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

Building America Spring 2012 Stakeholder Meeting Report

Austin, Texas: February 29-March 2, 2012

May 2012

Building America U.S. Department of Energy

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Building America Spring 2012 Stakeholder Meeting Report

Prepared for:

Building America

Building Technologies Program

Office of Energy Efficiency and Renewable Energy

U.S. Department of Energy

Prepared by:

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About This Report

The research results, needs, and opportunities identified in this report do not represent the opinion or positions of the U.S. Department of Energy (DOE) or the National Renewable Energy Laboratory (NREL) and NREL and DOE do not necessarily agree with all of the points made by the meeting presenters. This report is not intended to be a complete summary of results, needs, and opportunities, but to address a small segment of key topics that were chosen for the meeting agenda.

Program Background

Building America (BA) is part of the U.S. Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy (EERE), Building Technologies Program (BTP). The BA program focuses on conducting the systems research required to improve the efficiency of the 500,000-2,000,000 new homes built each year, as well as the approximately 116 million existing homes.

Building America research accelerates the development of reliable and effective whole house packages of measures for highly energy efficient new and existing homes that are tailored for each major U.S. climate region. This research can be implemented on a broad basis, while also reducing risks, increasing durability, and providing a reasonable return on investment. These improvements are accomplished through multiscale research, systems development, systems integration, large-scale field implementation and evaluation, and effective communication of key research results and system-based strategies. The near- and long-term performance targets for BA have been updated to help guide the energy efficiency of homes past code requirements and current standard practices, as well as to provide technical support for new residential initiatives including the Better Buildings Program.

Since July of 2010, the 10 research and deployment partnerships of the BA program have begun and implemented projects that help dramatically improve the energy efficiency of American homes. These highly qualified, multidisciplinary teams work to deliver innovative energy efficiency strategies to the residential market and address barriers to bringing high-efficiency homes within reach for all Americans.

Visit the BA website for more information about BA teams, projects, partners and tools: www.buildingamerica.gov.

Executive Summary

Figure 1. The annual Building America Stakeholder Meeting attracted hundreds of residential energy professionals in Austin, Texas.

The ***Building America Spring 2012 Stakeholder Meeting*** was held on February 29-March 2, 2012, in Austin, Texas. More than 300 professionals representing organizations with vested interests in energy efficiency improvements in residential buildings registered for the event. This diverse and dynamic team presented stakeholder needs, collaboration opportunities, and research results as they relate to the U.S. Department of Energy's (DOE) Residential Buildings Program.

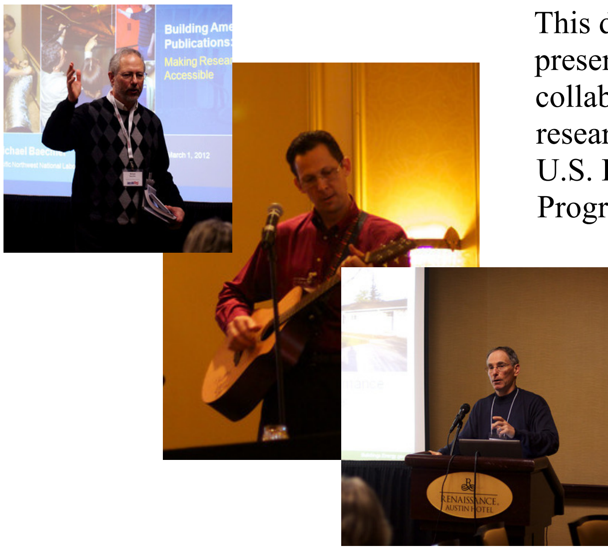

Figure 2. Sam Rashkin and Eric Werling (U.S. Department of Energy) and Michael Baechler (Pacific Northwest National Laboratory) participate in meeting sessions.

Presenters represented key industry stakeholder organizations as well as the 10 DOE Building America (BA) teams. Attendees represented a variety of industries, including manufacturing, government, utility companies, nonprofits, and private sector programs (see Meeting Participants section for a list of attending organizations).

