Advanced Buildings Workshop

Hosted by Advanced Research Projects Agency – Energy (ARPA-E) and the Office of Energy Efficiency and Renewable Energy (EERE)
When: December 15, 2009
Where: Hilton, Arlington (950 North Stafford Street, Arlington, Virginia)

Purpose of Workshop:
The purpose of this workshop is to allow DOE to gather input from leading technical experts and customers in the field of Advanced Buildings as it considers creating a targeted funding program in this topic area. ARPA-E and EERE are co-hosting this meeting, with representatives from DOE's Office of Science (Advanced Scientific Computing Research and Basic Energy Sciences). Representatives from NIST, NSF, DoD, GSA and OSTP will also be present.

Specifically, the goal is to gain a deeper understanding of those areas and technologies that have the highest potential to meet DOE's goal of developing the technical foundations necessary to enable massive reductions in energy consumption in buildings. Topical areas under consideration are as follows:

- Measurement and Communication
- Simulation and Computation
- Integrated Systems Approach to Fault Diagnostics and Controls
- Active and Passive Thermal Components.

Meeting Structure
Two keynote talks by Dr. Michael McQuade (Chief Technical Officer, United Technologies Corporation) and Dr. Yi Jiang (Dean of School of Architecture, Tsinghua University) will highlight the morning session. Dr. Hunter Fanney from NIST will give a brief report on NIST's recent workshop on Building Metrology.

The afternoon session will be highlighted by short-talks on building energy use in the federal government and the use of federal buildings as potential test-beds. Short talks will be given by the Department of Defense (Dr. Dorothy Robyn and Dr. Jeffrey Marqusee) General Services Administration (Mr. Kevin Kampschroer), and two new EERE user facilities at Oak-Ridge National Laboratory (Dr. Patrick Hughes), and Lawrence-Berkeley National Laboratory (Dr. Steve Selkowitz). Both the morning and afternoon sessions will include break-out sessions on the aforementioned topical areas. The break-out sessions will discuss a variety of topics that address the key parameters required to define a targeted funding opportunity. Subsequent to each break-out session, the session chair will brief all attendees on the findings. Also, Arun Majumdar, Srini Mirmira, Colin McCormick, and Joe Hagerman will be available for one-on-one meetings immediately after the workshop.

Meeting Output/Outcomes:
The purpose of the workshop will be for DOE to elicit feedback from leading experts on the most promising opportunities for high impact program areas and optimal program structures (i.e. application and technology focus, performance/cost targets, program/project size) for ARPA-E and EERE to support the development of more energy efficient buildings. The output of the workshop will inform ARPA-E and EERE as they consider potential program formation in this topic area. This workshop also provides a venue for attendees to share knowledge, begin

developing relationships, and consider collaborative efforts to develop novel approaches to solve complex problems.

A workshop summary document will be prepared after the meeting which will include all materials presented at the meeting as well as a summary of key ARPA-E and EERE takeaways and findings from the workshop. This workshop summary document will be posted publicly on a DOE website after the meeting.

Agenda

7:15 AM - 8:00 AM	Registration & Continental Breakfast
8:00 AM – 8:10 AM	Welcome Henry Kelly Principal Deputy Assistant Secretary, Office of Energy Efficiency and Renewable Energy Arun Majumdar Director, ARPA-E **Gallery Ballroom**
8:10 AM – 8:35 AM	Keynote 1 - Michael McQuade, Chief Technology Officer, United Technologies Corporation **Gallery Ballroom**
8:35 AM – 9:00 AM	Keynote 2 - Yi Jiang, Vice Dean, School of Architecture, Tsinghua University **Gallery Ballroom**
9:00 – 9:20 AM	Workshop Technical Overview and Context Arun Majumdar Director, ARPA-E **Gallery Ballroom**
9:20 AM – 9:35 AM	Report on "Measurement Science for Net-Zero Energy Buildings Workshop" A. Hunter Fanney, Division Chief, Building Environment Division, Building and Fire Research Laboratory, National Institute of Standards and Technology **Gallery Ballroom**
9:35 AM – 9:45 AM	Introduction of Breakout Sessions and Format Colin McCormick, EERE **Gallery Ballroom**
9:45 AM – 10:00 AM	Break- **Foyer**
10:00 AM – 11:30 AM	Concurrent Breakout Sessions Measurement and Communication - Group 1 **Renoir** Shyam Sunder, NIST Measurement and Communication - Group 2 **Matisse/DaVinci** David Culler, UC Berkeley Simulation and Computation - Group 1 **Picasso** Ron Judkoff, NREL

