportunities presented by affordable homes that combine energy-efficient construction and

appliances with renewable energy systems that are available today; provide student participants with unique training to help fill jobs in our nation's clean-energy economy; and promote an integrated, or "whole building design," approach to new construction.



### A. Relevance

This project was rated **4.0** for its relevance to Building Technologies Office (BTO) goals and objectives.

- BTO's mission and goals are clearly set forth on the BTO website home page "Securing America's Future with Energy Efficient Buildings." The BTO works to help families save money while enhancing comfort, supporting the U.S. economy, improving energy security, and protecting the environment. Specifically, relative to the residential sector, "[t]he Building Technologies Office collaborates with the residential building industry to improve the energy efficiency of both new and existing homes. By developing, demonstrating, and deploying cost-effective solutions, BTO strives to reduce energy consumption across the residential building sector by at least 50%." (<http://www1.eere.energy.gov/buildings/residential/index.html>, accessed 2013.04.08) This goal is addressed across several categories: research and development, market stimulation, and building codes and equipment standards. The Solar Decathlon comprises a robust program that addresses major and supporting goals and objectives across the BTO spectrum. From training future members of the workforce to transforming building science education, the Solar Decathlon changes the lives of students, faculty, and professionals who come together to compete, as well as the hundreds of thousands of visitors of all ages who come to tour the houses, visit the websites, and talk with the teams. The Solar Decathlon provides a venue that encourages university teams to cross disciplinary boundaries in order to advance innovative solutions, showcasing the tools now available to change the way buildings are design and built.
- The Solar Decathlon directly aligns with BTO's goals of:
  - Producing real customer impacts by showcasing sustainable strategies and technologies to the general public through a public demonstration and expo.
  - Creating opportunities for high-impact research and development as a method for breaking down market barriers to scale by partnering with industry leaders to create sustainable technologies.

Through the solicitation of sponsors, university teams are working directly with companies to test and develop new technologies. The Solar Decathlon has become a platform for showcasing innovative technologies that are either on the verge of going to market or brand new to the market.

- Enabling a 50% reduction in U.S. building related energy use in 2030 by creating a competition that produces net-zero energy houses. The houses utilize various energy saving appliances, systems, and technologies—many of which are available to the market.

The university teams are also developing new energy-saving systems as part of their research and innovation and partnering with the private sector to bring these technologies to market.

- There is no greater argument for the relevance of DOE's Solar Decathlon than the tremendous growth of the program over the years, especially now that this effort has garnered international support as well. Increased participation at the college and university level ensures that the fundamental approach and mission statement of the program are right on target. The efficacy of the program centers squarely on the individual students who recognize this once-in-a-lifetime opportunity to work on a project that has lasting implications in terms of driving the students into academic disciplines as varied as engineering, architecture, and design. This project also creates public awareness of residential energy efficiency and the benefits of technological innovations.
- This project is an innovative and fresh avenue to job growth and future technologies implementation and deployment within DOE. A large percentage of the students move on to work in the "green jobs" field and this project is an incubator for the future of the country and others around the world. Looking at the budget, it provides a return on DOE's investment above and beyond the norm. In addition, it encourages visitors and participants alike to conserve energy and save money while doing so.
- This is a fantastic outreach to help students in the engineering and similar fields get real-world experience with designing, installing, and marketing systems that work. This fits in very well with all three parts of the ecosystem, particularly research and development and codes and standards.
- The Solar Decathlon has done an excellent job of integrating advanced technology solutions and preparing a (future) workforce, along with educating and invigorating the public on renewable technologies and energy-efficiency opportunities. Since only so much education can be accomplished through online resources, this event brings real-world applications to participant/visitor's fingertips.

## B. Approach

This project was rated **3.8** for its approach.

- The solar decathlon is a very high-level competition designed toward producing a large-scale product that can be marketed to the public. By providing the "seed money," the teams are motivated to solicit additional sponsorship and diversify their funding. This also forces the teams to have a realistic budget for development, construction, and marketing. For a "real-world" lesson on how to develop and implement innovation, this is an excellent approach. Additionally, the marketing of the competition itself is in tune with the audience that it serves the best; the use of social media and properly crafted media releases have produced tangible results as far as reaching the collegiate participants. By making this a multi-pronged competition, each participant has an opportunity to leave with some recognition for their efforts. There is not much more that could be done to improve on what this team has done to bring this competition to the level it currently stands at. They have made this a grand event.
- The success of any good program relies heavily on good planning and a solid approach toward implementation. The Solar Decathlon approach has distinctive characteristics that enable it to be successful across all of its various components. Creative management allows for barriers to be identified and then successfully surmounted so that innovation can be fostered continually as the event evolves. The program's success is a remarkable tribute to its ability to overcome difficult obstacles so that in the end, the focus is on the achievements of the students highlighted by their innovative projects.
- The key areas of the approach are clearly identified: competition administration through fair and meaningful scoring; developing necessary infrastructure; mounting an education/outreach campaign; DOE team collaboration; developing broad industry support; and highlighting the achievements of the teams, DOE, and the collateral agencies and stakeholders. Strategies and tactics have been devised to implement the goals and address barriers.



- The Solar Decathlon faces two main challenges, funding and scalability. To move forward in a tough budget climate the project organizers will need to think creatively on how university teams can obtain an appropriate amount of funding to incent their participation. Cutting back on current funding could be detrimental to the competition as most institutions of higher education are also tight with budgets. There are great opportunities to engage more industry leaders as sponsors and the competition organizers could help get the word out to industry. The project organizers should also consider available creative funding mechanisms to share with teams as they seek funding on their own. The second challenge is that of scale. There is enormous opportunity available through a host of outreach mechanisms to help get the word out about the competition and to engage and educate the general public about energy efficiency, conservation and generation, as well as sustainability as a whole. The project organizers should consider how they can leverage existing networks of partners and seek new partners as part of a broader outreach campaign. The website can be used in a more dynamic way to engage visitors. For example, on the home page the domestic map of solar decathlon houses should be prominent so that visitors can learn where the closest house is to their home and if it is accessible to the public. This could be a “button” on the home page that says “Interested in visiting a Solar Decathlon house? Click here.” There are also opportunities to work with partners such as the American Institute of Architects, the American Society of Heating Refrigeration and Air Conditioning Engineers, and the Green Building Certification Institute to offer continuing education credits for professionals by repurposing videos and creating short quizzes. Online courses about the Solar Decathlon should be considered as a mechanism for reaching both the K–12 sector and higher education community. Podcasts could be created that would allow people to follow the competition from the comfort of their car or while working out. A public virtual expo is another opportunity to reach an even greater number of people and help with global reach.
- It is slightly difficult to rate this because there was not much time spent discussing challenges and how they were addressed. The location shift has created a new set of challenges. It seems that time will tell if these obstacles were addressed effectively. For example, since most southern Californians have not been exposed to the Solar Decathlon in the past, the event team will need to put in special, locally targeted, outreach efforts. This outreach cannot be evaluated because the reviewer panel was not provided with the information. Nonetheless, since several schools have applied to participate in more than one competition, that would be an indicator that participants have found the event well designed and executed. Furthermore, members of the audience, who were based in Washington, DC, expressed a passion for keeping the event in the Nation’s capital. Once again, this would be an indication that other stakeholders find the Solar Decathlon well run and successful.
- This is a project that requires a lot of planning. It is extremely difficult to meet the schedules and under-cost pressures. The National Renewable Energy Laboratory (NREL) and DOE teams do a great job in overcoming barriers to achieve the goal of the project for all the stakeholders.

### C. Accomplishments/Progress

This project was rated **4.0** for its accomplishments and progress.

- The accomplishments of this program are outstanding. It appears to have a significant fraction of traffic on the Office of Energy Efficiency and Renewable Energy (EERE) website. Two statistics shared during the presentation struck me the most: (1) the percentage of participants finding jobs in the clean energy sector and (2) the percentage (and market impact) of those who participated in the competition and then influenced decisions to purchase energy-efficient equipment. This shows a significant return on investment, and one that will last beyond the two years teams have to prepare for the competition. This must be part of the reason for another impressive accomplishment, which is the fact that the sponsorship and monetary investments are 4:1 over the initial DOE “seeding.” This demonstrates the credibility this event has with the “real world” market. While the collegiate participation is very impressive, the number of K–12 teachers and students who visit could be higher. Their participation and interest may help to drive more students into the science, technology, engineering, and mathematics (STEM) world, which has been a challenge. Having said that, the accomplishments of this program have been extremely impressive when looking at the number of participants, the “buzz” generated, the money raised, and the participation by the public. This truly appears to be a first-class event.
- The accomplishments are very clearly articulated and evaluated against quantitative measures. The degree of success demonstrated is phenomenal. This project has a 100% success rate in completed house designs



(accessible at [www.solardecathlon.gov](http://www.solardecathlon.gov)), virtually net-zero performance of the homes during the most inhospitable of weather conditions, more house visits to date than any previous decathlon—and a significant share of visits attributable to a K–12 audience, stratospheric media highlight figures, and measurable progress, which are good indicators for a successful upcoming Solar Decathlon 2013 event. The awards and recognition that this program has received go directly towards acknowledging the completion of BTO goals, including developing and demonstrating cost-effective solutions, as well as recognition for communications and outreach to consumers that disseminate the results of the success.

- The level of participation from universities, along with the media attention gained, are examples of how the event has been able to successfully educate the future workforce and engage the broader community. The data that has been collected and presented, such as 92% of decathletes believing they have been able to convince someone to implement an energy efficiency project, is an indicator that the market is being influenced by the event. Additionally, since 76% of the decathletes go on to work in the clean-energy industry, there clearly has been success in educating the workforce. Additionally, the fact that the Solar Decathlon program team has been approached by international organizations to help assist in developing a similar competition in two other continents is a testament to the event's success.
- The path to market transformation is through engagement of the younger generations. The following numbers speak to the success of the Solar Decathlon over the past 10 years: (a) more than 80% of decathletes learned more from their Solar Decathlon experience than they would have learned in the classroom alone; (b) since leaving college, 76% of decathletes are working in a clean-energy field, that is five times the number of comparable non-decathletes who have worked in the clean-energy field; (c) 92% of decathletes credit their Solar Decathlon experience with helping them get the job; and (d) 92% of decathletes have convinced someone to install energy-efficient equipment in homes and buildings. These students are not only being trained for a green economy for career purposes, but are also becoming advocates and educators.
- The Solar Decathlon has many accomplishments that it can be proud of, but if progress is measured in numbers alone, the quantitative performance indicators are off the charts. The 2011 Solar Decathlon had 357,000 house visits on site and more than 2 billion media impressions. These numbers not only demonstrate “measurable progress,” but also emphasize a universal affection for what has become a highly anticipated event.
- Regardless of the barriers, the Solar Decathlon is on schedule each time. This is due to the success of the project management team and all the students that work together to make this a great learning, job training, and work development effort at the national level for all to see.

#### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.8** for its collaboration and coordination with relevant stakeholders.

- The project staff collaborates with stakeholders not only nationally (DOE/EERE communications and outreach), but also through private-sector industry partners, universities numbering over 100 as of the date of this review, and internationally with collateral European and Asian governments to develop sister competitions. Technology transfer, deployment, and market impact are clearly demonstrated in the extraordinarily high percentages of team participants who attest to the education that the project affords them, the jobs that they have been able to secure due primarily to their Solar Decathlon participation, and in the feedback from homeowners who visit the Solar Decathlon each year.
- The core component of the program is outside engagement and collaboration. Universities conduct the majority of the work. A range of industry partners, from manufacturers to financiers, are actively engaged through the entire process. NREL interacts with all collaborators by providing key education and review (in addition to all of the event management). All of these engagements and collaborations have been successfully implemented. Once again, this is demonstrated through repeat participation. Financially, the event has been able to leverage 4:1 in investment dollars. This is also an indicator of quality engagement with collaborators. The format of the Solar Decathlon, displaying technologies and solutions that are being actively implemented, is a fantastic way of educating the public and promoting/accelerating market transformation.
- This event depends on collaboration. The participants must work in teams, develop sponsorships, and work amongst several discipline lines. It was interesting to note that at least one team this year is a combination

of two very different universities. The event itself requires major planning and collaboration or it would not have the success that it has achieved to date.

