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1791 Tullie Circle, NE • Atlanta, GA 30329-2305 USA • Tel 404.636.8400 • Fax 404.321.5478 • http://www.ashrae.org

Lynn G. Bellenger, P.E., FASHRAE
President

Reply to: PATHFINDER ENGINEERS & ARCHITECTS LLP
134 South Fitzhugh Street
Rochester, NY 14608-2268
☎ 585-325-6004 ext. 105
Fax: 585-325-6005
lbellenger@pathfinder-ea.com

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Asa Hopkins
U.S. Department of Energy
Office of the Under Secretary for Science (S4)
1000 Independence Ave., SW
Washington, DC 20585

Regarding Public Comment on the U.S. Department of Energy's Quadrennial Technology Review Framing Document

Dear Dr. Hopkins:

The American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc. (ASHRAE), founded in 1894, is an international organization of over 52,000 members. ASHRAE fulfills its mission of advancing heating, ventilation, air conditioning and refrigeration to serve humanity and promote a sustainable world through research, standards writing, publishing and continuing education.

As a leader in developing and maintaining premier consensus-based standards, in addition to professional certifications, advanced energy design guides, research, and other services, we offer the following recommendations to improve the U.S. Department of Energy's Quadrennial Technology Review Framing Document (Framing Document).

Summary of Recommendations

1. *DOE energy research mission: ASHRAE recommends replacing "scaling" with "commercialization" to clarify the meaning of DOE's mission.*

2. *What principles should the Department follow for allocating resources among technologies of disparate maturity and potential time to impact? ASHRAE recommends employing a balanced portfolio approach containing a blend of supply- and demand-side projects.*

3. *ASHRAE encourages DOE to invest substantial resources into research and development to better understand the energy flows of buildings to stimulate the development and deployment of lower-cost building and equipment monitoring technologies.*

4. *What, if any, role should the Department have in addressing non-technical barriers (e.g., codes and standards) to the deployment of energy technologies? ASHRAE recommends working with other federal agencies and departments to hasten the adoption of updated industry standards*

throughout the federal government. We also encourage DOE to reference and utilize private sector education, training, and certification programs, such as those developed by ASHRAE and other technical societies, for persons involved with building design, operation, and maintenance.

5. *Modernizing the grid: ASHRAE recommends using ASHRAE/NEMA Standard 201P and BACnet to help standardize information exchange and data management in the Smart Grid. The Society also recommends supporting research and development and customer incentives to speed the deployment and adoption of new technologies into the Smart Grid.*

6. *General recommendations and comments: Clarify the Department of Defense consumption figure, and emphasize DOE's collaborative relationship with the private sector.*

Background for Recommendations

1. *DOE energy research mission: ASHRAE recommends replacing "scaling" with "commercialization" to clarify the meaning of DOE's mission.*

ASHRAE recommends changing the wording of DOE's energy research mission statement to specify its meaning. The revised statement would read as follows (additions are underlined and deletions are struck through):

"To facilitate the invention, refinement, and early deployment of meaningful technologies that enable options for ~~scaling~~ <u>commercialization</u> by the private sector toward national energy goals."

ASHRAE supports DOE's energy research mission statement with this revision, and notes the similarity of its essential character to the Society's own Research Vision in ASHRAE's 2010-2015 Research Strategic Plan, which supports efforts to identify and overcome barriers to improving building efficiency, design, and performance:

"ASHRAE conducts timely research to remain the foremost, authoritative and responsive international source of technical and educational information, standards and guides on the interaction between people and the indoor and outdoor environment through the operation of HVAC&R systems in buildings and other applications.[1]"

2. *What principles should the Department follow for allocating resources among technologies of disparate maturity and potential time to impact? ASHRAE recommends employing a balanced portfolio approach containing a blend of supply- and demand-side projects.*

By balancing the allocation of resources between supply- and demand-side projects the Department may be able to ensure that the activities it funds have a higher probability of success. A good example is the juxtaposition between the Department's Advanced Research Projects Agency-Energy (ARPA-E), which funds early-stage, high-risk/high-reward projects, and the Department's Loan Guarantee Program, which funds projects that are closer to commercialization and have a higher likelihood of success.