	Simulation and Computation - Group 2 **Gallery Ballroom** Michael Wetter, LBNL
11:30 AM – 12:30 PM	Reports Out from Breakout Sessions Chairs brief whole group (10min each)/Discussion **Gallery Ballroom**
12:30 PM – 2:10 PM	Lunch and Presentations: Technology Testbeds, User Facilities, and Adoption Perspectives Dorothy Robyn/Jeffrey Marqusee, DoD Kevin Kampschroer, GSA Patrick Hughes, ORNL Steve Selkowitz, LBNL **Gallery Ballroom**
2:10 PM – 2:20 PM	Introduction of Breakouts: The Question of Integration Srini Mirmira, ARPA-E **Gallery Ballroom**
2:20 PM – 3:50 PM	Concurrent Breakout Sessions Systems Approach to Fault Diagnostics and Controls Group - 1 **Picasso** Scott Bortoff, Mitsubishi Electric Systems Approach to Fault Diagnostics and Controls Group - 2 **Renoir** Srinivas Katipamula, PNNL Active and Passive Thermal Components Group - 1 **Gallery Ballroom** Ravi Prasher, Intel Active and Passive Thermal Components Group - 2 Sam Baldwin, EERE **Matisse/DaVinci**
3:50 PM – 4:10 PM	Coffee Break- **Foyer**
4:10 PM – 5:30 PM	Reports Out from Breakout Sessions Chairs brief whole group (10 min each)/Discussion **Gallery Ballroom**
5:30 PM – 6:00 PM	Wrap-Up Arun Majumdar **Gallery Ballroom**

Breakout Questions

Over-Arching Questions or Discussion Topics

1. What is the present state-of-art of these technologies and what is their performance and cost?

2. What are the technical challenges and barriers?

3. In each identified topical area, what are the critical technologies that are required? What are the unique/transformational approaches to overcome these barriers/challenges?

4. What are specific performance and cost metrics for these technologies? (see expanded section below)

    a. Measurements and Communications.

    b. Simulation and Computation

    c. Systems Approach to Fault Diagnostics & Control

    d. Active and Passive Thermal Components.

5. Which technologies need to be developed for the:
    a. Near-term
    b. Mid-term
    c. Long-term
    What is the strategy to move from one to the next?

6. What are the challenges and barriers for the validation and adoption of these technologies?

7. What level of investment would be required to develop and deploy these technologies? What is the return on investment?

Measurement and Communication
Session 1 Chair: Shyam Sunder, NIST
Session 2 Chair: David Culler, UC Berkeley

- What are the critical parameters that should be measured in a building?
    - Mass flow
    - Electrical Power
    - Temperature
    - Humidity/Moisture
    - Others?
- Where should these measurements be taken?
- What is the appropriate frequency for each type of measurement?
- In order to precisely and accurately take measurements, what are the present sensor capabilities?

    - How much do they cost?
    - What is the fidelity of the collected data?
    - Are they feasible to use in the marketplace?
- What modeling capability is required?
- Is distributed or centralized processing of data preferable?
- What level of security is needed for these wireless systems to safely and accurately transmit measured data? What is required to make these networks tamper proof?
- What wireless systems will be required to transmit the collected data?
- Are the protocols we presently use sufficient (e.g. NIST- Bacnet)? If not, do we need better protocols? What would those protocols include?

Simulation and Computation
Session 1 Chair: Ron Judkoff, NREL
Session 2 Chair: Michael Wetter, LBNL

- What new challenges are posed on the simulation/computation of energy efficient buildings compared to current buildings? [Physics, controls, user-behavior, real-time simulation, uncertainty, analysis support beyond time-domain simulation.] Can they be addressed with today's technologies?
- What is required to simulate system level building performance and operation that is considered robust and scalable? What are the current limitations?
- How do we integrate foundational science, systems modeling and optimization, and building information to develop an organized and scalable model that could be used to design and operate a building efficiently?
- How do we use measurements to calibrate models in real-time?
- Are the present algorithms sufficient or do we need to develop new algorithms?
- What is the preferred data standard to collect inputs, generate outputs, transmit, and display information?
- How can simulation/computation be advanced to accelerate innovation towards ZEB?
- What – if anything – is unique in simulation of buildings compared to other engineering fields that also strive to increase performance through integration that leads to complex multi-scale systems?

Systems Approach to Fault Diagnostics & Controls
Session 1 Chair: Scott Bortoff, Mitsubishi Electric
Session 2 Chair: Srinivas Katipamula, PNNL

- What are the building services and indoor environment that need to be provided in terms of space and time? That is, what are the baseline conditions?
- How does one detect component and system level faults to improve the overall systems level efficiency? What is the most effective way of doing this? How could the building industry learn from other relevant industries?
- How does one account for human intervention? Does one enable humans to correct faults or should this be automated? Does one disable humans from causing faults?
- How can we best leverage system level interaction to increase the overall efficiency?

Active and Passive Thermal Components
Session 1 Chair: Ravi Prasher, Intel Corp.
Session 2 Chair: Sam Baldwin, EERE/DOE

- What are the active and passive thermal components in a building?
- What are the transformational concepts to create new thermal devices?
- What are the novel approaches at the system level (centralized and distributed for heating, cooling, and thermal storage?
- How do we leverage ventilation to decrease HVAC requirements and increase overall system level efficiency?
- What are the passive thermal components in a building?
- How do we tailor their properties to get the broadest operating range?
    - How does one improve the properties of the passive thermal components such as insulation and other building materials?
    - How do we exploit the relationship between the active and passive components in new ways? What are the relevant trade-offs?