- A strength of the Solar Decathlon program is its ability to collaborate with a broad representation of industry. Staff excels at recruiting motivated stakeholders. This helps to ensure the crossover of new technologies and practices into all the model homes.
- The success of the Solar Decathlon relies on partners. Without these relationships the competition would not be able to flourish. The project is a successful example of how academia and practice can co-develop and deliver applied research to the market.
- There are challenging but collaborative efforts and the technology deployed during the events in most cases ends up coming to the Home Depot. The degree to which partners can collaborate at times depends on the stability of the program and the consistency of the venue where the decathlon takes place. Over the past two Solar Decathlons, we have seen movement from the National Mall in Washington, DC, to West Potomac Park where the area was not as ready as the National Mall to host an event like this. In 2013, the Solar Decathlon is in California and there are probably many challenges to overcome since new relationships and collaborations need to be developed. An important key moving forward is the consistency of the venue and that the U.S. Department of the Interior grants DOE rights to host the event on the National Mall.

## E. Proposed Future Work

This project was rated **3.2** for its proposed future work.

- It is important to expand the presence of the Solar Decathlon on a national and global level, which the team seems to be doing well. Clearly the team will analyze the results from holding the event in the Irvine location and determine if it should be replicated outside of Washington, DC, again in the future. However, there is some concern that more of the burden (of the national competition) will be picked up by the universities and/or the commercial sector. Right now, many schools, especially state schools, are underfunded and thus may be barred from participating due to high costs. If commercial partners pick up more of the expense, then they are likely to want greater influence in the competition's implementation. There is a level of concern in having for-profit institutions command too much power over a public education program. Nonetheless, if this is the only way for the competition to continue due to federal budget cuts then it should be implemented carefully. Beyond the distribution of the finances, the presentation did not have time to cover other future changes.
- The project has been given the directive by DOE to reinvent the Solar Decathlon 2015 competition rules, public exhibit, and implementation. After 10 years of hosting the decathlon, there is a wonderful opportunity to assess the current goals and objectives. The project should consider scalability and refine processes and procedures in order to make the next 10 years even more impactful. Topical areas that should be considered are climate adaptation, resiliency, and net-positive homes. The project team should think about how the competition can raise the bar and continue to stay in a world of innovation. The competition serves as a driver for market transformation as well as a dynamic platform for public engagement.
- Now that the Solar Decathlon has expanded to outside the United States, it is curious and heartening that the program will take a step back, look inwardly, and reflect on how to reinvent the Solar Decathlon 2015 program in order to remain true to its focus. This is a good decision. It should be very helpful to take stock of where they have come from, recognize how things can be improved, and then move forward. In this way, the program can clearly build on its past progress and be sharply focused on eliminating future barriers to success.
- This is a great program for our nation. It creates jobs and trains the next generation while doing so. It educates the public in a host of DOE initiatives, not only solar but in housing construction, insulation, lighting, etc. It is now in Europe and China and it seems likely the rest of the world will follow. To this end, the Solar Decathlon needs to be permanently hosted in our Nation's Capital in the mall of the people, the National Mall. The Secretary of Energy needs to work with the U.S. National Park Service Director to make this happen. This is in the interest of the nation and needs to be given a high priority.
- The proposed future work in further developing the Solar Decathlon is promising. A reinvented decathlon will allow the event to transform based on its success since 2002, and will reflect the current workforce, status of involved industries, and new university realities.

- The proposed future work did not seem clear. It appears that the event in 2013 is planned and is ready for its rollout in the fall. However, the information about the next decathlon (2015) was rather vague. For a competition of this magnitude, planning should be well underway for the 2015 event. There was mention of some major overhaul, but the reasoning for that and the manner in which it would be done was not clear. It would seem that the planning for the 2015 event should have been started in the middle year of the previous decathlon (which would be 2012) so that it would be ready to build from the success of the 2013 event immediately after it is finished. To complete a major overhaul of the event could break some of the momentum built from the success of the 2013 event. If an “overhaul” is planned, it may be wiser to complete that now for a planned 2017 event and work on a more gradual transition with the 2015 event. As stated previously, it would be advisable to encourage (or even require) participants to partner with K–12 teachers and students, as it would help the collegiate students become better leaders/mentors, while hopefully sparking an interest in STEM with the understudies.

#### Project Strengths:

- The program’s strengths can be understood in several ways. An overarching principle of the program is that it directly addresses the BTO’s stated objectives in clear and measurable terms. Under that principle are several supporting successes: (1) Students’—our nation’s future practitioners— capacity to design, invent, execute, and prove that homes can be energy efficient and affordable. This is a bridge from where the industry is to where it needs to go. Their work is testimony to the quality of the Solar Decathlon program. (2) Lay people benefit from the communications engine that drives the competition and each team’s effort. During the years that the Solar Decathlon has been in Washington, DC, (the reviewer’s home) the reviewer has experienced the effect the competition has on people before, during, and after the event, sometimes on a daily basis. (3) Industry partners benefit from their participation in the project. The competition is a full-fledged “exhibit hall” of full-scale working models that demonstrate the interconnectedness of research, products, materials, technologies, and their integration in a holistic design.
- This is the kind of program that should be funded and encouraged to build from its successes. The investment in the future workforce is obvious and the results show this. Specific strengths include:
  - The ability to turn the initial federal seed money into an investment that is matched several times over
  - The outreach to young people who learn practical lessons in designing, building, and funding major innovations and learn to market their work
  - The development of practical skills that lead students into an emerging market
  - The lessons to the public about how energy efficiency and sustainable energy are achievable and that the goal of “net zero” is not a pipe dream.
  - The market power that has been (conservatively) estimated from the influence of those who have participated.

Other programs should use the approach and marketing of the Solar Decathlon as an example to follow if they want to have a significant impact on the “uber-goal” of a 50% reduction by 2030. This can surely help get us there.

- The core strengths of this program reside in its ability to enable creative and intelligent students to collaborate their energies on building highly energy-efficient projects that intrigue and amaze themselves, the industry, and the public at large. In the process, the students embrace the importance of energy efficiency, good design, and outside-the-box thinking to become energized themselves and help move the industry forward. This hands-on program encourages students to be drawn into the clean-energy workforce and at the same time become a strong voice for clean-energy solutions.
- For academia, the Solar Decathlon is an excellent example of a workforce training program, which offers an experiential learning opportunity for a diverse group of students. Students learn best by doing and are looking for ways to gain practical experience for post-graduation application. For the building industry, the decathlon is a model of how the integrated design process can and should work to produce high-performing buildings that are healthy, safe, and resource efficient. For the public, it serves as a view into the future where each person will be living in a sustainable community and provides tangible solutions for people to adopt now.
- Over 10,000 students participated in the program; 95% of all students inspired somebody to save energy; over \$10 million of new purchases have resulted from the technologies tested and transferred; and 85% of

students used the skills learned during the Solar Decathlon to get a new job. This is contributing to workforce development.

- The event deeply engages college and university students. It produces a set of individuals with hands-on experience implementing real-world applications. Additionally, it is an interactive, visual, and engaging format for the public, which allows the public to grasp a deeper understanding of possibilities.
- This project has completed 100% of its deliverables on time. More than 1 million people have visited the Solar Decathlon since its beginning. The entire world is aware and now there is a Solar Decathlon in Europe and China.

#### Project Weaknesses:

- The Solar Decathlon, like any project with a significant duration that has achieved international success, is both a “mirror” and a “lamp.” It mirrors back to us the state of where we are, yet simultaneously shines a lamp on the path of where we must go to, e.g., “Secure America’s Future with Energy Efficient Buildings.” The challenges that the program faces are (1) building on successes so that the program does not have to be reinvented each cycle and (2) allowing for appropriate transformation necessitated by the evolution of the program itself. The program could continue to go forward as it is, yet it must change in order to reflect the state of residential design and construction in this moment.
- Perhaps additional resources, for example on the website, could be produced for the public. These materials could address lower cost energy efficiency/sustainable projects that can easily be implemented at home. Visitors will likely leave the event excited and energized. This provides a great opportunity to take advantage of the engagement with steps for how the public can incorporate the Solar Decathlon ideas into their lives. These simple options can be a combination of generic projects, along with ones that are more relevant to the local area.
- The only weaknesses appear to be planning for the 2015 potential “overhaul,” which likely should have been determined last year to help structure and roll out this year, and a possible better outreach to primary and particularly secondary education to help stimulate interest in STEM. These are very minor compared to the strengths and are achievable particularly if a “major” overhaul is put off until 2017 with only intermediary changes in 2015.
- As mentioned already, the barriers serve as both opportunities and areas of risks. As part of the strategic planning process a strengths, weakness, opportunities, and threats analysis should be completed to inform future plans.
- One reviewer did not enter a response.

#### Recommendations:

- This project should continue to consider holding the event in other locations across the country. Although Washington, DC, is an important city with global influence, the rest of the United States does not necessarily follow everything that takes place in the capital. Despite a feeling that other sections of the country may not take this type of education seriously—frivolous Hollywood or bumpkin Midwest—the West Coast has led much of the renewable energy and energy efficiency trends in this country. Furthermore, if one looks at the map of where DOE energy efficiency programs are being implemented, much of the country is not covered, including many states with high heating costs that could really benefit from engagement. The Solar Decathlon listed that thousands of K–12 students visit the competition. By moving the location, this allows an entire new set of students to be exposed to the event. Therefore, there are several reasons for expanding/rotating the geography of the event’s impact. Due to the increased cost of new locations, one idea would be to alternate the location every other event, so that it is in Washington, DC, every four years. This would also allow longer planning cycles for different cities.
- Restructuring the rules could allow for ways that the “off” year might be productively used to keep the public more continuously engaged. For instance, the “off” year could include benchmarks for one or more of contests or sub-contest results announced. Parts of the communications and affordability contests (sub-contests) could be announced during the off year. This would ensure teams’ delivery of higher quality communications materials along the way and keep the public engaged in evaluating the value and cost of these homes as relevant to their own homes on a more frequent basis. If the Solar Decathlon competition is

present in peoples' minds for only 10 days in September or October on an every-other-year basis, it does not pack the wallop it could if its results were pushed out during the "off" year.

- Congratulations to DOE and the Solar Decathlon project team in delivering good performance each time around. The reviewer hopes this project gets the support it needs to come back to the National Mall where they can continue to shine around the world by creating innovative houses and educating our nation.
- There are no additional recommendations beyond what has been stated in the previous answers. This is a terrific program and should be encouraged and funded.
- The Solar Decathlon has established a very engaged community and built a vast network of partners. Project organizers should utilize this community during the 2015 strategic planning process. Research mechanisms could include surveys, one-on-one interviews, and/or focus groups.
- One reviewer did not enter a response.

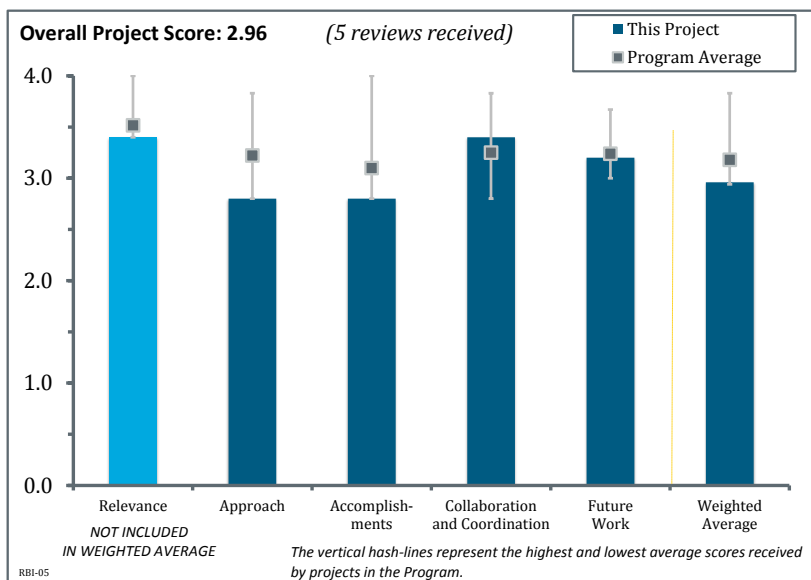
## Project # RBI-05: Home Performance with ENERGY STAR

Ely Jacobsohn, U.S. Department of Energy, [ely.jacobsohn@ee.doe.gov](mailto:ely.jacobsohn@ee.doe.gov)

### Brief Summary of Project

The goal of Home Performance with ENERGY STAR (HPwES) is to help homeowners improve the efficiency and comfort of their homes using a comprehensive, whole-house approach, while helping to protect the environment. The U.S. Department of Energy (DOE) began to administer the Home Performance with ENERGY STAR Program in October 2011 and works in conjunction with the U.S. Environmental Protection Agency (EPA) to support local sponsors. HPwES project provides homeowners with resources to identify trusted contractors that can help them understand their home's energy use as well as identify home improvements that increase energy

performance and improve comfort. Participating contractors recommend and perform energy improvements, such as air sealing, insulation that can fix drafty and uncomfortable rooms, and install high efficiency heating and cooling equipment. These improvements can lower utility bills. Contractors that participate in HPwES are qualified by local sponsors such as utilities, state energy offices, and other organizations to ensure that they can offer high-quality, comprehensive energy audits of a home's energy, health, and safety issues. HPwES is unique because local sponsors independently verify the quality of participating contractors' work. As a result, homeowners can feel confident in their contractor's recommendations and in the effectiveness of the work. In 2012, Home Performance with ENERGY STAR reached over 275,000 completed projects.



