Building Technologies Office
FY 2017 National Laboratory Call for Proposals & Merit Review

Lab Call Released	February 3, 2016
Informational Webinar	February 10, 2016
Letters of Intent Due	February 16, 2016 5:00 PM ET
Full Proposals Due	March 7, 2016 5:00 PM ET
Reviewer's Initial Comments Due	March 23, 2016
Presentations Due	March 30, 2016
Merit Review Meeting	April 7-8, 2016
Reviewer's Final Comments Due	April 15, 2016
Notification of Decisions	April 29, 2016

Informational Webinar:

The Building Technologies Office will be hosting a webinar on February 10, 2016, beginning at 12:30 PM (EST). Use the following link to register for attendance:

https://attendee.gotowebinar.com/register/6770137667142528258

After registering, you will receive a confirmation email containing information about joining the webinar.

Note: The webinar will be recorded and will be made available on the BTO website.

Merit Review Meeting: April 7-8, 2016; Falls Church Marriott Fairview Park, 3111 Fairview Park Drive, Falls Church, VA 22042, 1-703-849-8692, http://cwp.marriott.com/wasfp/usdoebtopeerreview/

Registration: Eligible applicants that will be attending the in-person Lab Call Merit Review are required to register, www.yesevents.com/BTO_2016_Peer/Merit_Review

Table of Contents

1. Introduction

The Department of Energy (DOE) Building Technologies Office (BTO) is leading a network of national laboratory, university, and industry partners to develop innovative, cost-effective energy saving solutions for U.S. buildings, the single largest energy-consuming sector in the nation. In 2014, residential and commercial buildings consumed more than 40 percent of the Nation's total energy and more than 70 percent of the electrical energy, resulting in an estimated annual national energy bill totaling $433 billion.[1] Widespread adoption of existing energy-efficiency building technologies—and the introduction and use of new technologies—could eventually reduce energy use in homes and commercial buildings by 50 percent. This would save more than $200 billion annually and reduce U.S. energy-related greenhouse gas emissions by about 20 percent.

BTO's **mission** is to develop, demonstrate, and accelerate the adoption of technologies, techniques, tools and services that are affordable and enable high performing, energy efficient residential and commercial buildings in both the new and existing buildings market. This mission requires a multi-pronged strategy to address diverse market, technology, and regulatory challenges. BTO's strategy, or ecosystem, functions through five interdependent programs:

1. **Emerging Technologies (ET) s**upports research and development of high-impact building energy efficiency technologies, taking into account both performance and cost in order to drive these technologies to successful commercialization.
2. **Residential Buildings Integration (RBI)** accelerates energy performance improvements in existing and new homes by integrating technologies and practices to verify and optimize performance in buildings; providing data, design, and decision support tools; and partnering with public and private stakeholders to increase adoption of energy-efficiency services, technologies, and practices.
3. **Commercial Buildings Integration (CBI)** accelerates the commercialization and market uptake of energy efficient technologies and practices in existing and new commercial buildings; providing interoperable data tools and design and decision support guides and resources; and partnering with market leaders to increase adoption of those technologies and products, developing, demonstrating, and deploying a suite of cost-effective technologies, tools, and solutions.
4. **Building Energy Codes (BEC) s**upports increased energy efficiency in commercial and residential buildings through the upgrade of model building energy codes and by providing technical assistance to states as they implement energy codes.
5. **Appliance and Equipment Standards** develops and implements energy conservation standards for appliances and building equipment, and enforces standards through product testing and compliance efforts.

[1] U.S. Energy Information Administration. *Annual Energy Outlook 2015 with projections to 2040*, http://www.eia.gov/forecasts/aeo/. Accessed Jan 21, 2016

BTO's overarching long-term goal is to reduce the energy use per square foot of U.S. buildings by 50% compared to 2010 levels. Based on current analysis of the building sector and BTO program planning, BTO has established a goal of reducing building energy use intensity (EUI) by 30% by 2030.

To support the achievement of this 2030 goal, each BTO program has identified market-focused interim goals:

- **Emerging Technologies Program**: By 2020, accelerated technology development will make available new, cost effective technologies capable of reducing the energy use of typical buildings by 30% compared to high-efficiency technologies available in 2010.
- **Residential Buildings Integration Program**: By 2025, improvements in the efficiency of space conditioning and water heating in typical single-family homes will reduce these energy uses by 40% from 2010 levels.
- **Commercial Buildings Integration Program**: By 2025, actions by market leaders, representing 20% or more of the sector, will cut the energy use of their buildings by at least 35% relative to typical commercial buildings in 2010.
- **Building Energy Codes Program**: By 2025, improvements in the typical design and construction of new buildings will be sufficient to reduce their energy use by 40% compared to typical new buildings in 2010.
- **Appliance and Equipment Standards Program**: By 2025, increases in the efficiency of new products will cut the energy use per square foot of the buildings sector by at least 20% from 2010 levels.

The Office of Energy Efficiency and Renewable Energy (EERE) has implemented a policy to merit review 100% of national laboratory projects related to core and enabling capabilities prior to funding by the start of Fiscal Year (FY) 2018 (i.e., October 2017).

2. FY 2017 Lab Call Merit Review

The Department of Energy's Building Technologies Office (BTO) is seeking multi-year (3+ years) project proposals from national laboratories ('Labs') for activities to incorporate into the FY 2017, FY 2018, and FY 2019 Annual Operating Plans (AOPs). **Only proposals for which a DOE national laboratory is the prime recipient will be considered for funding; all other proposals will be returned without review.** This Lab Merit Review will evaluate funding proposals for direct lab work portions of the Residential Buildings Integration Program and Emerging Technologies' (ET) sensors and controls sub-program.

To ensure BTO's compliance with EERE's merit review policy, any new or remaining topic areas related to direct lab work not covered in this Lab Call will be part of next year's FY 2018 Merit Review.

Eligibility

Only DOE/NNSA Federally Funded Research and Development Centers (FFRDCs) and DOE Government-Operated Government-Owned laboratories (GOGOs) are eligible to apply for funding as a prime recipient. These laboratories include all the "Labs and Technology Centers" listed on http://energy.gov/offices.

Figure 1 BTO's National Laboratories' Facility and Capability Matrix

■ Core Capability ◧ Enabling Capability

	State	Related Facility	ANL	LBNL	NREL	ORNL	PNNL	SNL	Cross-Walk to DOE Core Capabilities	Comments
Emerging Technologies Development (ET)									19, 22, 23	
HVAC, Appliances and Equipment	Existing	BTRIC				■				
Envelope	Existing	BTRIC				■				
Windows - Performance Testing & Simulation	Existing	FLEXLab		■						
Windows - Durability Testing	Existing	ESIF			◧					
Lighting-Testing	Existing	SSL					■			
Building Energy Modeling R&D	Existing	BTRIC, FLEXLab		◧	◧	◧				
Advanced Controls for Buildings	Emerging									
Sensors to Volume Manufacturing	Emerging	BTRIC				◧				
Interoperable Execution Platform for Controls*	Existing						◧			
*The Interoperable Execution Platform refers to VOLTTRON. This includes platform development and maintenance, but does not include application development utilizing the platform.										
Building Integration and Solution (RBI, CBI)									19, 22, 23	
Whole Building Energy Performance	Existing	FLEXLab		◧	◧	◧	◧			
Building Energy Modeling Deployment	Existing	BTRIC, FLEXLab		◧	◧	◧	◧			
HVAC	Existing	BTRIC, FLEXLab			◧	◧				
Envelope, Windows, Shading	Existing	BTRIC, FLEXLab		◧		◧				
Residential IAQ/Ventillation	Existing			■						
Lighting	Existing			◧	◧		◧			
Plug Loads	Existing				◧					
Energy Management and Demand Response	Existing	ESIF		◧			◧			
Integrated Renewables and Grid, Demonstration/Deployment	Emerging	ESIF								
Regulatory (Codes, Appliance and Equipment Standards)									19, 22, 23	
Code Development and Analysis	Existing						■			
Code Compliance, Adoption	Existing						◧			
Appliance Standards - Engineering Analysis	Existing			◧						
Standards Economic Analysis - Consumer Products	Existing			■						
Standards Economic Analysis - Commercial Equipment	Existing						◧			
Appliance Standards - Test Procedures	Existing			◧			◧			
Appliance Standards - Product Testing, Research	Existing			◧		◧				

Further eligibility restrictions will be dependent upon the topic area's designation as a core or enabling capability, as shown in Figure 1. Topic areas designated as a core and enabling capability will be restricted to proposals from prime recipients from the respective lab(s).