Presenters delivered research results from dozens of BA projects, including presentations focused on:

- Why We Ventilate
- Barriers and Solutions to Contractor Acceptance in the Field
- Public-Private Sector Media Partnerships
- Smart Thermostats
- 10,000 Homes Prove Performance
- Building America and Ductless Heat Pumps in the Pacific Northwest
- Field Evaluation of New Residential Products
- Community-Scale Energy Improvements
- Home Inspectors Driving Demand for Home Energy Upgrades
- Residential Humidity Control Strategies
- Research and Lessons Learned from Comprehensive Energy Audits
- Harmonizing "Above Code" Codes… and more.

In addition, Building America held their Standing Technical Committee meetings during this time. This report captures the meeting in summary form only. For more information on specific speakers and sessions, please refer to the full meeting program online at www.buildingamerica.gov.

Meeting Participants

1st Choice Energy	DOE HPwES/SRA	Honeywell
A.O. Smith Corporation	DuPont	HUD
Abrams Design Build LLC	East Carolina University	IBACOS, Inc.
ACCA Austin	East Carolina University	ICF International
ACT Inc. D'MAND SYSTEMS	Eco Smart Building LLC	ImagineHomes
Advanced Energy Corp	Ecobee	InterNACHI
Affiliated International Management, LLC	Ecotelligent Design	International Code Council
Alaska Center for Appropriate Technology	EEBA	J. Neymark & Associates
American Building Diagnostics	Efficiency First	JEA
American Chemistry Council	Electric Power Research Institute	Johns Manville
Apple Energy Group	Ellen Pulner Hunt Architect, Inc.	Keller Williams Realty
AppleBlossom Energy Inc.	Emerson Climate Technologies	La Mirada Homes
ARBI	Energy Audit Institute	LaHouse Resource Center
Armando Cobo, Designer	Energy Sense	Lawrence Berkeley National Laboratory
Aspen Hill LLC	EnergyBright	Lend Lease America
Austin Energy / City of Austin	EPA	M.A. Peterson
BARA	EQS Inc/Hometrust Mortgage	M4K3
Barley & Pfeiffer Architects	Essential 3 LLC Building Design	Mariposa
Bayer Corp	EverSealed Windows, Inc.	McCoy Corporation
BCFS HHS YouthBuild	F G S	McCullough Heating and Air Conditioning
Bonneville Power Administration	Farmers Electric Cooperative	Metropolitan Energy Center
BPI	Faught Service Company	Michael Hurst & Associates, Inc.
Brad Marshall Homes	Ferris State University	Midwest Energy Efficiency Alliance (MEEA)
Building America Retrofit Alliance	Florida H.E.R.O.	Momentis
Building Codes Assistance Project	Florida Solar Energy Center	Mountain Energy Partnership
Building Science Corporation	Fraunhofer CSE	MWSBuilders
Building Science Institute Inc.	Frontier Associates	Myers Verde Company
Built Green Custom Homes	G STREET	NAHB Research Center
CAI Member	g.m	National Renewable Energy Laboratory
Calcs-Plus	Garner-Whorton Insurance Services	Natural Resources Canada
Card Payment Consultants	Gas Technology Institute	Navigant Consulting
Carnegie Mellon University	Gateway Green	NERD
CDH Energy Corp / ARIES	GE Home Energy Solutions	Newport Partners, LLC
Center for Building Excellence at BASF	Geavista Group	Northeast Utilities
Center for Energy and Environment	Georgia-Pacific LLC	NorthernSTAR - University of Minnesota
CertainTeed Corporation	Good Company Associates	Northwest ENERGY STAR Homes
Charles Gierman Associates	Green Building Authority	Northwest Energy Works
City of Beaumont Housing Dept	Green Canary	Norwich Homes
City of San Antonio	Green Potential Consultants Inia Pvt.Ltd.	NT Window, Inc.
CMHC International	Greenberg Energy Services, LLC	Oak Ridge National Laboratory
CNT Energy	GTI/PARR	Owens Corning
Cocoon	Gulf Concrete Technology, LLc	Pacific Northwest National Laboratory
Confluence Communications	Habitat for Humanity of Denton Co. Texas	Panasonic Eco Solutions
Contects	Habitat for Humanity Texas	Pecan Street, Inc.
CPS Energy	Hanley Wood LLC	Pella Corporation
Dan Fette Builders Inc.	High Tech irrigation	Pentair Water Pool and Spa
Davis Energy Group	Hill Country Ecobuilders	Performance Systems Development
D. Donovan	Home Energy Magazine	PlaGar Engineering LLC