### A. Relevance

This project was rated **3.4** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This is a critical program. It provides the means to transform the residential sector, to have renovations and other work done in a manner that maximizes energy efficiency, and finds a way to do so without having the public depend on rebates. There is just not enough public money to convince enough people to make energy-efficiency improvements to their homes with rebates. The public needs to value energy efficiency and understand that it is worth their investment with or without incentives.
- This fits in well with the BTO ecosystem, particularly in the aspect of market stimulation (and some with codes and standards). The \$86 to \$1 investment ratio of outside funds leveraged for U.S. Department of Energy (DOE) investment is impressive.
- Home Performance with ENERGY STAR (HPwES) is the core program to take residential energy efficiency to the next level.
- This project promotes high standards and has a viable strategic vision.
- The presentation on the program did not answer what the program is and how it functions in the building community. It does appear to support BTO's goals for efficiency.



## B. Approach

This project was rated **2.8** for its approach.

- The program is looking at the right things when it comes to scale and alignment of the various HPwES programs. Where this project falls a little short is on working through the policy, information, and policy barriers. This is difficult because most state agencies, legislatures, and public service commissions probably are not looking for advice from the federal government. That being said, this is one of the biggest core issues for HPwES programs. It would be great if everyone's goal was to fix as many houses as possible, but that just is not the reality. For example, at the state level, different entities want and care about savings for different fuel types. Where DOE can help is to look across all programs in the United States; determine where they are set-up and what their funding sources are; create best practices for agencies, utility commissions, and state government; and get that information into the contractors' hands. DOE could also provide information on how contractors can advocate for better programs on the ground.
- HPwES was built around a set of technical standards, which are excellent, and two core business models: consultant and contractor driven with a "market transformation" framework. But in the world of utility program sponsorship (where most of the money is), there is a third model called "resource acquisition," where the utility hires a program implementer to get savings to fulfill a regulatory requirement in the most cost-effective manner possible. The technical issues remain the same and the advantages of a whole-house approach still exist, but the motivation to drive production has different consequences from the motivation to "transform the market." A significant part of the difficulties that HPwES has faced expanding into the utility-funded market stem from this issue, which is a self-imposed narrowness of design not inherent in the technical standards or whole-house approach.
- The HPwES program has undergone some transitions since DOE took responsibility for it. The project team initially proposed an approach that was not well received; but, based on good listening, discussion, and collaboration, is now on a track that will likely garner support from stakeholders. The program design is still undergoing development, and therefore is only rated "good" at this time. However, the reviewer appreciates very much the stakeholder involvement.
- The reviewer struggled between making this rating "fair" or "good," but based on the results and the impact, bumped it to "good." The idea of the "whole-house approach," local delivery infrastructure, and the alignment with a recognizable program (ENERGY STAR) are the positives. However, the reviewer is concerned that the initial approach described here may be missing the vast majority of those who would benefit the most: existing homeowners. While housing starts do seem to be making a recovery, the renovation market should also be a significant focus; here the program could help homeowners make strategic decisions as to where they should focus their efforts for the "biggest bang for the buck." From what was said during the presentation, the market penetration with new homes is still falling short, and moving more focus to the renovation market may yield better results.
- Some of the barriers that were presented could have been avoided with a better organized program. This program seems to be fairly fluid.

## C. Accomplishments/Progress

This project was rated **2.8** for its accomplishments and progress.

- HPwES has not, in most venues, broken through into true mass production. The approach is now widely understood and has many sponsors, but it is seen (somewhat unfairly) as cumbersome for sponsors and overly complex for many contractors. Hence, there is pressure for fewer (or no) standards, simple audits, and no certification requirements. While the solution of reducing standards is a mistake, the problem of limited growth for the program is real. Some advances are under discussion in HPwES version 1.5, which is being circulated. But a significant part of the Home Performance future almost certainly lies in aiding utilities with fulfilling their regulatory obligations in which "market transformation" is a nice side effect of resource acquisition, not the goal of the program.
- Based on the project plan and schedule outlined in the slide deck, a significant amount of work was accomplished during fiscal year 2012 and into 2013. The funding level seems to be appropriate for this type of program.



- So far, so good. The pivot from thrusting version 2.0 on the industry to creating version 1.5 was a savvy move.
- While progress has been slow, and perhaps is more reflective of a rating of “fair,” it must be remembered that DOE took over this program only a year and a half ago, while the Better Buildings program and a number of other market complications were underway. Making progress will be a challenge. The shift in approach, based on listening to feedback from stakeholders, has been a major accomplishment on its own.
- The presenter conceded that this program has had rather limited market penetration. Additionally, it seems that a few sponsors are doing most of the work. Hopefully, working at a local level and possibly diversifying the approach will help spread that effort and help the program live up to its potential.

#### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.4** for its collaboration and coordination with relevant stakeholders.

- HPwES has promoted the whole-house integrated analysis and treatment approach more successfully than any other program the reviewer knows of. It (and the Home Star legislation, once a bright prospect for lots of federal funding) have attracted a wide variety of industry players, from implementation firms, to manufacturers and big box stores, to inventors and entrepreneurs, who are all working to solve a problem (getting homeowners to retrofit their homes using a comprehensive building science approach) that most people did not know existed. When you move industry players to change their business approach to solve a problem that most people do not know exists, you have achieved something unusual in the market.
- Project participants are present and approachable at industry events, which is most important. They want to understand and be a part of the industry, which is key. Everything this project is doing around data is exactly what it should be doing. However, more can be done in order to help the agencies better relate to their contractors. The bottom line is that better contractors mean more energy savings. Due to the high cost of customer acquisition resulting from the audit process, home performance will not work for every contractor. In fact, if you broke down savings/close rate/project size by contractor business model (primarily HVAC with a subcontracted home performance throw-on, home performance through-and-through, etc.) the statistics could likely be illuminating.
- This program seems to have good market penetration in the states that they are working.
- This program requires close collaboration with a multitude of stakeholders. Any program that is intended to support the goal of transforming the residential marketplace must be supported by the contractors delivering the services. The program team has grown to understand how important that is, and is now doing a great job of communicating (delivering and listening) with the stakeholders.
- The reviewer struggled between rating this project “good” or “fair.” The leverage of outside funds and the fact that those who have bought into the program (even if it is through state mandates) have done much of the work pushed it to “good.” Having ENERGY STAR as the centerpiece is what will continue to propel this effort forward. There appears to be a significant opportunity here if this program could also include the Home Energy Score, which is another BTO-funded program. Neither of these programs seems to acknowledge the existence of the other.

#### E. Proposed Future Work

This project was rated **3.2** for its proposed future work.

- Version 1.5 is a promising modification of current practices that should improve acceptability. In an era of relatively low natural gas prices and increased pressure on utility programs for cost effectiveness, HPwES needs to both assist its sponsors in defending the truth of the underlying whole-house approach, particularly with regard to building shell treatments and safety testing and to work with market actors to raise the impact (documented savings) of projects while holding down costs.
- This program has a lot of potential, though it appears to have a limited focus now. By working at the state and local level, there should be a significant push forward. Again, diversifying the program to include more than just new housing will only help move that along.
- The planned continued dialog with stakeholders, combined with pilot initiatives, holds great promise in further refining the HPwES model. Great job!

- The work that is proposed makes sense as hopefully it will help clarify the program and make it easier to implement and understand.
- This project does not have enough integration with actual contractors on the ground. There is not enough focus on helping the HPwES programs find ways to make the “pay as you save” cash positive value proposition work, e.g., via financing and/or rebates. There is a need to look at how we can make financing available for more homeowners and what the federal government can do to support that.

#### Project Strengths:

- Despite some of the previous criticisms offered by this reviewer, this program has a lot to celebrate. The use of ENERGY STAR as a tool to help homeowners make decisions on the investment in their home has enormous potential. The return on DOE dollars invested has shown that this program can work. The whole-house focus is good, though some program components should be focused on helping homeowners make smaller scale decisions. This program has a lot of potential.
- The success of this program will depend on finding the right balance of national standards setting and local marketplace tailoring. Ramping up participation levels can only be done with buy-in from large potential contractors, so the collaborative approach being taken by the team is critical.
- The reviewer believes DOE is doing as much as it can given the key limitation that DOE is not providing funding. That creates a difficult position out of the gate. The approaches taken to glean best practices are smart and balanced.
- This reviewer’s comments come out of experience in managing or overseeing the programs that produce about half the annual HPwES production in the country.
- The program seems well laid out and the reviewer knows that it is being used in the states, but this was not made clear in the presentation.

#### Project Weaknesses:

- This project team can teach other programs that having their consultant program administrators do a focus group or two throughout the year is not enough to understand how to best support the contractors. Approximately 85% of a contractor’s business comes from referrals, so there is no need for more money to be spent on outside marketing firms who know nothing about home performance to come in and do market segmentation studies. The HPwES programs need to get out there with the best performing contractors to try new methods on a regular basis and encourage more referrals. This project should look more at the contracting businesses doing the work. The advice and help contractors need is different depending on the business size, goals, and business model.
- Version 1.5 is a promising modification of current practice, which should improve acceptability. In an era of relatively low natural gas prices and increased pressure on utility programs for cost effectiveness, HPwES needs to assist its sponsors in defending the truth of the underlying whole-house approach, particularly with regard to building shell treatments and safety testing, and work with market actors to raise the impact (documented savings) of projects while holding down costs.
- The program team must determine where the greatest potential for ramp-up lies: with the 20% doing 80% of the work now, or with new players who may respond better to a different model. This is not an easy question to answer, and the risk is in losing the 20% in the effort to bring in new players.
- The program focus seems a bit too broad to reach its maximum potential. With a name like “Energy Performance with Energy Star,” an average homeowner may be led to believe they could use this program to help make their home more energy efficient. This leaves out the do-it-yourselfers and the systems renovation market (e.g., building envelope; heating, ventilation, and air conditioning; lighting; etc). Some of the low-hanging fruit opportunities should be an integral part of this program to help it build up to the whole-house approach, instead of simply focusing on building down from that approach. For many, it may be more reachable, less intimidating, and more financially feasible if some of these opportunities were included.
- Clarity is the biggest issue with this program, since the goal of energy efficiency make sense.

**Recommendations:**

- HPwES should take the lead in pushing performance-based metrics and performance-based incentives (for homeowners and contractors) based on real data taking into account average job size, average savings, etc. The contractors who help the program get closer to its goals are the contractors who should get more financial support from the programs. For the most part, it is a one size fits all model that is not helping the contractors DOE should be most interested in supporting—the pure home performance contractors. This project should give those home performance contractors every opportunity to leverage the whole-house approach to grow and replicate their businesses. The project should also provide more support for programs that are working, see how they can make them even better, and share what is learned with the other programs as part of a continuous improvement philosophy.
- This project should continue tapping into the expertise and ideas from the variety of stakeholders that are at its disposal. The project must find a way to ramp up participation. Consumer education is an important missing element, but it takes funds that just do not exist in public programs. The project needs to find a way to bring in big new players without losing the existing partners, since those big new players potentially have the deep pockets that can motivate consumers to act.
- There appears to be a significant opportunity here if this program could also include the Home Energy Score, another BTO-funded program. Neither of these programs seems to acknowledge the existence of the other. With both of these being federally funded programs, the impact would be maximized if they could somehow work together for the new and existing home markets.
- HPwES should continue to seek feedback on the program's design, as stakeholders stand ready to continue to provide support and suggestions.
- One reviewer did not enter a response.