In both cases, prime recipients are encouraged to include other entities as sub-recipients, and to form teams with other labs, as appropriate. Where several labs have designated enabling capabilities, it is desirable for these labs to work together to provide BTO one integrated project proposal. Further information on the guidelines for both core and enabling technologies in the Labs is provided in the EERE-National Laboratory Guiding Principles, published March 9, 2015.

Topics of Interest

Specific topics of interest are described in APPENDIX A (ET) and APPENDIX B (RBI), which include the anticipated deliverables and the maximum annual budget.

Evaluation Process & Criteria

A four-step application process will be followed:

- The first step is the submission of a letter of intent that will not be reviewed, but rather serves to assist BTO in organizing reviewers and the review sessions. BTO will also use letters of intent to determine eligibility.
- The second step is the submission of a written proposal, with page lengths for the Technical Volume specified in Table 2 that vary depending on the program (ET or RBI).
- The third step is the submission of a PowerPoint slide deck prior to the Merit Review. Note that applicants will have the benefit of seeing the reviewers' initial comments prior to submitting this slide deck.
- The fourth step is the delivery of an oral presentation to an external review panel in a closed (private) setting, using the slide deck submitted earlier. The length of the presentation depends on the program (ET or RBI) and is also specified in Table 2. The presentation period will include time for questions from the external review panel.

2.1.1. Submit a 1-page letter of intent

Applicants are required to submit a 1-page letter of intent (LOI) by the submission deadline specified on the first page. The LOI should be submitted via EERE Exchange at https://eere-exchange.energy.gov/. The LOI should include the following information:

- Program area (ET or RBI)
- Sub-program and topic area
- Project title
- Lead laboratory and project director
- Partner institutions (if any), including labs, companies, universities, non-profits, etc.
- 1-paragraph description of the proposed project

2.1.2. Submit a written proposal

Only applicants who submitted a timely Letter of Intent are eligible to submit a written proposal. Written proposals in the format described in APPENDIX C are due by the date given on the first page. Page limits for the written Technical Volumes vary depending on the program (ET and RBI), and are specified in Table 2. The proposals will be reviewed by external reviewers, who will provide an initial evaluation of the proposals based on the review criteria defined in APPENDIX D. The evaluators' comments, in turn, will be made available to the applicants in EERE Exchange at https://eere-exchange.energy.gov/ so that the applicants can take those comments into account as they prepare their PowerPoint slide deck for the oral presentation.

2.1.3. Submit a PowerPoint slide deck

Only applicants who submitted a timely written proposal are eligible to submit a PowerPoint slide deck in EERE Exchange at https://eere-exchange.energy.gov/. All applicants to this Lab Call are required to make an in-person oral presentation to an external review committee, and the PowerPoint slide deck used for the presentation must be delivered to BTO in EERE Exchange at https://eere-exchange.energy.gov/ by the deadline specified on the first page (i.e., March 30, 2016) so that it can be made available to the review committee prior to the presentation. Applicants are free to choose the format and content of their presentation; no template will be provided by BTO.

Table 2 Merit review Technical Volume length and oral presentation duration for ET and RBI

Program	Merit Review Technical Volume Length	Oral Presentation Duration†
Emerging Technologies (ET)	15	60 min**
Residential Buildings Integration (RBI)	7	40 min

† Presentation lengths include presentation from proposal team, Q&A with reviewers and proposal teams, and reviewer discussion without proposal team. 60 minute duration breaks out to 40 minute presentation from proposal team, 10 minute Q&A with proposal team, and 10 minute reviewer discussion without proposal team. 40 minute duration breaks out to 20 minute presentation from proposal team, 10 minute Q&A with proposal team, and 10 minute reviewer discussion without proposal team.

* Depending on the number of proposals received, the total time allotted for each presentation (including questions) may have to be reduced.

While there are no format and content restrictions, applicant's presentations must:

- Include a 'cover page' slide that includes the name of the lab, title of proposal, and indicate if it is a core or enabling technology;
- Not exceed 20Mb file size;
- Be provided as a .pdf to EERE Exchange at https://eere-exchange.energy.gov/ and be submitted no later than the deadline March 30, 2016; and
- Conform to the time limits detailed in Table 2, keeping in mind that the total time allotted includes time for questions and answers. Reviewers will be able to comment on both the written proposals and on the PowerPoint slide decks.

Some best practices to consider when developing presentations include:

- Understanding that reviewers have already reviewed your written proposals and will be familiar with your proposed work;
- Structuring presentations to focus on the review criteria (with weight consideration) provided in APPENDIX D;
- Using the presentation as an opportunity to discuss some key aspects in more detail that may not have come across in the written proposal; and
- Using the presentation as a rebuttal to reviewers' questions and comments from the written proposal, and not present the proposal from scratch.

2.1.4. Make an oral presentation to an external review panel

During the merit review each applicant will make an oral presentation, using the slide deck provided earlier, to a review committee consisting largely of non-Federal experts. Each program area (ET and RBI) will assemble its own review committee. The oral presentations will take place one-by-one in a closed-door session (not open to the public, nor to other applicants). All members of the review committee will be encouraged to ask questions of the applicants, and to provide written comments and scores in EERE Exchange after the presentation.

Funding Decisions and Next Steps

BTO will make funding decisions, by the date shown on the first page, that are informed by the written comments and scores provided by the external review committees and their scores in EERE Exchange. BTO may choose to fund all, some, or none of the applicants. After funding decisions are announced, successful applicants will be asked to develop corresponding multi-year Statements of Work (SOWs) based on their proposals, feedback from the external reviewers, and feedback from BTO.

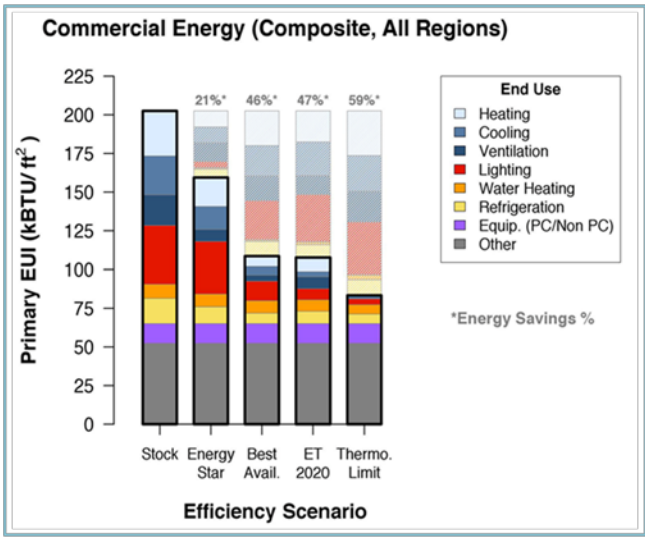
APPENDIX A. Emerging Technologies (ET) Topics of Interest

Proposals are sought for direct lab work in three topic areas within ET's sensors and controls sub-program. All applicants are strongly encouraged to review the existing ET portfolio.[2] Technology-specific descriptions are provided for each topic area for which proposals are sought in this cycle.