Pohler Appraisal	Southface Energy Institute	Thornhill Custom Homes
Polycoat Products	SPEER	Train2Build
Priest Inc	SRA International	U.S. Department of Energy
PSD	SSHC, Inc.	U.S. Energy Institute
R. Pelton Builders, Inc.	St. Edward's University	U.S. Environmental Protection Agency
Ray Tonjes Builder, Inc.	Stan's heating and air conditioning	Univ of Texas at Tyler
Real Property Counselors, Inc.	Steve Easley and Associates, BARA	University of Minnesota
Remax	Steven Winter Associates, Inc.	Urban NW Homes / Bella Links
Renewable Energy Student Association	Sun Hill LLC	USEPA
RESNET	Superior Products Home Improvements	UT-Austin
Retired Military	Sustainable San Marcos	UTC Climate Controls & Security
Retrotec Inc.	SWEEP	VIC'S HEAT & AIR
Rise Above	Syntheon Inc.	VSI
Saving America Energy, LLC	TDS Custom Construction, Inc	Washington State University
Security and Compliance Consultant	Texas A&M University	Window & Door Dealers Alliance
SERVITAS LLC	Texas Association of Builders	Window & Door Manufacturers Association
SIPA	Texas Solar Energy Society	Windows of Texas, Inc.
Skillpoint Alliance	TexEnergy Solutions	WSU yoUtilBill
SMUD	The Levy Partnership, Inc.	
Solluna Builders, LLC	The Overton Firm	

Acknowledgments

The authors would like to thank the U.S. Department of Energy for hosting the meeting that is summarized in this report. We would also like to acknowledge the contributions of the Standing Technical Committee chairs for their work in conducting the meeting. Finally, a special thanks to Confluence Communications for providing invaluable assistance to NREL in the production of the meeting and this report.

1 Standing Technical Committees Meeting

The BA program actively engages all relevant industry stakeholders in the research planning process, primarily through standing technical committees (STCs). The STCs focus on identifying key technical issues required to meet BA program goals.

The STC meetings were held on February 29 and March 1. Each meeting included a summary of activities to date and new developments, and review of the recently updated STC Strategic Plans. The gaps that were discussed during each meeting are listed in this report under each STC heading. More information on the goals of the STCs and summary reports for each research need can be found on the BA website at:
http://www1.eere.energy.gov/buildings/building_america/strategic_plan.html

As a reminder, the STCs are open to all stakeholders and play a critical role in the BA research planning process. If you would like to participate, please contact the appropriate STC Chair. You may also refer to the presentations for more details. These can be found at: **www.buildingamerica.gov**.

The following section summarizes key points by STC session:

1.1 Space Conditioning (Janet McIlvaine, FSEC)

- Review of draft strategic goals for the committee. Are new/different goals needed? (Refer to Strategic Plan)
- Is there a need for explicit references to "cost-effectiveness" in the strategic goal statements? Does this term need to be clearly defined for the STC? For the program?
- The need for better coordination between BA, utility research programs (e.g., at SMUD), and other research organizations (e.g., EPRI) was identified. Reference was made to an "Emerging Technology Coordination Council" in California.
- Coordination with other programs was also discussed, particularly Home Performance with ENERGY STAR (HPwES). An example of poor practice was given: HPwES requires duct sealing, but often ductwork needs total replacement. Sealing these ducts is wasted time and effort resulting in suboptimal performance improvements. Measure-centric programmatic requirements may not lead to the best outcomes.
- The rating of equipment and analysis was deemed important. Work done by NREL was referenced regarding "up to SEER 21" rated equipment not hitting the high mark.
- The need for a "clearinghouse" of trusted information was noted. There is a lot of information available but not always helpful and/or accurate.
- The difference between "research" and "reality" can be frustrating for those practicing. Need to clearly identify what works in the field. What works on paper may be complicated in the field. "Designing things the right way and installing them may be very different." How can builders be brought into the conversation? Why aren't they?