## Project # RBI-06: Home Energy Score

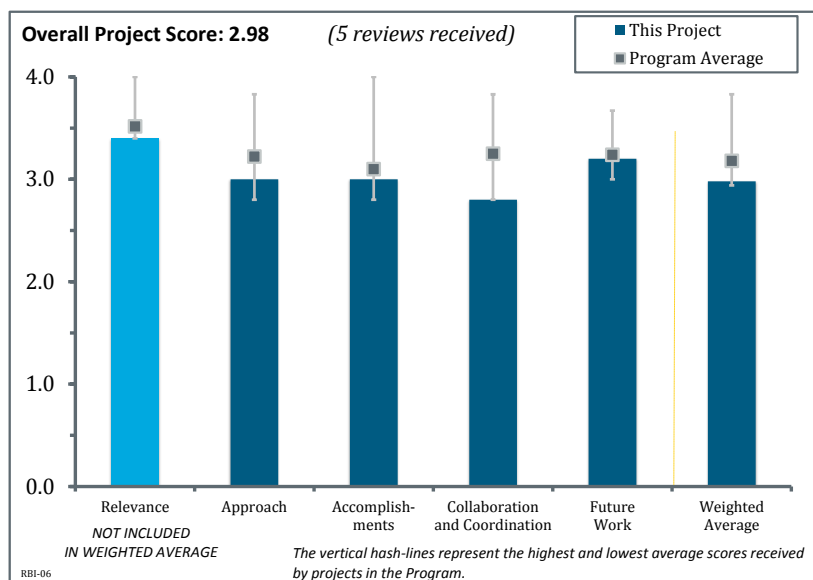
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Norm Bourassa, Lawrence Berkeley National Laboratory, njbourassa@lbl.gov

### Brief Summary of Project

The Home Energy Score offers homeowners and buyers an easy and economical way to get a credible home energy assessment, with customized advice on how to save energy and money on home utility bills. From November 2010 to July 2011, the U.S. Department of Energy (DOE) engaged with 10 partners to run a year-long pilot program to test the accuracy of the scoring Tool and gather assessor and homeowner feedback. Based on that pilot, the Home Energy Score was further refined and was launched nationally in June 2012. DOE is planning to release a new version of the Home Energy Scoring Tool in July 2013,

building on lessons learned and feedback received during the last year of nationwide program implementation. DOE is partnering with state and local governments, utilities, and non-profit organizations across the country to make the Home Energy Score widely available to homeowners.



### A. Relevance

This project was rated **3.4** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This has a huge potential to be a positive tool for a large segment of the public and really ties into all aspects of the BTO ecosystem. It also is a politically attractive program, tying into the “Recovery through Retrofit” effort.
- With a goal of the initiative being investment in energy efficiency by homeowners, this initiative is well aligned with BTO goals.
- Better information about the existing condition of a home should result in more investment toward performance improvement.
- This reviewer is actually a bit unsure about this project’s relevance. The Home Energy Score is in development, and the development has been positive, with very good access for input from stakeholders. So, on a technical level the relevance is good, within its definition as a program asset rating. But relevance comes from impacting the market, and that remains to be proven by widespread deployment over time.
- One reviewer did not enter a response.

### B. Approach

This project was rated **3.0** for its approach.

- The effort seems to have been very well researched and documented, and it is progressing ahead of schedule in terms of number of homes rated.
- Using the simplistic and understandable score is a very good strategy. Even though there was a comment made that the “estimated savings” tool was not palatable to the real estate market, it could be a very strong tool for sparking investment in making that jump in score. Use of “auditors” may not be the best approach,

and in the long term could tie the score into real estate transactions, which could make this dependent on the strong, and rather self-serving, real estate lobby. Many homeowners would not likely hire an auditor unless they were forced to do it, and this could cause some resentment and pushback with the tool. In addition, the real estate lobby could severely limit the utility of this tool if it is allowed to control its implementation and results. Commensurate with the above, there should be some consideration to making this more of a “do-it-yourself” tool. There is a need for an independent, vetted reference for many homeowners who want to make their home more efficient and help the environment while saving money. This sort of approach would eliminate the control the real estate lobby could have on the implementation of the program and make it more useful for the ultimate customer. In addition, other systems should be included with the score. Lighting is significant and is a good low-hanging fruit that could be addressed by the average homeowner. It could also pull this program away from being so tied into transactions and more into “everyday living.” This could also offer a large opportunity to bring some behavioral factors into the same tool and make it more comprehensive for those it is intended to serve.

- This reviewer has both kudos and concerns. The reviewer understands the argument for an asset-based rating in terms of the goal of objectivity and repeatability. However, it is likely that without truing up ratings against actual consumption, the program will find more variability in scores by scoring providers (shading up to satisfy customers, or down to drive customers to buy upgrades from someone) than expected, but this will prove itself one way or another when the score gets into the field. Within the asset-based framework the approach is satisfactory overall, since it has been adjusted to take account of outside commentary. It is likely that significant parts of the scoring are going to be accomplished by data mining and bulk analysis supplementing and cross-checking the work of in-home inspections. The final approach should be structured to deal with this possibility. It is still not clear that there is consensus on what the score should represent—an absolute versus a relative score. It is also unclear how it will be used—as a means to reward customers, as a way to sell homes, or as a way to sell more comprehensive audits and follow-on work. It is not clear how much better this is than the U.S. Department of Energy (DOE) Yardstick, or if that a one-size-fits-all approach is useful nationally. This reviewer does not get a sense that the program team has figured out the desired end-state of this tool.
- One reviewer did not enter a response.

### C. Accomplishments/Progress

This project was rated **3.0** for its accomplishments and progress.

- The progress involves, thus far, creating and improving the model and approach as well as limited field testing; this has been done well. As with any product rollout, the big test comes next—whether this approach will catch on and enhance the energy-efficiency home improvement market.
- This program has enormous potential for homeowners. It appears to be too early in its evolution for significant accolades (though the R&D 100 Award is impressive). However, this received a “good” rating because the progress made in a relatively short time has been impressive.
- The tool has had a couple of iterations, with good testing, and it seems to be a robust tool that assessors find useful. There has not yet been any real evaluation of whether use of the Home Energy Score tool is driving more investment in efficiency improvements.
- Because of the lack of clarity in the approach, it is difficult to determine how much progress has really been made. There have been achievements related to numbers (homes scored) and milestones (licensing, training, etc.), but from a big-picture perspective, it is still not clear what all of that means or whether it will be useful (or more useful than what is already there).
- One reviewer did not enter a response.

### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **2.8** for its collaboration and coordination with relevant stakeholders.

- Technical development and collaboration with industry players has been very good on this project. Market impact will be seen in the next phase.

- It appears that there has been strong collaboration with important market actors, and that the tool has been developed to complement existing activities. While a larger-than-projected number of homes have already been rated, the impact of the tool has not yet been evaluated.
- The only concern this reviewer has with this is that it could get too tied into certain aspects of the marketplace and the utility of the tool could get diluted. There is potential for this to be a very useful tool for many taxpayers.
- More collaboration might help better answer some of the questions for this project.
- One reviewer did not enter a response.

### E. Proposed Future Work

This project was rated **3.2** for its proposed future work.

- By producing a simple, relatively easy, and quick tool for homeowners to use to potentially help them make buying decisions, this could make an impact on the market and could even become a basis for some codes and standards with real estate transactions. By keeping the dollars to raise the score (and showing the return on investment) in a prominent place, the tool would be even more influential for its intended purpose.
- It was great to hear that the project team plans on taking on the realtor lobby to make this part of the Multiple Listing Service listings. When homeowners see Home Performance as an investment in their home, it is just another reason to go through with the work. This will help to unlock the industry.
- If the Home Energy Score tool is demonstrated to cause more investment than other existing rating systems, ongoing support should be provided to continually update and improve its effectiveness. This could also be an important source for data to feed into DOE building performance data tracking systems.
- Unless the certification approach derails the project, it should be possible to achieve production at scale in some locations over the next year and get into the crux of the matter—whether the score impacts the market.
- This reviewer is not sure where this is going in the future.

### Project Strengths:

- The positive comments primarily come from the Conservation Services Group's (CSG's) technical staff that has been working with Lawrence Berkeley National Laboratory and others to improve the technical approach embodied in the score. The numerous small- and medium-sized technical adjustments that have been made and the large and difficult adjustment of the scaling of the report has greatly improved the product.
- Strengths include the “dashboard” approach, the simplicity of the information that is presented, and the easily understandable format. This has enormous potential to become a very relevant and common reference tool if it is implemented correctly.
- There is a need for a tool that will help consumers understand the performance of their home, as compared to others of the same type and usage, and as compared to its potential. This may help homeowners value energy-efficiency work, both every day and when properties are changing hands.
- The application programming interface (API) and layers to the software were well thought out and will help for large-scale adoption.
- The concept of developing a “miles-per-gallon” rating for homes is laudable, and, if successful, it could have great market-transforming impacts.

### Project Weaknesses:

- Because the Home Energy Score program is so early in its implementation, the weaknesses are also opportunities. The first and foremost weakness is the limited approach. By directing it primarily toward transactions (and thus outside auditors), there is a large segment of homeowners who would not fully benefit from the utility of this tool. In addition, the approach opens up the implementation and potential code adoption to possible corruption by the powerful real estate lobby. The fact that only limited home energy systems are included also seems to support the score's use only in transactions. If the approach were to include more of the “real world” of a typical homeowner, there is an opportunity for much of the public

to use this tool to make internally driven changes (e.g., behavior) and externally driven decisions (e.g., replacing a major system) that could produce savings and help reduce their own carbon footprint.

- The score has not been proven to move the market of homeowners, realtors, or others to spend money on energy-efficiency improvements to raise their score. There is anecdotal evidence that energy-efficiency ratings matter in new and used homes sales, but there has been no proof yet that the scoring system contemplated here will capture that value. The scoring system should be tried out and tweaked as needed.
- As opposed to starting with a product and then trying to figure out where it fits, it might be better to start by exploring the real needs and designing a product to meet those needs. There are many roles for a scoring tool in the marketplace, but this reviewer does not get the sense that this project has yet determined what is being built.
- There is a very fine balance between the goal of providing low-cost information for decision makers and providing consistent, validated information. Quality control and the repeatability of results by different energy raters will be critical if this is to be a useful tool.
- One reviewer did not enter a response.

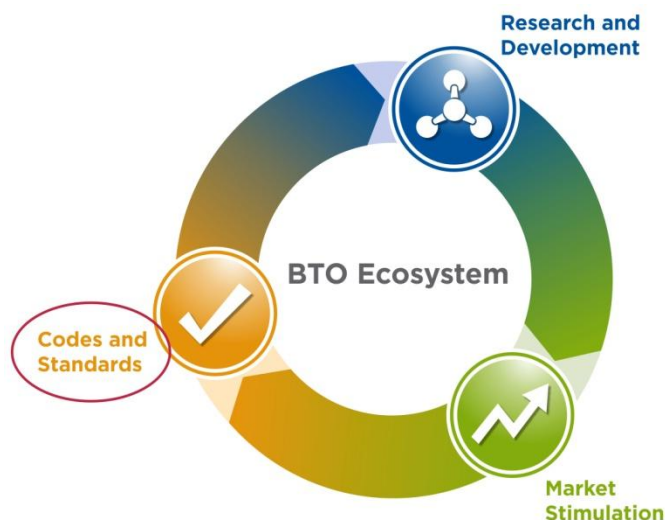
#### Recommendations:

- This program should be aligned tightly with the Home Performance with ENERGY STAR program. That program seems to be covering the new homes market, but it may be the weaker program because of its limited approach. The Home Energy Score program appears to have a refreshing, new, simpler approach that has enormous potential. Aligning the two programs as equal partners could really have a huge market impact and allow them to become major players in reducing energy use across the board.
- It appears that this project is getting more complex as time goes on. To improve the “correct bin” score of 67%, more fine-tuning is likely needed. It is unclear how the value of the score compares to auditing tools or if 67% is good enough. It is not clear how this can be used in the marketplace.
- The project team should carefully study whether Home Energy Score participants really implement more projects (greater investment in energy efficiency) than participants who use other tools in the market.
- This reviewer has not used the tool, and therefore does not have any detailed recommendations to offer. However, the project team seems to be taking an intelligent approach. The conclusions reached by the team regarding the challenges it uncovered were balanced and thoughtful. The reviewer looks forward to incorporating Home Energy Score in the field.
- One reviewer did not enter a response.



## 6. Building Energy Codes Program Summary

Through BTO's Building Energy Codes Program, the U.S. Department of Energy supports efforts to increase the energy efficiency of buildings by developing and implementing model codes and standards. Building energy codes and standards are designed to set minimum efficiency requirements for new and renovated buildings so as to reduce energy use and emissions over the life of the building. The Building Energy Codes Program, in addition to the Appliance Standards Program, are viewed as BTO efforts to "lock in the savings" of building efficiency technologies through voluntary and regulatory activities (see Figure 7).



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

In addition to developing model energy codes and standards, the Building Energy Codes Program:

- Supports energy code adoption and implementation in states and local jurisdictions;
- Assists building industry stakeholders and enforcement officials in achieving compliance of energy codes;
- Establishes regulations for energy efficiency in Federal buildings and manufactured housing; and
- Provides compliance tools, training materials, and technical assistance options.

The Program's goal is to enable energy savings of 1.3 quads by 2020, saving consumers \$7.4 billion, and reducing carbon pollution by 93 million metric tons annually. The Program monitors state and local-level building energy code adoption and compliance to assess its effectiveness in influencing changes in code development, adoption, and compliance.