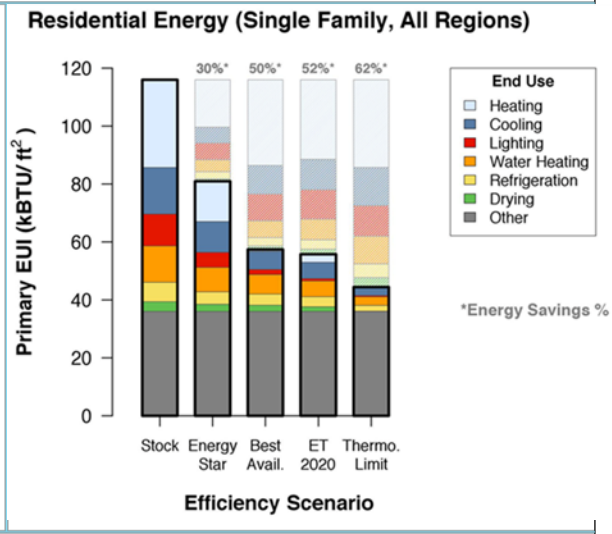
Annual progress will be monitored through go/no-go SMART[3] milestones, with the possibility that tasks or even entire projects could be terminated due to lack of progress. Unless stated otherwise, in addition to achieving the broad goals defined in Figure A 1, project success will be measured by the metrics specified in Table A1. Note that the three most important progress metrics are commercialized products, the projected primary energy savings resulting from those commercialized products, and the cost effectiveness as measured by the *Simple Payback*. It is not expected that each project will lead to progress in all metrics (e.g., CRADA projects may not yield peer-reviewed publications), but the performance of ALL projects will be measured by at least these three most important metrics (commercialized products,

Figure A 1 BTO Emerging Technology (ET) program goals

To enable the development of cost-effective technologies that will be capable of reducing a building's energy use per square foot by 30% by 2020 and of cutting a building's use by 45% by 2030, relative to 2010 high-efficiency technologies.



2020 Commercial building energy savings goals



2020 Residential building energy savings goals

Source: 2015 U.S. Department of Energy Quadrennial Technology Review, Chapter 5

[2] http://energy.gov/eere/buildings/emerging-technologies

[3] SMART: S = Specific, M = Measurable, A = Achievable, R = Relevant, T = Timely

Table A 1 Description of metrics by which progress will be measured

Metric	Description
Commercialized Products at Market-Acceptable Costs*	Number of products that are commercialized, with corresponding primary energy savings impacts
Primary Energy Savings*	Projected Quads of primary energy (technical potential) saved through commercialized products
Cost Effectiveness*	The simple payback period of the proposed technology based on energy savings and compared to current state of the art
Industry Interactions	Number of private and public organizations which are supplying funds or in-kind support for research projects
Cost Share	Amount of funds or in-kind support supplied by private and public organizations (non-BTO)
Intellectual Property (IP)	Number of invention disclosures, patent applications, awarded patents, and licensing agreements
Communications	Number of peer-reviewed journal articles

* Most important metrics.

projected primary energy savings, and cost-effectiveness), with the understanding that software is considered 'commercialized' if it is available to the public and broadly distributed.

Estimates of technical potential primary energy savings should clearly state the baseline technology (or technologies) being replaced, the size of the relevant market in the year 2030, and any assumptions applied in the analysis. The *Primary Energy Savings Technical Potential* is calculated from Eq. (1):

$$\begin{bmatrix}\text{Primary Energy Savings}\\ \text{Technical Potential}\\ \text{(TBtu)}\end{bmatrix} = \begin{bmatrix}\text{\% Energy Savings}\\ \text{Over Typical New}\\ \text{Technology}\end{bmatrix} \times \begin{bmatrix}\text{2030 Energy Market}\\ \text{Size}\\ \text{(TBtu)}\end{bmatrix} \quad (1)$$

The *2030 Energy Market Size* (TBtu) can be determined from the market addressed by the technology (residential, commercial, new, retrofit, etc.), the end use (space air conditioning, lighting, cooking, refrigeration, etc.), the climate zone (1 – 5), and other information. The BTO Market Calculator (http://trynthink.github.io/scout/calculator.html) tool facilitates the determination of the *2030 Energy Market Size*. If a proposed technology or approach affects energy use in multiple end uses (e.g. an HVAC technology that operates in both heating and cooling modes), the BTO Market Calculator will need to be used twice to obtain the market size for each affected end use. Detailed instructions on how to use the BTO Market Calculator are provided on the website. The "Typical New Technology" is the technology that is being replaced. For "covered" technologies, that is, technologies subject to minimum efficiency standards,[4] Applicants should assume the efficiency of the "Typical New Technology" to be greater than or equal to the applicable efficiency standard. For "covered" and other

[4] http://www1.eere.energy.gov/buildings/appliance_standards/standards_test_procedures.html

technologies, Table A 2 presents the projected 2030 stock and average stock efficiency for a variety of residential equipment that may be used in this calculation. Corresponding 2030 average stock efficiencies for commercial units are provided in Table A 3. In all cases Applicants should ensure that if a "covered" technology is being replaced, the efficiency of the "Typical New Technology" is equal to or greater than the applicable efficiency standard.

Table A 2 2030 Residential equipment stock and average efficiency[5]

Equipment Class	Stock (million units)	Stock Average Efficiency
Main Space Heaters		
Electric Heat Pumps (HSPF)	15.30	8.81
Natural Gas Heat Pumps (GCOP)	0.38	1.30
Geothermal Heat Pumps (COP)	1.69	3.45
Natural Gas Furnace (AFUE)	67.19	0.85
Distillate Furnace (AFUE)	5.59	0.87
Space Cooling		
Electric Heat Pumps (SEER)	15.30	14.08
Natural Gas Heat Pumps (GCOP)	0.38	0.67
Geothermal Heat Pumps (EER)	1.69	15.77
Central Air Conditioners (SEER)	76.96	13.61
Room Air Conditioners (EER)	47.05	10.52
Water Heaters		
Electric (EF)	60.56	0.97
Natural Gas (EF)	65.28	0.63
Distillate Fuel Oil (EF)	1.64	0.62
Propane (EF)	2.32	0.62
Refrigeration		
Refrigerators (kW.hr/yr)	166.17	479.30
Freezers (kW.hr/yr)	43.36	412.56

[5] Residential Sector Equipment Stock and Efficiency, Reference case: http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2015&subject=12-AEO2015&table=30-AEO2015&region=0-0&cases=ref2015-d021915a

Table A 3 2030 Commercial equipment average efficiency[6]

Equipment Class	Stock Average Efficiency[7]
Space Heating	
Electricity	1.63
Natural Gas	0.78
Distillate Fuel Oil	0.80
Space Cooling	
Electricity	3.75
Natural Gas	0.98
Water Heating	
Electricity	1.10
Natural Gas	0.91
Distillate Fuel Oil	0.79
Ventilation (cfm/Btu)	0.50
Refrigeration	3.16

If the provided information is not used to calculate the *Energy Market Size* (TBtu), then a comparable approach can be applied, with corresponding justification.

The cost effectiveness, as measured by the *Simple Payback* will be applicable only to technology innovations, and not to other innovations such as design tools or enabling technologies for which primary energy savings and/or payback are difficult to describe. Proposers should compute the *Simple Payback* for their proposed technology innovation per Eq. (2):

[6] Commercial Sector Energy Consumption, Floorspace, and Equipment Efficiency, Reference case: http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2015&subject=13-AEO2015&table=32-AEO2015&region=0-0&cases=ref2015-d021915a. Note that the stock (millions of units) are not available from this source.

[7] Unless noted otherwise, efficiencies are in units of Btu's of energy output divided by Btu's of energy input.

$$\left[\begin{array}{c}\text{Simple}\\ \text{Payback}\\ (\text{Yr})\end{array}\right] = \frac{\left[\begin{array}{c}\text{Incremental Initial}\\ \text{Cost of Proposed}\\ \text{Technology at Scale}\,(\$)\end{array}\right]}{\left[\begin{array}{c}\text{Cost}\\ \text{Savings}\left(\frac{\$}{\text{Yr}}\right)\end{array}\right]}$$

$$= \frac{\left[\begin{array}{c}\text{Incremental Initial}\\ \text{Cost of Proposed}\\ \text{Technology at Scale}\,(\$)\end{array}\right]}{\left[\begin{array}{c}\text{Unit Energy Consumed by}\\ \text{Typical New Technology}\\ \text{Per Year}\,(\text{kWh/Yr})\end{array}\right]\left[\begin{array}{c}\text{Energy}\\ \text{Cost}\left(\frac{\$}{\text{kWh}}\right)\end{array}\right]\left[\begin{array}{c}\text{\% Energy Savings}\\ \text{Over Typical New}\\ \text{Technology}\end{array}\right]} \quad (2)$$

where the *Incremental Initial Cost of Proposed Technology at Scale ($)* is computed from

$$\left[\begin{array}{c}\text{Incremental Initial}\\ \text{Cost of Proposed}\\ \text{Technology at Scale}\,(\$)\end{array}\right] = \left[\begin{array}{c}\text{Unit Cost of}\\ \text{Proposed Technology}\\ \text{at Scale}\,(\$)\end{array}\right] - \left[\begin{array}{c}\text{Unit Cost of}\\ \text{Typical New}\\ \text{Technology}\,(\$)\end{array}\right] \quad (3)$$

Note that the *% Energy Savings OverTypical New Technology* term in Eq. (2) is the same as that in Eq. (1). The "Energy Cost" can be specified alternatively in $/MMBtu (i.e., for natural-gas-fired systems), or in whatever units are most appropriate. The nationally averaged energy costs specified in Table A 4 *must* be used for this calculation. The proposer should describe, and provide supporting documentation, what they consider to be an acceptable maximum payback (in years), which can vary significantly depending on the end use.