- From a utility perspective, the performance path is cumbersome and requires too much up-front effort. Recommend a validated deemed savings approach. Response from utility attendee: recommend AC tonnage reductions. These are significant demand reductions and they are permanent.
- Occupant behavior remains a major complicating factor in system performance.

1.2 Automated Home Energy Management (AHEM) STC (Lieko Earle and Bethany Sparn, NREL)

- From 2011, four main gaps were identified:
    - Unknown ROI of AHEM systems.
    - Lack of consumer awareness.
    - Low interest in managing energy use.
    - Complexity of AHEM products.
- Emphasis should be placed on novel sensor and control strategies to increase comfort and/or convenience while reducing energy use.
- The main points the chairs wanted to make are:
    - AHEM is a systems integration problem, not an isolated topic; therefore need all other systems groups involved (e.g., sensor based HVAC diagnostics).
    - Don't start at AHEM, start at needs of separate systems and tie them together.
- Example of control need includes: light sensors, utility demand response, MELs.
- The committee needs to stay focused on things that are actionable and measurable. Many AHEM research topics are important, but very difficult to test in broad, meaningful ways (e.g. behavioral response).
- Align BA technical focus and expertise with complimentary behavioral experts to answer behavioral questions.
- Utilities struggle with security issues regarding smart grid. Smart grid/utility interface is a big issue. IT security will not allow outsiders into the meter. What are the IT security issues? What are the competing protocols? What are their relative strengths and weaknesses?
- Behavioral challenge is the transitory nature of apps (for phone) because users will use them for a time but then taper off. How do you install a green switch? What appliances, loads do you connect? Can a green switch be added to a retrofit?
- The committee may consider creating a central repository of products on the market that are AHEM-related. AHEM is quick moving and it's important to stay on top of market response and quality/performance of product availability.
- Cost of implementation of AHEM solutions cannot be ignored.

- There is a need for commonly accepted taxonomy in this technical space: different words are often used for the same or different things. This is confusing.
- A major barrier is complexity; average consumers need simplicity. Example given of interior "green, yellow, red" indicator light with respect to household energy use. This is an understandable signal that many homeowners comprehend and can act on.
  - One commentator thought this to be the wrong approach. More automation is needed. One cannot rely on homeowners to act. Make automation more robust, reliable, and effective. What research is needed to go in this direction?
- Education is needed on what consumers want in their house and how it impacts their life. The challenge is that measuring end uses is not trivial to accomplish in a meaningful way.
- Could AHEM be used as a commissioning (Cx) measure? Can AHEM demonstrate short cycling of oversized HVAC systems to help convince the HVAC industry that there is not a significant risk to "right-sizing" HVAC equipment?
- Attendee proposed the 80/20 rule: maybe 20% of all end uses use 80% of energy, therefore AHEM can't be all things to all people.
  - Respondent disagreed: the same info can be used to save energy in the 80% of end uses and can be used across all end uses; the decision-making structure is the same. Industry/research needs to provide a consistent platform.
- One observer noted that there are many proprietary UIs for new equipment and that new HVAC have a lot of built in sensors but it is hard to access data.
  - Note: "it's the wild west and everything is proprietary."
- Apartment buildings can be utilized as test beds for good, simple systems.
- Manufacturer note: need to develop technologies that are responsive to homeowner needs.
- There is broad interest in low-cost monitoring equipment packages.
- Simplicity is king.
- Home automation is coming, but will it involve energy management?

1.3 Hot Water (Marc Hoeschele, ARBI)

- Major uncertainty in hot water systems relates to what happens to the water once it leaves the water heating equipment.
- Combined Hydronic:
  - Need to better understand climatic design considerations. An industry design guide would be useful.
  - System (as opposed to equipment) performance ratings are needed.
  - What are the cost and performance tradeoffs vs. conventional high efficiency systems and how do they vary with climate and load?