However, even within ARPA-E and the Loan Guarantee Program, it is important to strive to achieve a balance between funding projects that would improve the production or supply energy, and those that would lower energy consumption by increasing the efficiency of buildings and other users. This is especially important because the goal of meeting the nation's energy needs cannot be achieved

[1] ASHRAE Research Strategic Plan 2010-2015: Navigation for a Sustainable Future. http://www.ashrae.org/File%20Library/docLib/Public/20100621_strategicnavigationbrochure.pdf.

simply by continuously increasing the supply of energy; instead we must place an equal, if not greater focus on improving the efficient use of energy, which will reduce demand and increase available capacity.

3. *ASHRAE encourages DOE to invest substantial resources into research and development to better understand the energy flows of buildings to stimulate the development and deployment of lower-cost building and equipment monitoring technologies.*

Even after decades of effort, the building industry has very poor understanding of the flows of energy in buildings, and how the details of energy use differ from expectations, standards, and models. For many reasons, "as designed" is generally different from "as operated", and "certified" equipment performance gives a one- or two-dimensional picture that cannot reflect the energy savings benefits of advanced but unrated features. Until we understand how residential and commercial buildings, systems, equipment, and components actually work, we will continue to focus on treating symptoms of inefficiency rather than the direct causes.

After decades of effort, field studies are still very expensive "one-offs." Thus, there isn't the basic data for developing retrofit approaches specific to building types and construction variations that will allow us to get to scale to retrofit the building stock – and design new buildings with confidence. We recognize that DOE funding for the Greater Philadelphia Innovation Cluster is a major initiative in advancing our understanding of retrofit possibilities in existing buildings.

We recommend that DOE devote substantial resources to stimulate the development and deployment of standardized, lower-cost building and equipment monitoring technologies and methods that can be widely and cost-effectively employed to solidly establish an empirical basis for building science, and to enable much greater efficiency gains (and much better control of indoor environmental conditions), more quickly than the piece-meal approach of the past four decades. We believe that enormous gains could be made with competitive procurement strategies that pay for studies in large groups of similar buildings, allowing contractors to focus on scalable methods and reduced labor costs.

4. *What, if any, role should the Department have in addressing non-technical barriers (e.g., codes and standards) to the deployment of energy technologies? ASHRAE recommends working with other federal agencies and departments to hasten the adoption of updated industry standards throughout the federal government. We also encourage DOE to reference and utilize private sector education, training, and certification programs, such as those developed by ASHRAE and other technical societies, for persons involved with building design, operation, and maintenance.*

In response to a December 8, 2010 request for information in the *Federal Register*[2], ASHRAE worked with the American National Standards Institute (ANSI) to submit comments[3] to the National Institute of Standards and Technology in the U.S. Department of Commerce.

The comments explain that, for various reasons, federal agencies are not always able to make timely updates to industry standards referenced in rules and regulations when new versions of

[2] Request for Information on the Effectiveness of Federal Agency Participation in Standardization in Select Technology Sectors for National Science and Technology Council's Sub-Committee on Standardization. http://www.federalregister.gov/articles/2011/01/21/2011-1005/effectiveness-of-federal-agency-participation-in-standardization-in-select-technology-sectors-for

[3] ANSI Response to Request for Information on Federal Agencies' Participation in Standards and Conformity Assessment Activities. http://standards.gov/standards_gov/sos_rfi_docs/7_ANSI.pdf

these standards are published. This has the potential to create confusion within the federal government and private sector, and impede the greater deployment of new technologies with higher efficiencies.

To overcome this challenge, the comments recommend that federal agencies follow a different approach, in which an agency would have "90 days after the promulgation of a revision of a referenced standard to update the Code of Federal Regulations (CFR). If the agency does not do so within the 90-day period, it will be presumed that the revision of the standard would be accepted as the new standard. An agency could create a due diligence requirement that such a revision has to be noticed in the *Federal Register* for 30, 60, or 90 days. If no significant opposition has been heard, the revision becomes the new standard. A number of agencies have successfully used this approach.[4]"

The Department can help remove barriers to the deployment of new energy technologies by adopting this alternative pathway to updated industry standards.

Additionally, ASHRAE encourages DOE to reference and utilize private sector education, training, and certification programs for persons involved with building design, operation, and maintenance.

ASHRAE has worked with the U.S. General Services Administration, and other technical societies to develop several professional certifications[5]. ASHRAE's current certifications include:

- Operations & Performance Management Professional
- High-Performance Building Design Professional
- Healthcare Facility Design Professional
- Commissioning Process Management Professional
- Building Energy Modeling Professional
- Building Energy Assessment Professional

These certifications would help prepare building personnel to design, operate, and maintain buildings at high performance. Without this training, even well-designed buildings may not achieve their highest potential efficiencies.