## Project # COD-01: Building Codes Technical Assistance

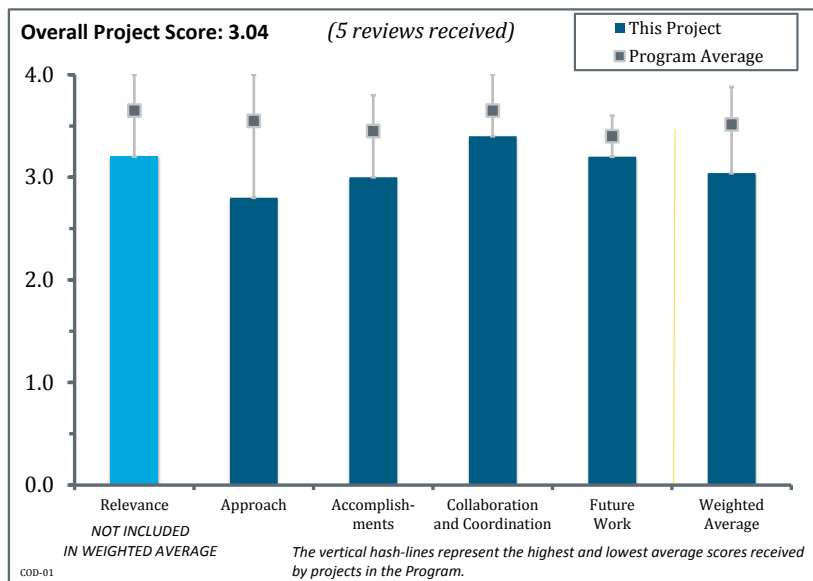
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### Brief Summary of Project

The primary goal of this project is to engage, through technical assistance, state energy offices (SEOs) in energy code adoption, implementation, and compliance activities. Objectives include the facilitation of interactions between SEOs and utilities, coordination of code support based on individual state needs, and the creation of case studies and other resources. Through its unique relationship with SEOs, the National Association of State Energy Officials (NASEO) has the capacity to disseminate its technical knowledge, support, and resources to this key stakeholder group, as well as communicate their needs up to the national level. These activities

increase SEO involvement in adoption and compliance, which helps to ensure state-level support.



### A. Relevance

This project was rated **3.2** for its relevance to Building Technologies Office (BTO) goals and objectives.

- This program provides direct support to one of BTO's most important partners and allies—SEOs. This NASEO program helps keep building energy code policy and progress as a priority in SEOs. It also helps educate the SEOs on current U.S. Department of Energy (DOE) energy code policies and goals for proper coordination. More broadly, the NASEO program also coordinates efforts with the larger energy code advocacy community.
- The involvement of SEOs in the national policy-level discussions about building efficiency is crucial. Because many of these offices are either directly or indirectly involved in the adoption and implementation of building energy codes, they simply cannot be ignored in the process.
- The activities that NASEO is involved in support BTO goals and objectives. That being said, the project duplicates activities that others (e.g., the Midwest Energy Efficiency Alliance [MEEA], Southeast Energy Efficiency Alliance, Building Codes Assistance Project [BCAP], and Responsible Energy Codes Alliance) are already performing; for example, webinars, contact with SEOs, outreach and working directly with states, and conference calls with SEOs focused on energy-code-related topics. This is viewed as a duplication of effort. Working with utilities is valuable, but others (e.g., MEEA and the Southwest Energy Efficiency Project) are also doing this.
- The project supports the BTO goals and objectives. The project supports the compliance and enforcement of residential and commercial building energy codes through collaborative efforts with local governments and industry groups and by improving awareness among SEOs regarding key tools and assistance for code compliance and enforcement. However, the project fails to address code adoption.
- The project team needs to differentiate what gap this project fills that is not filled by other organizations. The team should consider what this project does that is different from other groups, and what activities are best suited for certain states.

## B. Approach

This project was rated **2.8** for its approach.

- NASEO has convened discussions about utility involvement in building codes and compliance with existing codes in a way that other entities probably could not. Because NASEO is already an established, stand-alone entity that serves the needs of SEOs, it is viewed as a trusted and unbiased source of information.
- The predominant approach for the NASEO project might be described as leveraging resources, extensive outreach and education, and broad coordination with allied groups. It seems to be addressing the barriers presented in the session.
- The project identifies the fact that states have limited ongoing funding sources to make their activities sustainable. The project works to overcome this barrier through utility engagement and coordination with other energy codes organizations. The design of the project is good if one is fortunate enough to have utilities that want to work with the SEOs. That is not always the case. The project needs to make a better effort to understand specific state needs.
- The barriers were identified—one of them being a shift in emphasis from adoption to enforcement—but it did not appear that NASEO addressed the state compliance issues.
- The barriers are not really addressed; however, overall it seems like a good approach. It is unclear if the project team has a means for tracking the impacts of its efforts within states beyond contacts or attendance.

## C. Accomplishments/Progress

This project was rated **3.0** for its accomplishments and progress.

- Most aspects of the project align with BTO objectives in the following ways: (1) The project supports state efforts to improve energy codes compliance and enforcement by creating opportunities for states to learn from one another, and it works with the Building Energy Codes Program/Pacific Northwest National Laboratory (PNNL) and others to promote compliance tools to the states. (2) The project provides key tools and assistance for code development, adoption, and implementation by organizing frequent exchange with NASEO's Buildings Committee, disseminating resources to code contacts at SEOs, and developing codes needs assessments based on SEO input. (3) The project promotes increased utility support for building energy codes programs by providing outreach to utility associations and engaging their members. It also encourages SEO engagement with public utility commissions on the value of energy codes compliance programs under utility efficiency programs.
- The NASEO program is accomplishing all that it can, given the challenges of the subject matter and the relatively modest program resources. One of NASEO's main "products" is information exchange, and the project plan indicates that all milestones are being met. This includes webinars, research reports, meetings, and so forth.
- Based on the presentation, it appeared that NASEO accomplished what it had set out to do during the last two quarters of 2012 and the first quarter of 2013.
- Accomplishments are represented by the number and nature of contacts, attendance, etc. The project seems to be on its time line. Without having seen the original proposal, it is difficult to understand whether the project is meeting its qualitative performance indicators.
- Many of the stated project goals, such as meetings and webinars, are difficult to quantify in terms of success. NASEO presented a solid list of webinars, publications, and other activities that all generally support the broader BTO goals. While NASEO appears to have the right large-scale goals in mind, the project could benefit from some additional focus on specific accomplishments. Given the relatively small size of the budget for a group representing 56 states and territories, it may help to reduce the scope to one or two of the stated goals. Utility work and state code compliance are two massive topics that involve many players. NASEO has the capability to promote specific causes within these categories, but it cannot solve all of the problems itself.

#### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.4** for its collaboration and coordination with relevant stakeholders.

- The NASEO program is all about collaborations, tech transfer, and having an impact with the SEOs. As one example, NASEO's research report on utilities and building energy codes has had an impact in raising awareness on this topic among policy makers. NASEO has been one of the leading advocates for utility involvement in building energy code compliance.
- The project staff coordinates with regional and national codes organizations to accelerate movement of practices into the market. This is accomplished by a variety of methods—webinars, conference calls, in-person meetings, and case studies.
- NASEO has done a good job in coordinating with the regional energy efficiency organizations (REEOs), DOE, BCAP, and PNNL. NASEO also coordinates extensively with the SEOs.
- This project features good coordination and interaction with a variety of organizations.
- NASEO has access to a large body of stakeholders at multiple levels. While NASEO appears to be a part of many important conversations about building efficiency, this project could use a more focused mission. It is unclear whether NASEO is a facilitator of these conversations or if it is driving its membership and others toward a common goal. For example, NASEO might consider locally or regionally focused utility work or compliance initiatives that are more natural outgrowths of its capabilities.

#### E. Proposed Future Work

This project was rated **3.2** for its proposed future work.

- The NASEO program's future plans call for greater efforts with utilities and energy code compliance programs, with the Tennessee Valley Authority as a major potential participant. These are important initiatives that build on past progress. The plans also call for more webinar educational outreach on code topics as well as a research project of state-level energy code compliance best practices. These future plans clearly build on past progress and are sharply focused on barriers.
- The proposed future work articulates future elements under the contract and considers what activities are needed beyond this contract.
- The goals appear to be in the right place, including utility involvement in building energy codes and better compliance. The project could use a more focused path to the future, possibly including development of its own keystone issues.
- New work was identified that will be of value, especially the project team's engagement with utilities. The team has proposed tracking activity across the country, but it is unclear what it will do with the information and how it will get this into the hands of those who need it. Future work should also include holding the national energy conference and developing case studies on states that have successfully met the 90% compliance goal.
- The proposed future work builds on past progress but does not seem to consider impediments to its goals.

#### Project Strengths:

- The major strengths of the NASEO program are the following:
  - Provides access and direct support to an important DOE BTO constituent group.
  - Oriented to producing information products that can be shared and used by SEOs.
  - Provides outreach, education, and support for emerging solutions such as utility support for energy code compliance.
  - Networking, coordinating, and relationship building are an integral part of the program.
  - Delivers value for a relatively modest budget.
- Given the funding levels (\$175,000), the project team has accomplished what it set out to do. It has contacts with each SEO and can effectively distribute information to them.
- NASEO's existing network of 56 state and territory energy offices and its committee structure are strengths that gives great potential for meaningful contact with states.

- This project does a great job of improving awareness among SEOs regarding energy codes resources. The project improves the coordination of various energy codes organizations at the national and regional levels in order to improve support provided to the states.
- NASEO brings an important perspective to the discussion about building energy codes.

### Project Weaknesses:

- The project team has to operate in the state government political environment to some extent, which limits what they can do.
- The only weakness—and it is not clear if it is a true weakness—is that about half of the states are not working more closely with NASEO.
- While NASEO seems to have a good handle on the needs of its individual members, there appears to be a great deal of overlap between its efforts and those of other organizations. NASEO represents a very important pipeline for the advancement of building energy codes, and it could take on a more advocacy-driven and focused role.
- The tasks that NASEO is performing are a duplication of others' efforts. The REEOs and BCAP have been effectively working in this field for several years and perform the same functions as NASEO, but they have more experience in this area. It would be best to shift the contract emphasis to hosting the national energy code conference and away from the current work plan.
- The project fails to address code adoption and assumes that all utilities are willing to work with SEOs.

### Recommendations:

- The NASEO project is an important conduit to a key constituency with a track record of performance, and it should be continued.
- The project team needs to identify opportunities to work with specific energy offices to incorporate compliance, enforcement, and training programs that have been effective in other states.
- Two reviewers did not enter a response.

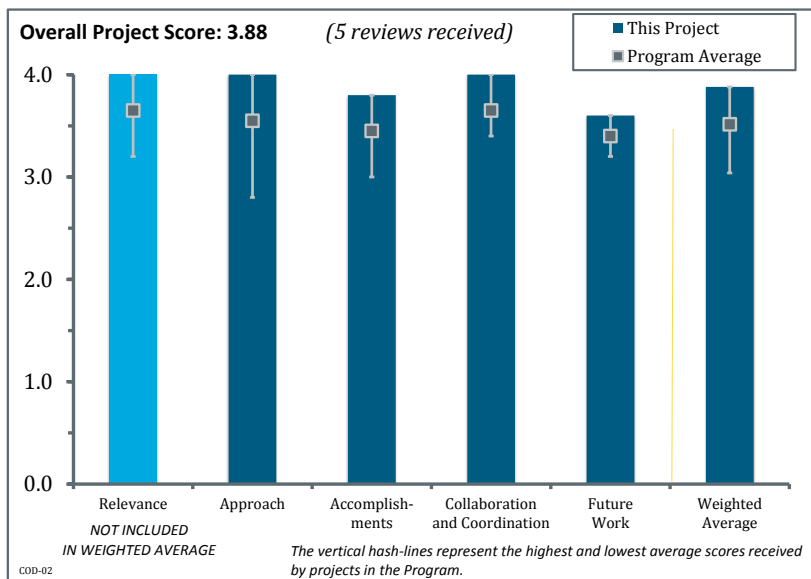
## Project # COD-02: Midwest Building Codes Technical Assistance and Commercial Projects

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### Brief Summary of Project

The goal of the Midwest Energy Efficiency Alliance (MEEA) project is to provide technical assistance and stakeholder engagement in support of energy code activities in states and municipalities in the Midwest. Specific objectives include adoption technical assistance, compliance technical assistance, and collaboration with the National Collaborative on Energy Codes. MEEA maintains a reputation as the technical expert for energy code issues in the Midwest, and through this project can identify opportunities for code advancement, direct necessary resources to states and jurisdictions in need, and respond to issues as they arise. As such, MEEA's project helps to ensure that states and municipalities throughout the Midwest adopt more stringent energy codes and implement them effectively.