- Can we reliably maintain condensing efficiencies and preserve comfort?
- What delivery options are best for different load and climate configurations?
- Does the appropriate equipment exist for low load combined system applications?

- Heat Pump Water Heaters:
  - Reliability, durability, maintenance, and customer satisfaction questions remain unanswered. Service questions also remain, regarding most appropriate trade to service (plumbing or HVAC). What are the long-term maintenance costs?
  - How does the recovery capacity change relative to 0.5 or 1 ton compressors?
  - Energy savings relative to control settings require further study.
  - What is the dehumidification potential from a systems integration point of view?
- Distribution:
  - In single-family homes, lack of plumbing design often leads to poorly performing "oversized" systems, especially with PEX. Better design guidance needed.
  - There is a lack of definitive data on how distribution systems perform and how different system types compare.
  - Availability of accurate, high-resolution software tools and good input data limit the ability to compare and evaluate performance tradeoffs.
  - When does distribution system type "X" make sense?
- Tankless:
  - Does "endless hot water" affect hot water usage?
  - Gas line upsizing remains a retrofit barrier; are there alternative solutions?
  - Venting requirements remain a retrofit barrier.
  - More field performance data needed (rated vs. actual energy factors).
  - Non-compliance with NOX requirements in some air quality management districts remains an issue.
  - Service infrastructure, long-term reliability, and maintenance issues remain.
  - There is a need for water treatment in some areas. What is the best solution (lowest cost with lowest ongoing maintenance)?
- Codes and Standards:
  - Current Energy Factor test procedure does not equitably assess performance of different system types nor recognize impact of lower or higher loads.
  - Revised test procedures must accommodate emerging technologies.
  - Fixture unit sizing tables not designed for low-flow fixtures and smooth pipe; difficult to use 3/8" tubing.

    - Codes need to facilitate future replacements with advanced technologies (gas line, venting, 240V) and renewable system options.
- Software Development and Validation:
    - Improved tools are needed to model the complexities of short duration hot water draw events.
    - Model validation is an ongoing need.
    - How best to integrate hot water simulation tools with existing hourly tools?
    - Input data to drive the models is critical (gal/day, use patterns, environment temperatures, installed pipe configuration, usage behaviors).
    - Validated tools and field data can be used to develop design guides and contribute to codes and standards activities.
- Retrofit Challenges:
    - Economics of high efficiency system installations.
    - Ability to affect overall system performance, not just a water heater upgrade.
- Solar and Heat Recovery Opportunities:
    - Need for further solar thermal system installed cost reductions.
    - Future single-family water heating loads will likely be lower, leading to reduced savings potential.
    - Are there heat recovery systems that make sense in residential buildings?

1.4 Enclosures (Katie Boucher, BSC)

- There is not a complete enough set of construction details for advanced framing.
- Packaging of available information is lacking. Need central clearinghouse of trusted information.
- Need 2” exterior foam details for multifamily as well as other details for upgrading multifamily enclosures.
- What is the limit on wall performance relative to payback? At what point do diminishing returns limit the amount of insulation installed? What other challenges (e.g., special fasteners) limit improving wall performance?
- What is the contribution of air leakage, specific to building components and/or technology?
- How can insulating existing walls be made less intrusive?
- Slab edge insulation: need predicted performance, impact on indoor moisture/health.
- Code impediments exist to high performance foam solutions.
- Fire/structural questions regarding exterior insulation remain unanswered.

- When retrofitting attics, guidance needed on non-vented to vented conversion strategies.
- Interface questions when upgrading structures (e.g., wall to roof).
- Need grade scale for open cell spray foam insulation in walls (grade I, II, III, IV).
- Joist band detail between first/second story: spray foam needed but often not available on-site. Are there other workable strategies?
- "Accidental" conversions of vented attic assemblies to unvented when spraying in insulation have been observed. What are the risks? How severe?
- How to address thermal bridging in block assemblies?
- Lack of details online for non-cold climate zones.
- Expansive soils: can't insulate sub-grade assemblies in certain areas due to expansive soil but concerned that codes may come to require it. What is the best solution?
- Good experimental datasets are needed for model validation (note: Oak Ridge National Laboratory (ORNL) working on sub-grade WUFI model in 2012).