Table A 4 Retail energy 2015 pricing (year-to-date)

Sector	Electricity, ¢/kWh[8]	Natural Gas	
		$/Thousand Cubic Feet[9]	$/MMBTU[10]
Residential	12.64	12.36	12.02
Commercial	10.65	8.15	7.93

Proposers of non-technological solutions, e.g., modeling approaches, are also required to provide an estimate of primary energy savings potentially resulting from their innovation, as

[8] http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_3
[9] http://www.eia.gov/dnav/ng/ng_pri_sum_a_EPG0_PCS_DMcf_a.htm
[10] http://www.eia.gov/tools/faqs/faq.cfm?id=45&t=8

well as an analysis of their cost effectiveness. The approaches used in these analyses need to be appropriately justified.

Starting in FY16, all software developed under ET support must be open source. For existing software products that are not currently open source, plans for converting the software development process to open source must be presented such that the software is open source by the end of FY17. The definition of open-source software and acceptable licenses are provided in APPENDIX E.

A detailed description of the specific topics solicited for ET's sensors and controls sub-program is provided below. **The anticipated maximum annual budget for the sub-program is $2 million. Individual proposals for each topic area are sought that may vary between $500k and $2 million per year.** BTO may issue awards in one, multiple, or none of the three topic areas. **Although individual proposals are sought for each topic area, each proposal should address how the project will enable achieving the goals of the entire sub-program**. Each lab can apply to more than one topic area as the lead, but only one proposal will be accepted by an individual lab as lead within a specific topic area. Labs are also strongly encouraged to partner with external organizations and/or with one another to incorporate all the capabilities and facilities needed to meet the needs of the sub-program and maximize impact and success for the specified topic area.

Note the following guidance based on the designations included in Figure 1 and requirements in APPENDIX C:

Labs proposing controls solutions designed to operate on the customer side of the meter (e.g. within a building, within a lighting system, within a building automation system) must propose open source software solutions, with clearly articulated plans to address interoperability (see APPENDIX C), and how the outcome will be scalable in the market, including a preliminary market impact assessment. Where possible, all device(s) to be controlled should be accessed by open communication standards, and using open or consensus-based information/data standards.

Applicants must be aware of the DOE-supported open execution platform (VOLTTRON), and to the extent practical and applicable, consider incorporating their new equipment controls work into that platform to increase its use and scalability, and well as utilizing the existing cybersecurity benefits DOE has built into, and will continue to develop, for VOLTTRON. This can easily be accomplished through discussions with PNNL transactive controls personnel either in the proposal and/or during the negotiation phase if a proposal is selected.

Labs proposing research solutions that operate across the meter (e.g. from buildings to the grid, building to building, campuses, neighborhoods) consistent with the BTO transactive control and transactive energy visions, need to include the PNNL VOLTTRON platform in the proposal, and may or may not include funding for PNNL. If a proposal is selected for negotiations, DOE will have the ultimate responsibility for this determination. Coordination with PNNL in terms of

distribution, release, cyber security testing, incorporation into the core transactive controls platform, etc. will need to occur during the negotiation phase, if not sooner, for selected proposals.

Applicants for sensor related work should be aware of the expertise and existing facilities at ORNL that are aligned with reducing the cost and time involved in designing and manufacturing sensors. If ORNL facilities and expertise will not be advantageous to the outcome, beyond what the proposing lab already has at their disposal, you do not need to coordinate further with them. If ORNL can provide unique expertise or facilities that would reduce the costs or otherwise improve the sensor outcome, you should either coordinate during proposal development, or, if selected for negotiations, during the negotiation phase with BTO.

Sensors & Controls Sub-program

The Sensors and Controls sub-program in ET is focused on developing sensor and control solutions to achieve building energy savings and to unlock new building market and financial opportunities for owners, operators, and end uses. Some, but not all of these opportunities arise from the continuous engagement and management of building systems, devices, or equipment (including, but not limited to, appliances, lighting, and HVAC systems) and through the addition of communication and information technologies (including commingling energy and information). Researchers principally focus on R&D of open-source sensor solutions and foundational controls opportunities. All projects are driven by use cases and have clear end use applications. This way, implementation and service companies can adopt and drive the solutions into the market or into utility supported programs.

Sensors and controls are the most basic requirements for traditional building operations and lead to "smarter" buildings when optimally utilized. Traditional building energy management systems have largely been used only in commercial buildings over 50,000 square feet, where the return-on-investment has been most cost-effective (three years or less). Approximately 70% of large commercial buildings have some type of building energy management system installed to enable some degree of automation, compared to just 20% of medium commercial buildings (5,000-50,000 square feet), and under 10% of small commercial buildings (under 5,000 square feet).[11] Even the buildings that have building automation systems (BASs) do not make use of the full capabilities with as much as 30% of the energy consumed by building HVAC lighting systems resulting from both inadequate sensing and controls, as well as improper use of existing BAS.[12] As building systems, buildings, and the grid become increasingly integrated, systems and devices must automatically communicate their identity, status, and availability to facilitate and "optimize" energy management at the grid, utility, and building levels. Additionally, sensors and controls will improve traditional building energy management

[11] CBECS 2012.

[12] Brambley, M.R., and Katipamula, S. 2009. "Commercial Building Re-Turning: A Low-cost Approach to Improved Performance and Energy Efficiency." *ASHRAE Journal* 51(10): 12-23.

and result in reduced energy use and building systems maintenance costs, simultaneously ensuring more competitive energy pricing and utilization. If properly developed, these systems can deliver a plug-and-play scalable solution, lowering the cost of implementation so that all buildings, regardless of size, can benefit from grid optimization and related strategies that have historically only been available in large, highly sophisticated buildings. The goal of the Sensors and Controls sub-program is to develop low-cost, self-powered wireless sensor platforms and automated commissioning, configuration, and optimization of controls that will lead to energy savings by optimizing building performance. The sub-program also coordinates with the Department's Grid Modernization Initiative[13] in order to enable integration of buildings with the rest of the electric grid. Transaction-based controls decisions are solutions that allow operational decisions to be based on market signals, including commodity, service, condition of the systems, or retrofits. These decisions can be direct (*i.e.,* time-of-day electricity price) or indirect (*i.e.,* price given the fuel and carbon impact of the existing electricity mix) and are financially based. For example, transaction-based control decisions can be deployed alongside smart grid investments to allow consumers to easily interact with the electricity system to capture previously shielded value streams. These systems have proven a more economically efficient method of managing a complex system because end-use control with connectivity is less expensive to deploy than traditional, stationary storage solutions or other ancillary service solutions.

BTO envisions a future in which building control strategies include automated configuration, commissioning, and learning so that the integrated result is optimized operations, maximized energy savings, and participation in grid services. According to this vision, energy is capable of being transacted within the building (through the offering of end-user services), between buildings (through the offering of energy market services), and with the electric grid (by offering grid services).[14]

BTO invests in open-source software solutions in order to accelerate market penetration and address the key requirements for sensing and monitoring in commercial and residential buildings: interoperability, scalability, ease of deployment, availability, and affordability.