### A. Relevance

This project was rated **4.0** for its relevance to Building Technologies Office (BTO) goals and objectives.

- The MEEA is one of the regional energy efficiency organizations (REEOs) that support the U.S. Department of Energy (DOE) directly for state and regional code activity. The goals and objectives of MEEA and the REEOs are well coordinated with DOE's goals and objectives, as well as with other sponsors of this kind of work, including the Energy Foundation. Considerable effort was put into a reorganization of REEO effort over the past couple of years. This has resulted in smoother operations among national, regional, and local advocacy groups. MEEA's program summary presentation demonstrates the in-depth alignment between MEEA and the DOE program. This was carried all the way through the evaluation session.
- MEEA fills a crucial role in a region that has undergone significant political change in recent years. Building energy efficiency is no less important now than it was a few years ago, yet MEEA faces increasing opposition to energy efficiency policies. While many individual groups are involved in specific components of the building energy efficiency effort in the Midwest, MEEA is the trusted, well-positioned entity that is able to bring these components together.
- MEEA has done an outstanding job of supporting the BTO goals and objectives through its work in getting state adoption in states that have been slow to adopt (e.g., Ohio, Minnesota, and Illinois). MEEA has also been successful in getting adoption in jurisdictions that are part of home rule states. It has also been very proactive in working with utilities in getting them to support energy code compliance.
- This project has made significant progress toward BTO goals and objectives. The project fully supports BTO's aims to improve building energy efficiency and to help states achieve 90% compliance with their energy codes.
- This project features good interaction with other key organizations in bringing energy code adoption and compliance to states.



## B. Approach

This project was rated **4.0** for its approach.

- Given the fluid nature of energy code adoption, MEEA has done an excellent job of working with the stakeholders within each of the states that it has focused on for adoption to get the code into those states. This has been done without a significant amount of resources (barrier), and while working with multiple stakeholders that may only support code adoption, under their circumstances (barrier). MEEA has also had to find technical information to support its efforts, or in some cases, to create the resources (barrier).
- MEEA's approach to carrying out this work in a difficult region is well thought out and well executed. The key components of MEEA's approach as laid out in its presentation include considerable outreach and education and technical support. MEEA also addresses the formation of local stakeholder groups. MEEA also has targeted approaches for both code-related activity and benchmarking activities. This approach is the kind needed to tackle the major barriers MEEA identified on slide 2 of the presentation.
- MEEA fills an important policy and technical role in the Midwest. In the realm of state energy code adoption, implementation, and enforcement, it is important to have a handle on the large-scale political issues, as well as an eye for the technical feasibility of building energy efficiency policies. MEEA's staff includes some of the nation's best policy and technical experts.
- The project does an outstanding job of identifying the critical barriers and addressing each with the approach used to overcome them. The project's design is wonderful. Customizing strategies for each state and targeted municipality makes the project very feasible.
- The approach addressed barriers such as decentralized code adoption; lack of resources for enforcement; big variation among the states; multiple stakeholders; and the lack of factual, policy, and technical information. The approach was thoughtful, and it included regional specifics and benchmarking, as well as a focus on newly elected officials (since 2008, all new governors and 40% new legislators, with an increase in Republicans).

## C. Accomplishments/Progress

This project was rated **3.8** for its accomplishments and progress.

- MEEA has been outstanding in its accomplishments through the DOE program sponsorship. For energy codes, the 2012 International Energy Conservation Code (IECC) adoption in Illinois was a major regional milestone in a formerly home rule state for energy codes. The adoption of the 2009 IECC in six states and several large municipal jurisdictions in a difficult region showcases MEEA's advocacy abilities. MEEA is also at the forefront of a serious effort in Illinois to have the utility regulator (the Illinois Commerce Commission [ICC]) launch a proceeding to include energy code compliance support in utility efficiency programs and for the utilities to receive credit for their efforts. MEEA has also made considerable progress on benchmarking policies in the region. Overall, MEEA is an outstanding organization with true regional reach.
- MEEA has proven to be highly adaptable when it comes to promoting energy efficiency in the Midwest. While "success" is difficult to quantify in absolute terms, MEEA's staff has been extremely effective at being at the core of significant energy efficiency decisions on a regular basis. Although the resistance to progress has been particularly strong in recent years, MEEA has shown its ability to create new opportunities to advance building energy codes.
- This project has made significant progress toward the BTO goals and objectives. The progress is evidenced by the billions of Btu saved annually in both residential and commercial construction.
- The presenter reported specific accomplishments on code adoption in states. These seem to be the right actions that organizations such as this should be undertaking in keeping momentum on energy codes in the states.
- If code adoption is a measure of an accomplishment, MEEA has performed very well in this contract.



#### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **4.0** for its collaboration and coordination with relevant stakeholders.

- As shown in its presentation documents, MEEA carries out extensive coordination and collaboration with national and regional stakeholders to accomplish its program goals. The collaboration work is focused on overcoming the barriers MEEA has identified. The tech transfer efforts have focused on the utility codes program efforts in the region and on benchmarking processes. For the code adoption activities for the 2012 and 2009 IECC, MEEA has estimated Midwest regional market impacts for residential codes and commercial codes at 3.7 billion and 1.9 billion Btu, respectively, with additional impacts from benchmarking programs.
- Although MEEA is a part of multiple efforts to improve building energy codes across the Midwest, MEEA staff appear to understand the delicacy and personalization required in adoption and implementation efforts in each state and locality. MEEA also contributes a significant amount of original concepts and approaches to the national effort. Many of MEEA's individual successes have been shared and repeated elsewhere in the country.
- The staff does a great job of collaborating and coordinating with local, regional, and national stakeholders in an effort to meet the project objectives. This has allowed customized strategies to be developed for each state and targeted municipalities.
- MEEA coordinates and collaborates with many key stakeholders in the states that it works in and effectively transfers information to others to help meet its goals.
- This project features good collaboration with appropriate groups.

#### E. Proposed Future Work

This project was rated **3.6** for its proposed future work.

- MEEA's future plans focus on promoting benchmarking programs around the Midwest region, including in Chicago, Michigan, and major municipalities. MEEA also plans to advocate for the adoption of the 2012 IECC in other Midwest states. MEEA will also pursue the utility codes program opportunity with ICC regulators in Illinois and use the successful results as a template for other efforts. The project team's future plans build on past progress and continue to focus on regional barriers to progress.
- The future plans clearly build on past progress. By using lessons learned, future efforts will be made with a better understanding of the barriers to the project goals. This will result in a greater ability to mitigate risk.
- MEEA has plotted a reasonable and achievable plan for the future, and it appears to be thinking forward in its approach to utility claimed savings.
- The proposed plan that MEEA has put forward for the future is a logical step based on the work completed to date.
- The proposed future plans laid out benchmarking plans.

#### Project Strengths:

- MEEA's project strengths include the following:
  - MEEA has earned a reputation as a center of excellence for energy policy and code advocacy throughout the Midwest region.
  - MEEA's project approach of outreach and coordination is a major element of the organization. MEEA serves a central organizing function for energy efficiency in the Midwest.
  - MEEA's accomplishments are truly impressive, especially given the degree of difficulty of promoting energy efficiency policies in a challenging political environment.
- Given the size of the DOE contribution to MEEA's budget and the impact of MEEA's programs on the Midwest (not to mention the creation of approaches with national appeal), this program gives an extremely high return on DOE investment.
- MEEA has been very successful in working with states in its region to increase code adoption. It has also been one of the leaders in getting utilities to support energy code efforts in addition to working on

benchmarking efforts. Funding MEEA is a great investment given the progress that it has made over the last few years.

- The project does a great job of collaborating with stakeholders. This allows customized strategies to be developed for each state. The project reflects the fact that there is no silver bullet.
- The presenter laid out specific accomplishments in activities and in energy saved. There is a typo on the quantities of energy savings on slide 10 when compared to slide 11. This organization is well connected and works with a variety of organizations.

### Project Weaknesses:

- There are no significant weaknesses with the MEEA program. MEEA is about as effective as it can be with the given resources.
- There are no weaknesses. The most intense activity takes place in Illinois. There is activity and intensity for other states, but the Chicago efforts should be matched in more locations. The future benchmarking activities do see to target other areas.
- It is difficult to point to particular weaknesses with MEEA, given the fluid nature of code adoption and compliance. Perhaps the greatest weakness is a lack of funding, given the number of states in the MEEA region.
- Two reviewers did not enter a response.

### Recommendations:

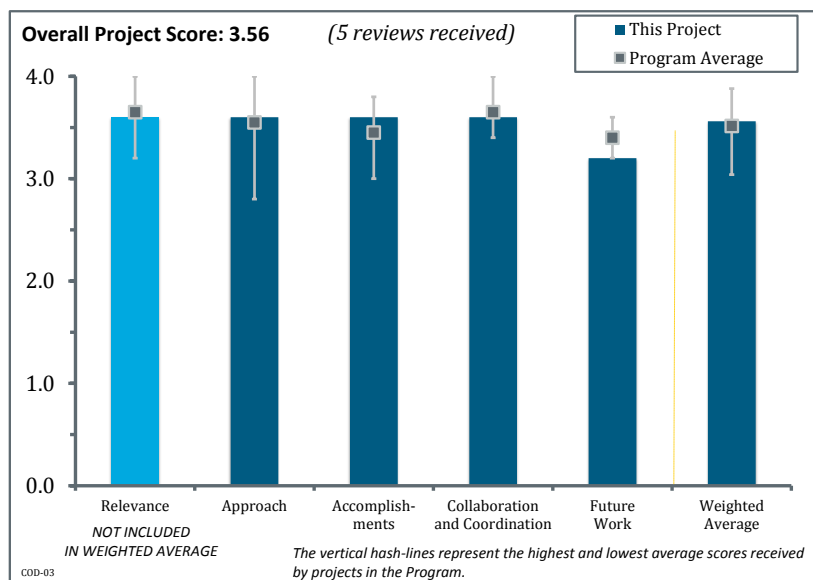
- It is important to bring state policy makers from both parties into the process. This will provide them with the best information to base their decisions on.
- DOE should continue this project.
- Two reviewers did not enter a response.

## Project # COD-03: National Building Codes Collaborative and Technical Assistance

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### Brief Summary of Project

The goal of this project is to coordinate the National Collaborative on Energy Codes, which includes the U.S. Department of Energy (DOE), Pacific Northwest National Laboratory, the regional energy efficiency organizations (REEOs), and the National Association of State Energy Officials, and to provide technical assistance to states. Through this effort, the objectives of the Building Codes Assistance Project (BCAP) are to develop and disseminate resources as needed, assist in state and local adoption and implementation strategies, provide local support as needed, and communicate needs and goals to and from DOE. BCAP has the capacity to engage the wide variety of energy code stakeholders and, through this project, coordinate and disseminate resources and support between the necessary channels. These efforts help to leverage the code support activities that all members of the National Collaborative engage in—ultimately supporting energy code adoption and compliance efforts.



### A. Relevance

This project was rated **3.6** for its relevance to Building Technologies Office (BTO) goals and objectives.

- BCAP provides information and leadership to the building energy codes community and is central to the national energy codes advocacy effort. Some of the key BCAP contributions include (1) direct energy code support to states, including code adoption information and code compliance gap analysis; (2) formation of state compliance collaboratives; (3) the Online Code Environment and Advocacy Network (OCEAN), the online energy code information resource; (4) impartial construction cost information for state International Energy Conservation Code (IECC) adoption; (5) estimates of energy code savings and impacts for state policy makers; (6) status of state code adoptions; and (7) newsletters and code alerts. BCAP is highly relevant and directly supports DOE's code adoption and compliance goals.
- BCAP is focused on assisting DOE in meeting its goals of 70% state energy code adoption and 90% compliance with the energy code. The BCAP project looks to be specifically designed to support these goals.
- BCAP is a critical hub of activity for the entire building efficiency community. No other organization provides such a robust clearinghouse for all publications, analyses, and other material supporting the advancement of energy efficiency in the built environment.
- This project is a clearinghouse and hub for information with the REEOs. It is focused on collaboration and working with other organizations. This type of organization is needed to work with the REEOs. It is a key leader in promoting energy codes adoption, training, and compliance.

- This project has made significant progress toward BTO goals and objectives. This project effectively assists states and jurisdictions in adoption and compliance efforts and serves to develop and work in partnership with organizations that support energy codes.

## B. Approach

This project was rated **3.6** for its approach.