1.5 Analysis Methods and Tools (Ben Polly, NREL)

- What key technologies cannot currently be modeled? Where are the capability gaps?
  - Conditioned crawl spaces.
  - Various non-energy performance metrics could be needed, including:
    - Comfort index (challenge of communicating improved comfort to homeowners).
    - Indoor-air quality.
    - Durability (but durability not defined).
  - Combustion safety, exposure under different pressure regimes.
  - Demand response (DR) and DR appliances.
  - Variable speed fan/pumps.
  - Minisplit and variable refrigerant flow systems.
  - Ground properties (conductivity, moisture).
  - Range of occupant effects vs. single assumed behavior.
  - Task heating, task lighting, task ventilation.
  - Passive and active solar combined.
- Accuracy: What needs to be more accurate?
  - Input information.
  - Easy generation of local weather files using actual weather data.

  - Actual occupant influence.
  - Water heating and distribution, HPWH, combi, tankless.
- Field Data and Audits: collection, transfer, storage, and input of info.
  - Minisplit.
  - Hot water use.
  - Data collection standard.
  - Input of infiltration data from diagnostic test (for BEopt).
  - Accounting for occupants (e.g., shower vs. bath).
  - Large uncertainty with respect to the existing stock remains.
- Simulation Protocols:
  - Appliance characteristics and operations.
- Other:
  - CFD or other fluid flow.
  - Simpler tools: use complex tools to inform simple tools.
  - Empirical modeling vs. physical modeling.
  - Inverse modeling approaches.

1.6 Test Methods and Protocols (Dane Christensen, NREL)

- Multifamily building test methods/protocols needed. Specific attention required for:
  - Airtightness.
  - Shared utilities.
  - Common-space occupancy profiles.
  - Energy savings of whole-building (e.g., enclosure, shared equipment) retrofits.
- How to test/audit loads for AHEM applications? Can AHEM be used as a continuous audit tool?
- A minimum test protocol for BA projects would be useful for all teams to use and force consistent minimum data collection. It would be more useful to have a minimum analysis guideline for all field tests. For example: pre-test analysis including model, uncertainty analysis of field data, post-test comparison of data to model.
- Protocol needed to test delivered load, efficiency, HVAC performance, and duct leakage.
- Test method for in-situ fan performance.
- Questions remain about installed performance despite proper system commissioning. Are current commissioning practices adequate?

- Need to show runtime performance on right-sized systems to convince builders that systems will deliver expected results.
- It would be valuable to have good field data on lighting use, characteristics, and schedules.
- There is a need for reliable and affordable RH sensors.

1.7 Implementation (Stacy Hunt and Deane Evans, BARA)

- There is need to develop non-energy key performance indicators to clearly communicate the value propositions relating to comfort, health, durability, etc.
- BA needs to focus on the innovation process, the top market innovators, leaders, and early adopters.
- Need to break out the demand/supply side implementation issues:
  - Simplicity is key.
  - Distillation of complex knowledge remains a challenge.
- Energy efficiency programs should not be ignored; there is a need to better integrate BA knowledge with all related programs.
- Need to focus on entire supply chain. The sales representatives are the people who interact most closely with homebuyers but often they are not well trained on complex building science issues. There is a need to better educate the real estate professionals.
- Too much focus is paid to the supply side of the industry.
- Cost information is primarily the language of builders/implementers. Other stakeholders may have different ideas of value.
  - Focus on customer-defined value, not our (BA) perceived or assumed value. The challenge remains how best to identify in diverse markets the customer-defined value.
- Need to identify intermediate customers and develop plans to reach these customers.
- Need to prioritize to whom we actively reach out.

2 Plenary Addresses

Plenary presentations at the BA meetings are intended to provide information and context on the direction of the DOE programs, to provide detail on the coming years' objectives, and to provide engaging research results from key programs.