The topic areas solicited in this call are described in more detail below. These topics are intended to augment and build off of ET's existing sensors and controls portfolio, as well as the FY16 BENEFIT FOA[15] topics on plug-and-play sensor systems and human-in-the-loop sensor and control solutions with the goal of enabling affordable and low cost manufacturing, installation, and ongoing operation of sensors and controls within buildings. In addition to the targets

[13] DOE Grid Modernization Multi-Year Program Plan, http://www.energy.gov/downloads/grid-modernization-multi-year-program-plan-mypp, accessed January 22, 2015.

[14] Clear use cases and value propositions of the various services that buildings can provide or access from sensors and controls are outlined in: Somasundaram, S. et al. *Reference Guide for a Transaction-Based Building Controls Framework: Unlocking energy efficiency and grid service values for building energy consumers*. PNNL-23302. Richland, WA: Pacific Northwest National Laboratory, 2014.

[15] https://eere-exchange.energy.gov/#FoaIdba0b5855-db5a-4b2b-8e13-bf48254c4624, DE-FOA-0001383 Building Energy Efficiency Frontiers and Innovation Technologies (BENEFIT) - 2016- Amendment 000001.docx, accessed Jan. 19, 2015.

provided in the topic area descriptions, applications should include performance metrics and targets specific to the proposed approach targeted within a topic area and incorporate as SMART milestones.

Topic Area 1: Occupant-driven Sensing and Controls

This topic area seeks applications for either improved occupancy detection and counting-based sensors, incorporation of such sensors to optimize control strategies, or a combination thereof. Occupancy sensors is an area of growing interest for improvements to building controls and energy management,[16] however reductions in cost and improvements in accuracy still need to be advanced for further market adoption. Proposed solutions, for example, can include proxy-based approaches or improvements to the accuracy and reduction in the cost of current state-of-the-art occupancy sensors (e.g. passive infrared, ultrasonic, etc.) that will enable, depending on the approach taken, near 100% accuracy, >100 feet effect range of detection, and $10/sensor node at scale. For improvements to control strategies that utilize occupancy data, a projected energy savings should be calculated and targeted with a 1-3 year payback period.

Topic Area 2: Building Equipment Sub-metering

In moving beyond manual maintenance and control, this topic area seeks applications for sub-metering solutions for all building equipment, systems, and plug loads that will enable monitoring-based commissioning to optimize building operations.[17] Sub-metering solutions monitor the actual energy consumption of individual building systems and components, including information on the state and usage patterns of specific equipment. Through monitoring-based commissioning, sub-metering can verify energy savings obtained through effective energy management and integration with the electric grid. Furthermore, this topic area seeks R&D solutions that will advance options and lower costs based on the outcomes of the CBI Wireless Submetering Challenge that was launched in 2013.[18] Sub-meter approaches can include, but are not limited to, integrated energy meters installed in all building equipment, retrofit "stick-on" meters, or advanced non-intrusive load monitoring. Proposed solutions should target achieving 100% coverage of the electric load being sub-metered, with $\leq$ 0.2% error in energy meter accuracy relative to actual energy use with an initial cost of <$10/metered device. This price point should include all hardware (metering device, current sensors, base station, software) but not design, installation, or operation labor.

Topic Area 3: Adaptive and Fault Tolerant Building Controls

This topic area seeks applications for developing self-correcting control solutions through data-driven or model-driven adaptive controls that will optimize building operation in response

[16] Liu, G., Dasu, A., Zhang, J. (2012). *Review of Literature on Terminal Box Control, Occupancy Sensing Technology and Multi-zone Demand Control Ventilation (DCV).* PNNL- 21281.
[17] National Science and Technology Council. *Submetering of building energy water usage: Analysis and recommendations of the Subcommittee on Buildings Technology Research and Development*. National Science and Technology Council, Committee on Technology, Washington, D.C., 2011.
[18] http://apps1.eere.energy.gov/buildings/publications/pdfs/alliances/wireless_energy_meter_specification.pdf

to environmental changes or the manifestation of faults and failures in building operation or equipment. Proposed technologies in this topic area include predictive maintenance algorithms for multiple building systems prioritized according to fault frequency and impact that lead to embedded and accurate (i.e., no false positives) solutions. Building-scale automated fault detection and diagnostics (AFDD) and prognostics,[19] automated commissioning and fault tolerance for instances when physical repair is required, as well as automated, accurate, and cost-effective point mapping are all of interest. A false alarm rate or number of false positives from the total number of faults detected of < 1-3% should be targeted, as well as an initial deployment return on investment of 2-3 years.

Expected Activities at the National Laboratories: Sensors & Controls Sub-Program

The lab performer(s) is expected to coordinate work closely with industry, FOA awardees, and SBIR awardees to advance open-source sensors and controls solutions to the marketplace. **Research collaborations that take the form of or result in CRADAs by the end of the project period are especially encouraged.**

Given that sensors & controls intersect with a large part of the ET, CBI, and RBI programs, it is essential that the lab performer(s) establish and maintain excellent communications with their counterparts funded by other parts of BTO and develop strong market transformation and commercialization plans. This is to ensure that the sensors & controls solutions will lead to widespread application in lighting, HVAC, dynamic windows, etc., in both commercial and residential buildings.

[19] Katipamula, S., and Brambley, M.R. (2005). *Methods for fault detection, diagnostics, and prognostics for buildings systems – A Review, Part II*. HVAC&R Research, 11, 169-187.

APPENDIX B. Residential Buildings Integration (RBI) Topics of Interest

The RBI Program accelerates energy performance improvements in existing and new homes by integrating energy-efficient technologies and practices to optimize energy performance in homes; providing data, design, and decision support tools; and partnering with building professionals, energy service providers, and other stakeholders on a national scale. The Program addresses technology integration and installation issues that can affect total home performance, including energy efficiency, especially issues related to water heating and heating and cooling loads, durability, comfort, and indoor air quality and moisture control, and ultimately prepares homes for renewable energy options.

By proving the viability and energy saving capabilities of energy saving technologies, techniques, and systems, RBI helps to accelerate their use across all housing types and diverse climates, and to move U.S. homes toward higher efficiency industry standards and building energy codes. RBI enables stakeholders to make informed decisions and reduce their risk in the implementation of energy saving solutions. Engaging with industry such as building professionals, manufacturers, educators, utilities, state and local energy offices, and non-governmental organizations to promote tools and successful approaches for constructing high-performing new homes and upgrading homes also helps to increase market adoption and the resulting benefits such as energy and cost savings.

The RBI Program's goal is to reduce, by 2025, the energy used for space conditioning and water heating by 40% in single family homes, from 2010 levels. RBI's focus on space conditioning and water heating offers the best opportunities for influencing residential energy use. A critical strategy for achieving this goal is to demonstrate and integrate cost-effective, energy-efficient technologies and practices in representative homes, which significantly reduce EUI and optimize home performance.

RBI's Building America program conducts applied research, development, and demonstration (RD&D) in residential buildings, in many cases linking technologies from the ET Program to the Building Energy Codes and Appliance and Equipment Standards Programs through demonstration projects that cost-effectively integrate these emerging technologies into residential building systems. Building America projects are led by U.S. Department of Energy (DOE) national laboratories and expert building science teams, in partnership with leading industry stakeholders (i.e., builders, contractors, manufacturers, and others).

DOE selects strategic Building America projects that can simultaneously develop and demonstrate better technologies and practices while overcoming critical market barriers to adoption, such as real and perceived technical and business risks and codes and standards limitations. DOE also prioritizes projects that can leverage influential early adopters in order to stimulate market adoption. Building America industry partnership teams then demonstrate that the high-performance technical solutions and best practices featured in the projects are low risk and can lead to added business benefits.

In November 2015, the RBI Building America Program released the Building America Research-to-Market Plan, which details the program's strategy over the coming years. The Plan provides a clear strategic framework for guiding future program investments and setting project objectives for overcoming the highest-priority RD&D challenges facing the high-performance housing industry. The plan details three integrated Roadmaps, which set specific objectives for 2020 in the following critical research areas.