Referencing and utilizing these certifications for federal and private sector building personnel may help meet the requirements of the Federal Buildings Personnel Training Act (P.L. 111-308), which requires federal personnel and contractors performing energy management, building operations and maintenance, safety, and other functions to participate in training and certification programs to enhance their competencies and comply with existing requirements under federal law.

5. *Modernizing the grid: ASHRAE recommends using ASHRAE/NEMA Standard 201P and BACnet to help standardize information exchange and data management in the Smart Grid. The Society also recommends supporting research and development, and customer incentives to speed the deployment and adoption of new technologies into the Smart Grid.*

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[4] Request for Information on the Effectiveness of Federal Agency Participation in Standardization in Select Technology Sectors for National Science and Technology Council's Sub-Committee on Standardization. http://standards.gov/standards_gov/sos_rfi_docs/7_ANSI.pdf

[5] For additional information on ASHRAE's professional certifications, visit http://www.ashrae.org/certification/.

Buildings account for 73 percent of all electrical energy consumption[6] and 55 percent of all natural gas consumption nationwide. Because buildings consume more electricity and natural gas than any other sector, buildings will play a central role in the modernization of the nation's current electrical grid to a Smart Grid, and will become active participants, as energy storage centers, dispersed renewable energy micro-generators, and electrical vehicle charging stations.

ASHRAE encourages the Department to consider using ASHRAE/NEMA Standard 201P *Facility Smart Grid Information Model* as a basis for common information exchange in the Smart Grid between control systems and end-use devices found in single- and multi-family homes, commercial and institutional buildings, and industrial facilities that is independent of the communication protocol in use.

Similarly, the Society encourages the Department to consider using BACnet® – *A Data Communication Protocol for Building Automation and Control Networks* (ANSI/ASHRAE Standard 135), and BACnet technologies to help modernize the grid.

The Society's rational for using BACnet stems from the belief that managing data in the Smart Grid will be a major issue. Data is generated at each stage of energy generation and consumption. Robust support for the data produced during the interplay of the on- and off-site generation of renewable and nonrenewable energy, its transmission, storage, and consumption will be required to capture efficiencies, and prevent data loss and unnecessary duplication of effort.

BACnet is a well-established data communication protocol for building automation and control networks, and has been communicating on standard IP networks for more than ten years. BACnet currently possesses energy management and load control capabilities and is a natural fit for integration into the Smart Grid. Not long ago, BACnet's Utility Integration Working Group was re-chartered as the Smart Grid Working Group. The Working Group focuses on enabling buildings to act as full participants in the Smart Grid – receiving price and event signals from grid operations, as well as requests for resource status and responding to grid signals with control actions to appropriately manage energy.

Regarding research and development to help modernize the grid, the Society encourages DOE and other federal agencies to continue and increase support for research and development of the Smart Grid. ASHRAE also supports private/public joint research and demonstration programs and deployment partnerships that will help to advance the Smart Grid. Research and demonstration projects that document the economic benefits of changing customer behavior also should be encouraged.

ASHRAE supports this recommendation because the implementation of the Smart Grid will be a complex process that affects all market sectors. Research and development is needed to more accurately assess its benefits and costs and to anticipate its requirements. Demonstration projects will help speed adoption of both technology and practices.

To help speed the deployment and adoption of new technologies into the emerging Smart Grid, ASHRAE recommends focusing on research and development on customer incentives. In particular, the Society recommends that research on balancing integrated load, generation, and thermal storage with response to a local price signal and toward stable grid operation should be actively funded. Research and demonstration projects that document the economic benefits of changing customer behavior will also speed adoption of both technology and practices. Voluntary participation driven by economic incentives is more likely to succeed than mandatory programs.

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[6] [6] U.S. Department of Energy. *2009 Buildings Energy Data Book*. http://buildingsdatabook.eren.doe.gov/.

ASHRAE's reasoning for this recommendation is based on numerous pilot programs that have taken place in the United States, which have made it clear that customers understand and will respond to pricing options if the on-peak off-peak differential makes it worthwhile to do so. There are studies from Georgia, California, Maryland, Washington DC, and many other parts of the U.S. that show that customers do respond, and that customers with automated systems respond to an even greater degree.

To avoid possible resistance to the Smart Grid, it should be emphasized that customer responses should not be forced; it will happen if pricing signals are adequate and response mechanisms are present. Commercial and industrial customers generally are not willing to cede control of equipment and building systems to an external energy services company. Likewise, as technology enables more appliances in the home to respond to grid signals, residential customers will likely also resist direct load control approaches.