- BCAP's approach in summary is collaboration, communication, and staying at the cutting edge of what states need and want. A couple of examples include the following:
  - In state code adoption proceedings, construction cost information is often contested. BCAP has provided objective fact sheets and cost estimates to provide an impartial view. This information has helped overcome that particular barrier in numerous states. BCAP also provides information on energy savings, environmental benefits, and consumer energy cost savings to state policy makers.
  - BCAP's compliance assistance project has provided states with an in-depth assessment of code compliance and enforcement capabilities in a given state. BCAP works with state and local stakeholders to implement the plan. This is a very hands-on approach, yet it provides a consistent template from state to state.
- Several barriers were identified including politics, different situations in each location, perceptions of increased costs, builder opposition, state agencies, local staff may not be knowledgeable, and a lack of advocates. The approach was identified as collaborative; staying at the cutting edge of what states need and want; maximizing results by leveraging other funding to DOE funding, 2:1; communication; and outreach. These all seem appropriate and match BTO objectives.
- This project does a good job of addressing the fact that there is a lack of knowledge, resources, and support at the state and local level. In an effort to overcome the issues, the project collaborates with state experts to provide state-customized resources.
- BCAP has a good handle on the high-impact issues facing building energy efficiency, as well as an eye to the future. For example, BCAP was well ahead of the curve on identifying compliance as a key issue in improving building efficiency across the country.
- BCAP has identified a short list of barriers that seem to cover the typical barriers common to code adoption and compliance. BCAP has addressed the barriers with the information and products that it has produced.

## C. Accomplishments/Progress

This project was rated **3.6** for its accomplishments and progress.

- The BCAP presentation package provides an overview of the organization's accomplishments. The key areas are the following:
  - Code adoption actions in 14 states. BCAP was a key participant in these state code adoptions. It appears that DOE's goal of 70% of the states adopting the 2009 IECC and ASHRAE 90.1-2007 has been met.
  - Code compliance initiatives in 24 states. BCAP worked with individual states to improve compliance with energy codes, making progress toward DOE's 90% compliance goal.
  - It is fair to say that BCAP made excellent, measurable progress toward DOE's objectives.
- BCAP is laying the groundwork for some good long-term successes. Success in energy code adoption and implementation is difficult to quantify, given the number of entities involved and the particular histories and challenges in each state and locality. However, BCAP has shown itself to be highly adaptable to these specific challenges—a quality that has led to improved collaboration among stakeholders, better coverage around the country, and better results.
- Given the funding level provided to BCAP, it has been successful in working with other interested and affected parties including the REEOs to get codes into the states. What is unclear is if BCAP is taking credit for code adoption within the United States or whether state code adoption is due to the work done by the REEOs. It is also unclear what impact the compliance plans that have been developed under this contract have had on energy code compliance.

- The presenter laid out several project accomplishments, including sharing best practices; serving as a catalyst for developing state-based, long-term solutions; and the OCEAN website. The project appears to be on track.
- With nine states adopting or updating energy codes in 2012, this project has demonstrated significant progress toward its objectives. The potential savings in all nine states further demonstrate measurable progress toward BTO goals.

#### D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.6** for its collaboration and coordination with relevant stakeholders.

- The heart of BCAP's operations is collaboration, mostly at the state level. BCAP has provided leadership, organization, and objective technical information to stakeholder groups working on code adoption or improving energy code compliance. Much of this is close, hands-on work, where success of the effort depends on partners being full participants. BCAP's participation accelerates progress on energy code issues. BCAP also collaborates with national and regional groups and holds stakeholder meetings and steering committee meetings. The tech transfer aspect of BCAP's work involves other capabilities.
- BCAP's OCEAN website is possibly the largest library of building-energy-related materials available on the Web today. Although some DOE sites may receive more monthly hits, the range of materials presented on OCEAN is much broader and often much more current.
- BCAP has taken the lead of the Energy Code Collaborative and has worked effectively in transferring information to stakeholders.
- This project is a clearinghouse and hub for information with the REEOs. It is focused on collaboration and working with other organizations, and it works with all of the major relevant organizations and REEOs.
- The project staff does a good job of collaborating and coordinating with stakeholders at both the state and national levels.

#### E. Proposed Future Work

This project was rated **3.2** for its proposed future work.

- BCAP appears to devote a good amount of its time to identifying barriers and plotting out its long-term strategy. This is a useful program that continues to achieve results, even in the face of increasing opposition from special interest groups at state legislatures and administrative bodies.
- BCAP's future plans emphasize expanding the energy code compliance efforts. These compliance initiatives directly target overcoming barriers to DOE's code compliance goals. The project team plans to expand proven programs that have worked in the field.
- The proposed future work is a logical next step, but it would be good to see evaluations built into any future plans to see how effective the activities are as they relate to compliance.
- The project team should provide more definition of future activities; some are extensions of current efforts. It is unclear what activity is needed in the next contract.
- Future plans are built on past progress, but they lack a state-specific focus.

#### Project Strengths:

- BCAP's rating is warranted because of the following reasons:
  - BCAP provides information and leadership to the building energy codes community and is central to the national energy codes advocacy effort.
  - BCAP provides direct energy code support to states, including code adoption information and code compliance gap analysis.
  - BCAP has provided objective fact sheets and cost estimates in code adoption proceedings to provide an impartial view. This information has helped overcome that particular barrier in numerous states.
  - BCAP made excellent, measurable progress toward DOE's objectives for code adoptions and code compliance.

- BCAP has provided leadership, organization, and objective technical information to stakeholder groups working on code adoption or improving energy code compliance. BCAP's participation accelerates progress on energy code issues.
- BCAP employs a well-organized and focused approach to promoting building efficiency around the country. It appears to balance its national expertise with a healthy amount of grassroots support to achieve success.
- Given the budget and scope of the project, BCAP has done a good job in assisting DOE meet its goals in adoption and compliance. BCAP has assisted when needed and has been proactive in providing resources where needed, including the state compliance plans.
- This organization is connected to all relevant groups, works closely with REEOs, and has activities in states. It is a key player in the national network for promoting energy code adoption and compliance.
- The project has the ability to disseminate a lot of information through its numerous partners.

#### Project Weaknesses:

- There are no perceived weaknesses other than that there can be a tendency to lock into a solution from one state and promote it for another state. It is important that the differences in individual REEOs and states may necessitate specialized approaches. One-size solutions will not fit all. While it is a benefit that there is a national perspective, state-specific solutions are needed. This organization does and must work very closely with the REEOs and states to make sure there is a relevant local stamp on its proposed solutions.
- One of OCEAN's strengths is at the root of perhaps its only weakness—the sheer volume of material on the website. It was encouraging to hear that BCAP intends to invest some additional time into organizing OCEAN according to topic areas.
- More evaluation should be included as part of the work plan to determine how effective the compliance plans are in addition to the collaborations that are being promoted in states.
- The project does not focus enough on state-specific needs.
- There are no significant weaknesses within the BCAP program.

#### Recommendations:

- Continue to support this valuable and effective program.
- No additional recommendations.
- Three reviewers did not enter a response.

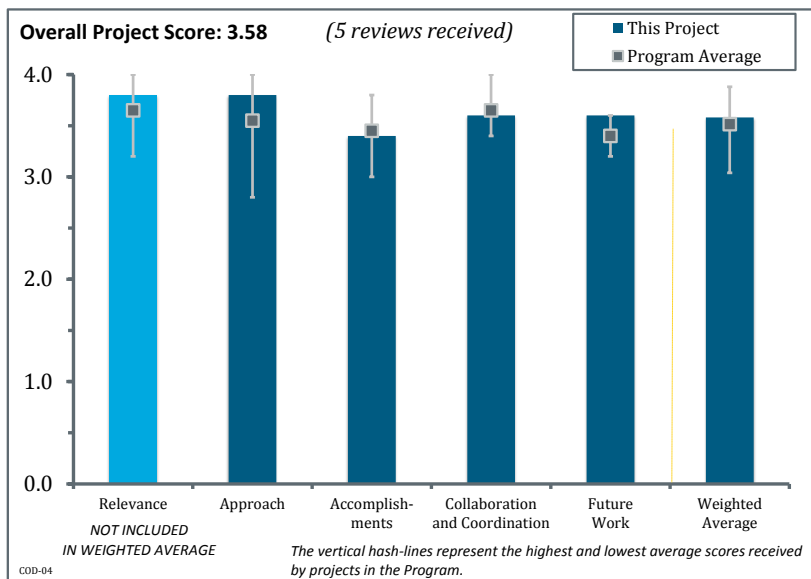
## Project # COD-04: Southeast Adoption and Compliance Technical Assistance

Jenah Zweig, Southeast Energy Efficiency Alliance, [jenah@seealliance.org](mailto:jenah@seealliance.org)

Kym Carey, U.S. Department of Energy, [kym.carey@ee.doe.gov](mailto:kym.carey@ee.doe.gov)

### Brief Summary of Project

The goal of the Southeast Energy Efficiency Alliance (SEEA) project is to provide technical assistance and regional stakeholder support for energy codes in the Southeast. Specific objectives include adoption technical assistance, compliance technical assistance, and collaboration with the National Collaborative on Energy Codes. SEEA meets these objectives by seeking strategic locations for adoption support and implementation programs, promoting regional and national best practices in “laggard” areas, and training stakeholders on new and updated energy codes. Through its on-the-ground support, SEEA’s project has played a role in a number of regional success stories, increasing code adoption and compliance while coordinating with the U.S. Department of Energy (DOE) and the rest of the National Collaborative.



### A. Relevance

This project was rated **3.8** for its relevance to Building Technologies Office (BTO) goals and objectives.

- SEEA is rated outstanding because the program is fully aligned with DOE goals and objectives for code progress in the region. SEEA is a critical organization because it provides unique access to energy-efficiency decision makers in the Southeast through stakeholder coalitions. SEEA is highly relevant to DOE. SEEA is a relatively young organization, but it has been able to establish itself as a respected, nonpartisan, and objective source of information on energy codes. SEEA’s accomplishments to date demonstrate its relevance in a challenging region.
- The goals of this project directly support DOE’s adoption goals of code adoption as well as its compliance goals. The adoption of ASHRAE 90.1-10 by Mississippi and the development of the compliance-related manuals by Georgia are prime examples of this effort.
- The Southeast is an area of opportunity for building energy efficiency. Although the region has some unique challenges, it is important to have a regionally based entity that can respond to the specific needs in these states. However, like any region of the country, the South is not monolithic. Where there are opportunities to advance energy efficiency, SEEA must take those opportunities. For the most part, SEEA has effectively identified these opportunities.
- The project supports greater adoption of residential and commercial building codes through collaborative efforts with local governments and industry groups, and by providing key tools and assistance for code development, adoption, and implementation.
- Regional energy efficiency organizations (REEOs) are necessary in providing momentum to individual states. They can act as a go between for national organizations such as DOE, the Building Codes Assistance Project, and individual states.



## B. Approach

This project was rated **3.8** for its approach.

- Success = vision + people + funding + politics. SEEA has a well-thought-out approach and is beginning to implement it in several states. Barriers cited include a lack of on-the-ground, in-state groups. SEEA provides momentum and resources for local/state groups.
- SEEA's approach is to invest in coalition and relationship building that leads to direct technical and educational support to energy code users. SEEA's coalition-building efforts have been challenging, but the organization has been able to find common ground with homebuilder associations and utilities. There has been considerable code training and "how-to" energy code guides for builders. There is certainly more that can be done and is addressed in SEEA's future plans. It is highly probable that SEEA will get "outstanding" ratings in this area in future program years.
- Given the lack of energy code adoption in the Southeast, except for in Florida and Georgia, SEEA has done an outstanding job of working with states that have not adopted codes in the past to get them to adopt. Its "people-oriented" approach has worked well.
- The barriers to code adoption, implementation, and compliance are addressed and ways to overcome the barriers are explained. The project's design is outstanding because it provides a tailored approach to specific state and locality needs. The tailored approach makes for a feasible plan.
- SEEA has been very effective at bringing together a variety of stakeholders into the process of updating and implementing building energy codes. As a new entity, SEEA has not yet established the same reputation as other regional entities, but it appears to be heading in the right direction.

## C. Accomplishments/Progress

This project was rated **3.4** for its accomplishments and progress.