1. High Performance, Moisture-Managed Envelope Solutions
2. Optimal Comfort for Low Load Homes
3. Optimal Ventilation and Indoor Air Quality Solutions

The Roadmaps and Plan will help RBI effectively coordinate within the BTO Ecosystem to help achieve BTO's technology-to-market goals for residential buildings. Linking the Roadmaps' applied RD&D and market engagement activities to BTO's advanced R&D (i.e., Emerging Technologies) will help build a more efficient innovation pipeline for the housing industry. Linking research activities with market deployment activities and codes and standards initiatives within the BTO Ecosystem helps to ensure BTO residential program activities are coordinated efficiently and collectively impact the market.

On November 18, 2015, RBI issued a Funding Opportunity Announcement (FOA) under its Building America Program. One of the topics of the 2016 FOA, which builds on the 2015 FOA, focuses on the three critical research areas highlighted by the Building America Research to Market Plan. The proposals in response to this FOA are currently under review by DOE.

The purpose of FY17 Lab Call and Merit Review is to help achieve the goals and objectives of the RBI program, through projects that either A) directly address Building America Research to Market Plan objectives and/or B) support Building America program implementation, including technical support to teams selected through the Building America FOA process in one of the critical Roadmap areas.

There are three technical topics to this lab call, described in further detail below, and corresponding to the Building America Technology to Market Roadmaps described in the Building America Research to Market Plan.

1. High Performance, Moisture-Managed Envelope Solutions
2. Optimal Comfort for Low Load Homes
3. Optimal Ventilation and Indoor Air Quality Solutions

RBI is NOT interested in proposals for this FY17 Lab Call that are in areas not covered in the RBI mission, the RBI strategic plan, or do not directly correlate with the Building America Program's activities under the Research to Market Plan. **The anticipated annual budget for RBI's topic areas is up to $2.5 million. Individual proposals for each topic area are sought that may vary in funding, up to $2.5 million per year.** BTO may issue awards in one, multiple, or none of the three topic areas.

Topic 1: High Performance, Moisture-managed Envelope Solutions

High-R-value (high-R) building envelope assemblies (i.e., foundation, walls, and roof) exceeding IECC 2012 are the biggest potential home energy-saving measures, according to several analyses by DOE national laboratories. Heating and cooling loads account for nearly 50% of home energy use, and significant end-use savings cannot be achieved without major improvements in building envelope performance. Based on a prioritized building envelope technologies assessment, the BTO Emerging Technologies Program, with analysis support from ORNL, determined that high-R building envelope assemblies in new and existing homes can decrease energy use by about 2.75 quads per year, which is nearly 3% of the energy consumed in the United States. However, advanced envelope systems are rarely selected by building designers. Current solutions are expensive and/or unfamiliar to many designers, builders, contractors, and code officials and therefore perceived as risky. Furthermore, the dominant perceived risk is durability specifically related to condensation and moisture accumulation in building assemblies. In addition, some high-R envelope solutions are limited by International Residential Code (IRC) code barriers (e.g., fire and structural).

DOE seeks to resolve perceived cost and risk barriers to broad market acceptance of optimized, high-R building envelope systems. This requires addressing both knowledge gaps about moisture risk management and validating performance of priority high-R envelope systems. DOE seeks proposals that focus on two main areas:

1. **Moisture risk management**, including RD&D to develop data, guidance, and tools—both research and design tools—that result in better industry standards and codes for managing moisture durability risks of insulated building assemblies. These data, guidance, and tools will help industry confidently identify and specify the least-cost high-R building assembly designs that are least likely to encounter moisture problems in each climate zone. They will also provide a comprehensive and compelling basis for building codes to adopt requirements for building envelope assemblies that are both energy efficient and moisture durable (i.e., high-performance, moisture-managed building envelopes).
2. **High-performance envelope systems**, developing and effectively disseminating best practice guidance and specifications for envelope systems with optimal thermal performance and minimal risk (e.g., moisture risk, structural risk, and fire risk) based on validated performance and accepted industry standards.

The anticipated annual budget for this RBI topic areas is up to $900k. Individual proposals for this topic area are sought that may vary between funding amounts, up to $900k. BTO may issue one, multiple, or no awards in this topic area.

A. Building America Technology to Market Roadmap projects

RBI seeks Laboratory proposals for projects that will directly address one or more of the objectives of the *High Performance, Moisture-managed Envelope Solutions* Roadmap, including as appropriate Laboratory R&D, development and implementation of guidance and/or tools,

and advancement of industry standard practice. Specifically, RBI requires Laboratories to conduct activities that advance objectives described in the following blocks of the envelope roadmap:

1. Laboratory and Field Moisture Risk Assessment of Priority High-R Assemblies and Materials
2. Research Supporting Advancement of Moisture Risk Assessment and Modeling Standards
3. Development of Moisture-Managed Guidance/Tools (e.g., "expert system" design tools for managing moisture risk in high-R envelope systems) and Best Practice Specs for Priority High-R Envelope Systems in Each Climate

B. Building America Program Support Activities

In addition to the items detailed in Topic 1.A, RBI seeks proposals regarding activities that support Building America teams or Building America program implementation activities. Proposals should describe how Laboratory activities will support program objectives and be linked to outcomes consistent with program goals. Examples of laboratory program support activities include:

- Envelope roadmap development and program planning support to RBI
- Analysis to support RBI policy and planning processes related to this roadmap
- Technical assistance to Building America teams performing work related to this roadmap, such as test plan review, etc.
- Participation in stakeholder engagement activities supporting Building America program planning and implementation
- Publication and presentation of research results that advance building science and engineering related to this roadmap

Topic 2: Optimal Comfort for Low Load Homes

The installed performance of HVAC systems, especially distribution system effectiveness and latent performance (i.e., humidity control), is typically suboptimal in American homes, and it is often significantly compromised because of design and/or installation defects. Compromised HVAC system performance can result in energy waste, building durability problems, and occupant discomfort. These can be critical risks in low-load homes, which often have lower HVAC system airflows and/or less operation time. Distribution system and RH optimization are not often ensured by manufacturers or regulated by codes or standards, and current solutions are labor-intensive and/or expensive.

High-performance, low-load homes face unique space conditioning challenges that are not adequately addressed by current HVAC design practices. Furthermore, equipment suitable for optimal performance in low-load homes is not yet commonly used by builders and HVAC contractors. Low-load home comfort systems must address (1) effective part-load temperature

and humidity control during all occupied times, and (2) effective air distribution and temperature control throughout the occupied spaces in a home. The goal is to ensure HVAC designers and builders have the tools necessary to design and install optimal comfort system solutions that address the needs of high-performance, low-load homes.

DOE's goal is to set a course for RD&D, standards, and market stimulation that will reduce the barriers to designing and installing high-performance space conditioning systems in low-load homes that meet occupant comfort expectations during all occupied hours so they will be voluntarily adopted by industry and ultimately addressed in building codes. As such, DOE seeks proposals that focus on two main areas:

1. **System design** ensuring occupant comfort is maintained uniformly throughout the home for the entire year.
2. **Smart systems and equipment** capable of efficiently and consistently conditioning low-load homes are available on the market.

The anticipated annual budget for this RBI topic areas is up to $300k. Individual proposals for this topic area are sought that may vary in funding amounts, up to $300k. BTO may issue one, multiple, or no awards in this topic area.