There will be situations where some consumers will not be interested in using Smart Grid technologies. For example, some/many consumers will not replace appliances they recently purchased in order to have an appliance that is "Smart Grid ready".

There is a link between energy efficiency, net zero energy buildings, and a Smart Grid. Policies that encourage energy efficiency can substantially reduce the need for new grid capacity. However, efficiency improvements lower the incentive to respond to price or demand response signals. For example, if a consumer replaces a 20 year-old refrigerator that uses about 1,000 kWh per year with a refrigerator that uses 450 kWh per year, the average and peak demand available for demand response will be much less. As another example, a customer with an old three-ton air conditioner rated at 9 EER will use about 4 kW at EER test conditions (95 degrees Fahrenheit outside ambient air). If the customer purchases a new air conditioner that is rated at 13 EER, the new peak demand will be 2.77 kW – a 31.25 percent reduction in peak demand, which also means a 31.25 percent reduction in potential demand response.

Federal policy should emphasize energy efficiency over the Smart Grid in the commercial/industrial and residential markets. Buildings operate on a very slow time scale in terms of the length of life of equipment/appliances and the life of the structure itself. As demonstrated above, there is generally not enough economic benefit in the Smart Grid to justify upgrading useful equipment and buildings to a more Smart Grid-ready model. However, there often is enough value, with the right price signal, to drive the investment in controls and energy management tools to provide better monitoring and energy management of existing equipment. We would also note that standards in the home domain are still developing and merit a slow roll-out of technology in the home space.

For residential power management, we note the progress in Europe with the Energy Research Centre of Netherlands' (ECN) PowerMatcher platform which has successfully used thermal storage attached to heat pumps to shift load off-peak, and an auction-based local power arbitration approach to integrate electric vehicles such that they charge off-peak. The Pacific Northwest National Laboratory is working on a similar approach to residential power management. Research along the lines of balancing integrated load, generation, and thermal storage with response to a local price signal and toward stable grid operation should be actively funded.

Part of designing for energy efficiency is installing sensors and controls to allow monitoring building performance over time. Equipment performance degrades and devices malfunction. Sensors can detect that degradation. Sensors and controls also enable fine-grained energy management such that one room can have fresh air and heat as needed for a large meeting, while the room next door has no lighting, and no heating and ventilation because it is unoccupied. If we design buildings for

that kind of energy efficiency and healthy operation, then we also have buildings that are optimally prepared to respond to grid events and changes in electricity price.

For large customers, even small price changes can provide an economic incentive. The experience of the Georgia Institute of Technology in responding to small 24-hour advanced notice price signals is an example[7]. In some cases capital investments to install thermal storage systems are needed to take advantage of dynamic pricing. Policies that make this capital investment easier would encourage adoption. Research and demonstration projects that document the economic benefits of changing customer behavior will also speed adoption of both technology and practices.

6. *General recommendations and comments: Clarify the Department of Defense consumption figure, and emphasize DOE's collaborative relationship with the private sector.*

Page seven of the Framing Document states that "almost 90% of federal energy use is in the Department of Defense". Clarification is needed on whether this figure represents energy used by the Department of Defense for ships, trucks, planes, etc., or stationary uses, such as buildings.

Pages 11 through 13 of the Framing Document discuss DOE's activities, however what is not mentioned is the Department's extensive collaboration with private sector non-governmental organizations and standards development organizations, such as ASHRAE, to help develop standards and codes, encourage their adoption, increase compliance rates, and disseminate information to stakeholders and the general public.

ASHRAE recommends amending the section of the Framing Document on DOE Activities to include an examination of this public-private relationship.

Conclusion

ASHRAE hopes that these comments and recommendations in response to the request for public comment on the Department of Energy's Quadrennial Technology Review Framing Document will assist DOE in identifying and overcoming challenges to meet the nation's energy efficiency goals.

We look forward to responding to any questions or comments DOE may have on ASHRAE's response. Please feel free to contact Mark Ames, ASHRAE Manager of Government Affairs, at mames@ashrae.org or 202-833-1830.

Personal regards,

Lynn G. Bellenger
ASHRAE President 2010-2011
LGB/gfc

[7] Alexander, Donald, Cornelius Ejimofor, and David Holmberg. "BACnet® at Georgia Tech." ASHRAE Journal Nov. 2007. http://www.nist.gov/manuscript-publication-search.cfm?pub_id=861044.