- SEEA covers a large region with a relatively small staff, so it is difficult to quantify or attribute successes during the project period. The stated goals and progress in SEEA's presentation cover a broader period than the project funding dates, but these projects often require attention for years before true success is achieved. SEEA has been involved in several states and localities and has built good relationships with key decision makers in the region. Although SEEA has begun developing its own brand of code compliance materials, there is still room for SEEA to grow in the South, both in code adoption and enforcement. The keys to future success will be applying SEEA's technical and policy expertise to solve specific problems in states and improving coordination with existing collaborations and stakeholders to maximize impact.
- The project has demonstrated significant progress toward BTO goals. Through collaborative efforts with local governments and industry groups, and by providing key tools and assistance, 7 of the 11 SEEA states have adopted the 2009 International Energy Conservation Code (IECC).
- SEEA's accomplishment list from the presentation is impressive, and it can point to demonstrated progress. However, SEEA is in a tough environment, and there are still states without up-to-date mandatory energy codes. Hopefully, modern energy codes can be adopted in all Southeast states in future program years. One of SEEA's main accomplishments is that it now has a prominent leadership role in the region's energy code discussion. It has built the relationships and organized state and regional coalitions. SEEA's future plans will build off of this base.
- Funding SEEA has been a great return on investment because 7 of its 11 states have adopted energy codes and because it has been able to also get utility funding to put toward energy codes activities.
- This is a new effort; it seems like the presenter is enthusiastic and that the project has accomplished a lot in its relatively short time. SEEA has laid out a good approach and seems to be executing it.

## D. Collaborations, Technology Transfer, and/or Market Impact

This project was rated **3.6** for its collaboration and coordination with relevant stakeholders.

- SEEA earns an "outstanding" rating for this area. SEEA's organizing efforts have led to much collaboration in the states and around the region. The tech transfer efforts with its IECC "Success" books

were done in collaboration with the “unconventional” allies of homebuilder associations and utilities, so SEEA might get double points for that.

- SEEA has effectively built new connections with a broad range of stakeholders and has collaborated well with industry for the most part. Of course, there is always more work to be done in this area. SEEA appears to be developing its own approach to energy code advocacy, and great care should be taken to understand and coordinate with the priorities of other stakeholders in the region.
- SEEA seems to focus on developing collaboratives within its region to meet its goals. It was very successful in developing energy code support materials in Georgia that it is using as a resource to get other states to adopt codes.
- The project staff collaborates and coordinates with multiple groups to transfer technologies and practices into the market. They have accomplished this through webinars, press releases, targeted training, conference presentations, one-on-ones, and policy updates.
- This project features good collaborations with several states and interface with national organizations.

### E. Proposed Future Work

This project was rated **3.6** for its proposed future work.

- SEEA’s plans focus on past progress and the outlook appears to be focused on the right large-scale goals. As SEEA continues to develop its reputation and expertise in the region, SEEA’s leadership role should also increase. Although a focus on “best practices” or “lessons learned” can be effective, it will be important for SEEA to carefully craft strategies for individual states and localities in order to maximize the potential improvements in energy efficiency in the region.
- SEEA’s future plans build on its solid accomplishments. SEEA plans for additional code adoptions in six states for the 2009 and 2012 IECC. It plans to expand its tech transfer work with additional “Success” energy code books in various states and offer more training. It also plans a circuit rider program and to expand code compliance efforts.
- The project’s proposed future work clearly builds on the past progress of its tailored approach.
- Future work items are indicated. The presenter could express them in more quantifiable goals. The project needs to leverage groups within states. SEEA should be an umbrella for activities within states; trainings can be state specific and conducted by others, but encouraged and supported by SEEA. SEEA should try to do all of the work itself.
- SEEA has proposed an ambitious future work plan that includes the implementation of a circuit rider program in addition to more state adoption of energy codes.

### Project Strengths:

- SEEA’s key strengths for this project are the following:
  - SEEA provides unique access to energy-efficiency decision makers in the Southeast through stakeholder coalitions.
  - SEEA has been able to establish itself as a respected, nonpartisan, and objective source of information on energy codes.
  - SEEA has invested in coalition and relationship building that leads to direct technical and educational support for energy code users.
  - SEEA now has a prominent leadership role in the region’s energy code discussion.
- SEEA has an important role in a region that has real potential for improvement in energy efficiency. Its core strengths are its access to key decision makers and stakeholders, its inclusion in national and state efforts to improve efficiency, and its ability to add a regional lens to common problems in the South.
- The project’s tailored approach to specific state and locality needs is its biggest strength. This approach is what creates the ability to engage with unique, unconventional stakeholders and make the most of limited resources.
- The Southeast has been lagging in energy code adoption for several years. The region now has 7 of 11 states adopting energy codes. This has been a great investment by DOE.
- This project features good leveraging of resources with funds from multiple groups.

### Project Weaknesses:

- Although SEEA appears to focus on replicating successes in the region and spreading “best practices” among the various states, SEEA must not overlook the diversity of interests represented in a region that includes Alabama, Mississippi, Florida, and Virginia. The ceiling for progress in building efficiency for one state, and the tactics for achieving success in that state, will be drastically different from other states in the region. SEEA needs to continue to look for opportunities to push the envelope for energy efficiency, even where it may seem difficult or impossible.
- The only weakness for SEEA is the lack of funding and the need for additional staff to do more good work.
- There are no significant weaknesses within the SEEA program.
- There are no apparent weaknesses.
- This project has no apparent weaknesses.

### Recommendations:

- Continue this SEEA program and provide additional support if possible.
- Three reviewers did not enter a response.

## 7. Summary

The *2013 Building Technologies Office Program Peer Review Report* presents the results of the 2013 Building Technologies Office (BTO) peer review, which was held in Washington, D.C., on April 2–4, 2013. The review was attended by over 300 participants and included presentations on 59 BTO-funded projects: 29 from BTO’s Emerging Technologies Program, 20 from the Commercial Buildings Integration Program, 6 from the Residential Buildings Integration Program, and 4 from the Building Energy Codes Program. This report summarizes the scores and comments provided by the independent reviewers for each project.

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.

The 60 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. Each project was reviewed by a minimum of 3 reviewers, with the majority of projects assigned 5 reviewers. The reviewers evaluated projects by using five weighted evaluation criteria and scoring them on a 1–4 scale, with four being the highest. In addition to numeric scores, reviewers were also asked to provide qualitative comments and feedback regarding the project’s strengths and weaknesses, and any suggestions related to the scope of the work.

A Summary Table is provided in Chapter 2 of the report, which presents a brief overview of reviewers’ comments and the weighted average score for each project. Chapters 3–6 are organized by BTO Program area and include, for each project, a brief project summary followed by the detailed reviewer comments and average score for each evaluation criterion. Each individual project report also includes a chart that shows the project’s weighted average and how it compares with the other reviewed projects within that BTO Program area.

BTO will use the information provided through this review process to enhance the management and effectiveness of existing efforts and inform the design of future programs and projects.

**Appendix A: Final List of Reviewers: 2013 Buildings Technologies Office  
Peer Review**

Anderson, Doug U.S. Environmental Protection Agency	Early, Michael U.S. Department of Housing and Urban Development	Lilya, Dustin DC Engineering
Andriuk, Patrick CBRE Global Corporate Services	Emrath, Paul National Association of Home Builders	Ljungquist, David Connecticut Clean Energy Fund Staff
Balbach, Chris Performance Systems Development of NY, LLC	Gardner, Amy University of Maryland	Lord, John Loudoun County Public Schools
Barancewicz, Michael Loudoun County Public Schools	Gonzalez, Barbara Pepco Holdings, Inc.	Makela, Eric Britt/Makela Group, Inc
Brook, Martha California Energy Commission	Hamilton, Karen New York State Energy Research and Development Authority	Memari, Ali The Pennsylvania State University
Callahan, Jack Bonneville Power Administration	Hartman, Thomas The Hartman Company	Misuriello, Harry The American Council for an Energy-Efficient Economy
Cioc, Sorin The University of Toledo	Hinge, Adam Sustainable Energy Partnerships	Moghaddam, Saeed University of Florida
Coble, Brian Advanced Energy	Hosni, Mo Kansas State University	Morris, Jim Virginia Beach City Public Schools
Crawley, Dru Bentley Systems, Inc.	Kartzman, Dan The Powersmith Service	Mrozowski, Tim Michigan State University
Delany, John ComEd	Knight, Dennis Whole Building Systems, LLC	Murphy, Pat Refrigeration Service Engineers Society
Dessiatoun, Serguei University of Maryland	Krarti, Moncef University of Colorado at Boulder	Nightingale, Trevor National Research Council Canada
Dillavou, Tyler Bonneville Power Administration	Kumar, Sneha TRACO, a division of Kawneer	Novoselac, Atila The University of Texas at Austin
Doria, Jordan Ingersoll Rand	Lacey, Eric Responsible Energy Codes Alliance	Porst, Kinga U.S. General Services Administration
Durkin, Tom Durkin & Villalta Partners Engineering	Larsen, Jim Cardinal Glass Industries	Potter, Dean K. Hovnanian Homes
Dyen, Mark Conservation Services Group, Inc.	Larson, Samara Enovity, Inc.	

Ritterpusch, John  
National Association of Home  
Builders

Rusert, Mead  
Carrier Corporation

Sachs, Harvey  
The American Council for an  
Energy-Efficient Economy

Sanders, Marci  
D&R International

Saucier, Dan  
Mississippi Development  
Authority

Scott, John  
Colliers International

Smyth, Ed  
DNV KEMA Energy &  
Sustainability

Talbott, John  
Private Consultant

Taya, Minoru  
University of Washington

Terry, David  
National Association of State  
Energy Officials

Tzempelikos, Thanos  
Purdue University

Van Mourik, Jamie  
U.S. Green Building Council

Vowles, Mira  
Bonneville Power  
Administration

Welch, Zelinda  
Enovity, Inc.

Wessel, Paul  
Green Parking Council

Zhivov, Alexander  
U.S. Army Corps of Engineers

## Appendix B: Project Evaluation Form

This evaluation form was used by reviewers to provide project ratings and comments during the 2013 Building Technologies Office Peer Review.

### PeerNet Evaluation Criteria: Project Evaluation Form

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*Provide specific, concise comments to support your evaluation.*

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

**4 - Outstanding.** Project is critical to the BTO and fully supports BTO objectives.

**3 - Good.** Most project aspects align with BTO objectives.

**2 - Fair.** Project partially supports BTO objectives.

**1 - Poor.** Project provides little support to BTO objectives.

☐ 4 - Outstanding

☐ 3 - Good

☐ 2 - Fair

☐ 1 - Poor

**Comments on Relevance:**

**2. Approach (20%)**—Degree to which barriers are identified and addressed, and quality of the project's design, feasibility, and integration with other efforts.

**4 - Outstanding.** Sharply focused on critical barriers; difficult to improve approach significantly.

**3 - Good.** Generally effective but could be improved; contributes to overcoming some barriers.

**2 - Fair.** Has significant weaknesses; may have some impact on overcoming barriers.

**1 - Poor.** Project is unlikely to contribute to overcoming the barriers.

☐ 4 - Outstanding

☐ 3 - Good

☐ 2 - Fair

☐ 1 - Poor

**Comments on Approach:**



**3. Accomplishments/Progress (40%)**—Degree to which progress has been made and measured against quantitative performance indicators, and the degree to which the project has demonstrated measurable progress toward BTO goals. (Note: New projects will not be evaluated on this criterion.)

**4 - Outstanding.** Excellent, measurable progress toward objectives; suggests that barrier(s) will be overcome.

**3 - Good.** Significant demonstrated progress toward objectives and overcoming one or more barriers.

**2 - Fair.** Modest progress in overcoming barriers; rate of progress has been slow.

**1 - Poor.** Little or no demonstrated progress toward objectives or barriers.

☐ 4 - Outstanding

☐ 3 - Good

☐ 2 - Fair

☐ 1 - Poor

**Comments on Accomplishments/Progress:**

**4. Collaborations, Technology Transfer, and/or Market Impact (20%)**—Degree to which the project staff collaborates or coordinates with industry or other relevant stakeholders to accelerate movement of technologies or practices into the market.

**4 - Outstanding.** Close, appropriate collaboration with industry and/or other institutions; partners are full participants.

**3 - Good.** Some collaboration exists; partners are fairly well coordinated.

**2 - Fair.** Coordination exists; collaboration could be significantly improved.

**1 - Poor.** Most work is done at the sponsoring organization with little outside collaboration or coordination.

☐ 4 - Outstanding

☐ 3 - Good

☐ 2 - Fair

☐ 1 - Poor

**Comments on Collaboration, Technology Transfer, and/or Market Impact:**

**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. (Weight = 10%) *[NOTE: if a project has ended, please leave this section blank.]*

**4 - Outstanding.** Plans clearly build on past progress and are sharply focused on barriers.

**3 - Good.** Plans build on past progress and generally address overcoming barriers.

**2 - Fair.** Plans may lead to improvements, but need better focus on overcoming barriers.

**1 - Poor.** Plans have little likelihood of eliminating barriers or meeting project or BTO objectives.

☐ 4 - Outstanding

☐ 3 - Good

☐ 2 - Fair

☐ 1 - Poor

**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:**



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