A. Building America Technology to Market Roadmap projects

RBI seeks Laboratory proposals for projects that will directly address one or more of the objectives of the *Optimal Comfort for Low-Load Homes* Roadmap, including as appropriate Laboratory R&D, development and implementation of guidance and/or tools, and advancement of industry standard practice. Specifically, RBI requires Laboratories to conduct activities that advance objectives described in the following blocks of the comfort roadmap:

1. Develop System Design Procedures/Tools and Comfort Metrics/ Criteria for Low-Load Homes
2. Develop Best Practice Guidance/Training/Tools on System Design, Installation/Commissioning, and Maintenance
3. Research to Support Improvements in System Design Standards that Address Comfort Criteria in Low-Load Homes
4. Assess Load Profiles/Market Demand for Low-Load Homes
5. Research to Advance the State of the Art and Help Manufacturers Develop Low-Load HVAC and Dehumidification Equipment
6. Research to Advance the State of the Art and Help Manufacturers Develop Automated FDD and Optimization Controls
7. Research to Support Development of FDD, Sensors/Controls, Metrics, and Performance Validation Standards

8. Develop Best Practice Guidance on Automated Smart HVAC Operation, Controls, and Maintenance

B. Building America Program Support Activities

In addition to the items detailed in Topic 2.A, RBI seeks proposals regarding activities that support Building America teams or Building America program implementation activities. Proposals should describe how Laboratory activities will support program objectives and be linked to outcomes consistent with program goals. Examples of laboratory program support activities include:

- Comfort roadmap development and program planning support to RBI
- Analysis to support RBI policy and planning processes related to this roadmap
- Technical assistance to Building America teams performing work related to this roadmap, such as test plan review, etc.
- Participation in stakeholder engagement activities supporting Building America program planning and implementation
- Publication and presentation of research results that advance building science and engineering related to this roadmap

Topic 3: Optimal Ventilation and Indoor Air Quality Solutions

Basic mechanical ventilation has become standard in new homes, building codes, and home performance and weatherization programs. However, current applications and standards do little to optimize either IAQ or IAQ system-related energy performance. For example, heat recovery is not required or encouraged in ASHRAE Standard 62.2, and it is less commonly specified. In addition, current ventilation solutions are limited by climate, sensor and control technologies, pollutant source control methods, and the system costs the market will bear.

However, even optimized ventilation solutions do not guarantee acceptable IAQ. This ventilation caveat is clearly stated in the scope of ASHRAE Standard 62.2. Acceptable IAQ requires addressing the sources of indoor pollutants through elimination or removal. Then, dilution ventilation can be more effectively applied to address general pollutants that cannot be eliminated or removed effectively at their sources, such as occupant-generated pollutants.

Finally, it is clear from decades of research and market experience through Building America and other programs that energy efficiency and high-performance homes will not be adopted by the market or industry standards if they cause IAQ problems. Furthermore, good IAQ and healthy home features have been shown to be a powerful driver for energy efficiency and improved home performance.

DOE seeks to guide RD&D to ensure that the development of best practices, specifications, and standards for existing home retrofits and high-performance new home construction accounts for the effects that the building and its systems may have on the health of occupants and the durability of the building itself, while minimizing energy usage. The end objectives of

this roadmap are smarter ventilation and IAQ solutions, more flexible and robust industry standards (e.g., future editions of ASHRAE 62.2), and IAQ valuation methods that enable market adoption of high-performance homes with optimal IAQ and minimal energy use. These will ease adoption of good IAQ by the housing industry and increase the attractiveness of high-performance homes to the public. The roadmap provides more detailed objectives by focusing on improving technologies and industry standards in the following three areas:

1. **Targeted pollutant solutions** that better control known indoor contaminants of concern, near their emission source(s), to allow for improved IAQ without increasing dilution ventilation requirements. Ideally, if all known contaminants of concern are controlled at their sources, very little dilution ventilation will be required to maintain acceptable IAQ.
2. **Smart ventilation** technology solutions that optimize the balance between IAQ and energy and account for other variables that affect IAQ, such as occupancy, exhaust fan (e.g., dryer and range hood) operation, indoor and outdoor temperature, RH, and outdoor pollutant levels (e.g., ozone and particles).
3. **IAQ valuation** that facilitates standardized, quantified assessments of home IAQ to encourage more informed and objective design decisions regarding IAQ measures. One promising approach being considered in this roadmap is the development of a standardized scale for scoring home IAQ, similar to energy scores (e.g., HERS Index). A standard IAQ scoring system could encourage better-informed choices about IAQ and provide a way to incent building industry stakeholders to provide healthier, more durable homes. IAQ valuation will also make pollutant measurements more meaningful and may lead to real-time IAQ controls that effectively respond to indoor environmental conditions.

The anticipated annual budget for this RBI topic area is up to $1.3 million. Individual proposals for this topic area are sought that may vary in funding amounts, up to $300k. BTO may issue one, multiple, or no awards in this topic area.

A. Building America Technology to Market Roadmap projects

RBI seeks Laboratory proposals for projects that will directly address one or more of the objectives of the *Optimal Ventilation and Indoor Air Quality Solutions* Roadmap, including as appropriate Laboratory R&D, development and implementation of guidance and/or tools, and advancement of industry standard practice. Specifically, RBI requires Laboratories to conduct activities that advance objectives described in the following blocks of the comfort roadmap:

1. Research to Advance the State of the Art and Help Manufacturers Develop Targeted IAQ Solutions
2. Research to Support Inclusion of Targeted IAQ Solutions in HVI Certification, ASHRAE 62.2, and 2021 I-Codes

3. Research to Advance the State of the Art and Help Manufacturers Develop Smart Ventilation Equipment and Real-Time Controls
4. Develop Smart Ventilation Specs
5. Develop IAQ Baselines and Valuation Metrics
6. Develop IAQ Guidance and Assessment Tools
7. Research to Support ASHRAE 62.2 Transition to IAQ Equivalence and Smart Systems

B. Building America Program Support Activities

In addition to the items detailed in Topic 3.A, RBI seeks proposals regarding activities that support Building America teams or Building America program implementation activities. Proposals should describe how Laboratory activities will support program objectives and be linked to outcomes consistent with program goals. Examples of laboratory program support activities include:

- IAQ roadmap development and program planning support to RBI
- Analysis to support RBI policy and planning processes related to this roadmap
- Technical assistance to Building America teams performing work related to this roadmap, such as test plan review, etc.
- Participation in stakeholder engagement activities supporting Building America program planning and implementation
- Publication and presentation of research results that advance building science and engineering related to this roadmap

APPENDIX C. Content and Form of Full Proposals

Full proposals must include the following:

- Technical volume
- Budget information
- 2-page CVs
- Current or prior related support
- Letters of support/commitment (as needed)

A description of each item is given below.

Technical Volume

Page lengths for the Technical Volume differ depending on the program area (ET – 15 pages and RBI 7 pages), as specified earlier in Table 2, but the proposal format is consistent and is given below.

1) Project Title; Topic area
2) Project High-Level Goal/Objective (2-3 sentences) that is relevant to national objectives on climate, oil dependency and economic competitiveness

   Project Description – Technical Merit, Innovation, and Impact (approx. 50%)

   a. For ET proposals:
      1) Overall objective and outcome of the project
      2) Define the current state-of-the art and baseline for the proposed technology
      3) Relevant technology barriers and targets/goals and how the proposed project addresses them
      4) Degree to which project is novel or has potential to advance state-of-the-art
   b. For RBI proposals:
      1) Overall objective and outcome of the project
      2) Degree to which project has potential to advance the state-of-the-art
      3) Degree to which the project supports RBI strategy and program objectives
      4) Degree to which the project improves the efficiency and effectiveness of RBI programs
   c. EERE questions (for ALL proposals):
      1) Impact: Is this a high-impact problem?
      2) Additionality: Will EERE funding make a large difference relative to existing funding from other sources, including the private sector?
      3) Openness: Are we focusing on the broad problem we are trying to solve and open to new ideas, approaches, and performers?
3) Project Approach (approx. 30%)
   a. Work Plan
      1)Key tasks with brief description, including roles and responsibilities of any partners
      2)SMART milestones, deliverables, go/no-go decisions
   b. Market Transformation
      1) If the project is R&D technology focused, how does it identify and address the current and/or potential opportunities to move that technology towards eventual transition to the private sector?

2)ET Projects should include a Market Transformation and Commercialization plan leading to commercialization of developed technologies within 3-5 years. This plan should include the following:

- Identification of the target market, quantification of the market opportunity, and distribution channels for proposed solution along with known or perceived barriers to market penetration, including a mitigation plan
- Identification of market barriers and a plan to overcome those barriers.
- Identification of a product development and/or service plan, commercialization timeline, financing, product marketing, legal/regulatory considerations including intellectual property, infrastructure requirements, data dissemination, U.S. manufacturing plan etc., and product distribution.
- Identification of the technology transition and commercialization plan and timeline, including strategic partnerships and potential follow-on funding sources, from its current state to ultimate market deployment. Please note that while some projects funded through this Lab Call will be ready to transition to a commercial or deployment-focused effort, this is not by any means a requirement. Examples of variables to be considered in the plan include:
- Product development, financing and/or service plan
- Product marketing strategy
- Legal and regulatory considerations including intellectual property, open source software distribution plan and data dissemination plans (as applicable)
- Infrastructure requirements such as existing utility practices U.S. manufacturing plan etc., and product distribution.

3)If a project is not R&D focused, how does it contribute to overcoming one or more key market barriers?

C. Open Source Software Distribution and Interoperability Plan for ET Proposals developing software:

1)Submission of the Open Source Software Distribution Plan (Appendix E), is required.

2)Plans for Interoperability covering each hierarchical level at which systems interact. As a minimal requirement, where possible all device(s) to be controlled should be accessed by open communication standards, and using open or consensus-based information and data standards. The VOLTTRON platform may also be leveraged as a resource, but is not required. The following elements should be addressed in the interoperability plan:

- Identify the information exchange interfaces for communicating devices and systems (i.e., their points of connection with other elements of the system),
- Identify the openly-available (and proprietary, if applicable) aspects of the interface specifications, and how existing (legacy) communicating devices or systems are integrated into the project,
  Note, that NIST's emerging smart grid framework (http://www.nist.gov/smartgrid/upload/NIST-SP-1108r3.pdf), may be a good framework to use to describe the project's interoperability but must address it in terms of buildings.

4)

4) Team and Resources (approx. 20%)

a. Total Budget: Please include any cost share and potential in-kind contribution (e.g., equipment)
b. Qualifications
c. Project performers / key personnel (names, brief description of pertinent qualifications)
d. Describe Inter-lab Collaboration, as appropriate
e. Facilities (specify where work will be done, and why it might be necessary to use unique capabilities of the facility)
f. Teaming and industrial/market partners (as applicable) – describe the nature of the teaming arrangement

Budget Information

A completed and signed Field Work Proposal (FWP, DOE O 412.1.A), supported by an SF-424-A Budget Information table (see final tab in EERE 335 Detailed Budget Justification document) is required as a part of the full proposal package. Applicants must use the forms available on EERE Exchange. There are no page limits for these forms.

CV's for the Lead PI and Key Personnel

CV's are required for the Lead PI and all key personnel. CV's may not exceed 2 pages per person, and should include at least the following:

- Academic/professional qualifications
- Bibliography of relevant publications and intellectual property

There are no page limits for this section, except the 2-page limit for each CV.

Current or Prior Related Support

Applicants should list any current or prior related funding support, including project title, beginning and ending dates, total funding amount, PI(s), and funding source. If any current or prior funding seems very closely related to the proposed work, the Applicants should discuss in the Technical Volume how the proposed work is distinct from the other project(s).

There are no page limits for this section.

Letters of Support or Commitment

Applicants may attach letters of support and/or commitment (i.e., cost share) from collaborators, as needed. There are no page limits for this section.

APPENDIX D. Proposal Review Criteria

Criterion 1: Technical Merit, Innovation, and Impact (Weight: 50%)

1(a) Degree to which the project addresses program barriers, contributes to achieving Office targets/goals, and has potential to advance state-of-the-art or achieve substantial market impact

1(b) Extent to which the proposed project addresses EERE questions

1(c) Sufficiency of technical detail to assess whether the proposed work is scientifically meritorious and make sense for the market

1(d) For deployment activities, the extent to which the proposal describes a clear target market, market barriers, target use case, problem statement, and deployment path

Criterion 2: Project Approach (Weight: 30%)

2(a) Relevance and appropriateness of the approach and critical path and description of key tasks, metrics (including baseline), and SMART milestones

2(b) Degree of likelihood that the work plan will succeed in meeting project goals

2(c) Identification of key technical risks and the quality of management and mitigation strategies to address them

2(d) Level and appropriateness of partnerships (e.g., “openness”), and the clarity in the description of roles and responsibilities

2(e) Degree to which the project identifies and addresses the current and/or potential opportunities to move EERE technologies towards eventual transition to the market (i.e., Market Transformation), including but not limited to product development and/or service plan, open-source software distribution and interoperability plan, commercialization timeline, financing, product marketing, legal/regulatory considerations including intellectual property, infrastructure requirements, data dissemination, U.S. manufacturing plan, and product distribution.

Criterion 3: Team and Resources (Weight: 20%)

3(a) Degree to which the project leverages a core or enabling capability

3(b) Capability of the Principal Investigator(s) and team to address all aspects of the work – qualifications, expertise, and time commitment of the team

3(c) Sufficiency of the facilities to support the work (if applicable)

3(d) Degree to which the team demonstrates the ability to facilitate and expedite further development and commercial deployment of the proposed technologies (or wider implementation of the proposed deployment activity)

3(e) Degree to which inter-lab collaboration is occurring, as appropriate.

3(f) Reasonableness of budget and spend plan for proposed project and objectives. Sufficiency of the budget for the innovation proposed.

APPENDIX E. Open Source Software Distribution Plan

Applicants that are applying to one or more Topic Areas for which open source software distribution is required must submit a plan describing how software produced under this Lab Call will be distributed. For a DOE National Laboratory or a FFRDC, the data rights clause, including rights and requirements pertaining to computer software, in its Management and Operating (M&O) Contract shall apply and shall take precedence over any requirement set forth in this Appendix. The plan must include the following elements:

1. A complete description of any existing software that will be modified or incorporated into software produced under this Lab Call, including a description of the license rights. The license rights must allow the modified or incorporated software to be distributed as open source.
2. A discussion of the open source license that the applicant plans to use for the software it plans to produce under the Lab Call, and how that choice furthers the goals of this Lab Call. The discussion must also address how the license conforms to the conditions listed below.
3. A method for depositing the software in a source code repository.
4. A method for sharing and disseminating the software and other information to team members or others when multiple parties will contribute to the development of the software or the Lab Call requires that the software or other information be shared or disseminated to others.

Open Source Definition: Open source licenses must conform to all of the following conditions:

Free Redistribution

The license shall not restrict any party from selling or giving away the software as a component of an aggregate software distribution containing programs from several different sources. The license shall not require a royalty or other fee for such sale. The rights attached to the software must apply to all to whom the software is redistributed without the need for execution of an additional license by those parties.

Source Code

The program must include source code, and must allow distribution in source code as well as compiled form. Where some form of a product is not distributed with source code, there must be a well-publicized means of obtaining the source code for no more than a reasonable reproduction cost preferably, i.e., downloading via the Internet without charge. The source code must be the preferred form in which a programmer would modify the program. Deliberately obfuscated source code and intermediate forms such as the output of a preprocessor or translator are not allowed.

Derived Works

The license must allow modifications and derived works, and permit the option of distributing the modifications and derived works under the same terms as the license of the original software.

Integrity of the Author's Source Code

The license may restrict source-code from being distributed in modified form only if the license allows the distribution of "patch files" with the source code for the purpose of modifying the program at build time. The license must explicitly permit distribution of software built from modified source code. The license may require derived works to carry a different name or version number from the original software.

No Restriction Against Fields of Endeavor

The license must not restrict anyone from making use of the program in a specific field of endeavor. For example, it may not restrict the program from being used in a business, or from being used for genetic research.

License Must Not Be Specific to a Product or Technology

The rights attached to the program must not depend on the program's being part of a particular software distribution. If the program is extracted from that distribution and used or distributed within the terms of the program's license, all parties to whom the program is redistributed should have the same rights as those that are granted in conjunction with the original software distribution. No provision of the license may be predicated on any individual technology or style of interface.

License Must Not Restrict Other Software

The license must not place restrictions on other software that is distributed along with the licensed software. For example, the license must not insist that all other programs distributed on the same medium must be open-source software.

Examples of Acceptable Licenses

Apache License, 2.0

http://www.apache.org/licenses

The 2.0 version of the Apache License was approved by the Apache Software Foundation (ASF) in 2004. The goals of this license revision were to reduce the number of frequently asked questions, to allow the license to be reusable without modification by any project (including non-ASF projects), to allow the license to be included by reference instead of listed in every file, to clarify the license on submission of contributions, to require a patent license on contributions that necessarily infringe the contributor's own patents, and to move comments regarding Apache and other inherited attribution notices to a location outside the license terms.

The result is a license that is compatible with other open source licenses, while remaining true to and supportive of collaborative development across both nonprofit and commercial organizations.

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