2.1 David Lee

David Lee, DOE, presented about the department's programs and objectives, with a focus on residential buildings. The audience learned about the interrelationship between the many programs managed by David Lee this year and how the BA fits into the overall budget.

2.2 Scott Hinson

Scott Hinson, Director of Homes Research Lab: Pecan Street Project presented about the project and key research results. The audience learned about the possible repercussions of the power signature of CFL light bulbs on the grid and the current infrastructure of most utilities.

3 Implementation Panel Discussion

This dynamic, facilitated session created a forum for industry leaders to discuss new and existing home performance implementation program needs and how BA program can provide solutions through the transfer of research results. The following summarizes the session:

3.1 Panel members:

- Sam Rashkin, U.S. Department of Energy; U.S. Department of Energy's Building America Builders Challenge
- Valerie Von Schramm, CPS Energy; Utility Incentive Programs
- Dean Gamble and David Price, U.S. Environmental Protection Agency; ENERGY STAR, Indoor airPLUS, and Home Performance with ENERGY STAR
- Jamie Peters, Midwest Energy Efficiency Alliance; ENERGY STAR, Indoor airPLUS, and Home Performance with ENERGY STAR
- Jay Murdoch, Efficiency First; Policy and Program Implementation Issues
- Ren Anderson, National Renewable Energy Laboratory (NREL); U.S. Department of Energy's Building America Program
- Philip Fairey, BA-PIRC (standing in for Steve Baden, RESNET); Home Energy Rating Industry.

3.2 Discussion Points

Overarching:
What are the needs of new and existing home performance programs and how can BA provide solutions for those needs?

General:

- Challenge to make your program distinctive in a pond that is getting more overrun.
- Challenge for participants to know which to choose.
- Need to educate the sales infrastructure to the importance of buying homes with better energy efficiency than your last because it is a sound investment.
- Lending and appraisal industries need to know how to value the market rate of energy efficiency. How do we get them the knowledge they need?

Miscellaneous Electric Loads (MELs):

- MELs are becoming more significant. How will this affect the thermal envelope, for example, the heat generated from more electronics? How will we account for electric vehicles?

Air Quality:

- People spend 90% of their day indoors; we need more scientific-based data on ventilation rates. Energy efficiency representatives want lower rates; others are concerned about health and moisture impacts.

Utilizing the HVAC Contractor:

- Seven percent of HVAC systems are replaced every year, leaving 95% of HVAC contractor business to replacement. How do we get people trained? How do we get the right equipment on the truck and up-sell?

What needs did the audience see as the most important? (Note: list is in no particular order)

- Aggregate separate contractors into a one-stop shop for homeowners to get a retrofit, and a financing mechanism once they decide to do one.
- Streamline all the confusing options for rating programs: one program, one metric, one message.
- Tool/calculator for appraisers and lenders to value energy efficient homes appropriately.
- Better distribution of BA knowledge/marketing campaigns like "the more you know."
- With certification programs, more education should be provided to:
    - Universities.
    - Installation contractors (properly installing new technologies, old technologies installed in new ways).
    - Builders.
- More education of energy value to:
    - Real estate agent.
    - Appraiser.
    - Home inspector (often missed).
    - Lender.
    - Homeowner – "know your bill" campaign.
    - Public.

4 Track A – Energy System Innovations Sessions

4.1 Session 1 – Space Conditioning and Hot Water Systems

This session included the following presentations:

- Ben Schoenbauer, NSTAR: Technical Barriers and Reasonable Price Solutions to Contractor Acceptance in the Field
- Carlos Colon, BA-PIRC: Side-By-Side Testing of Water Heating Systems
- Armin Rudd, BSC: Combined Systems With Tankless Water Heaters

The following summarizes the session:

What gap/barrier were you addressing?

- System performance of combination hot water and space conditioning systems, under both laboratory and field conditions.

What did you do to address it?

- Laboratory testing involved paired systems using nine water heaters (boilers, tankless, and storage units) + 15 FAUs and investigated idle losses, steady state efficiency, air handler capacity, and system evaluation. The laboratory was also used to train contractors in proper system set-up.
  - Standby operating costs ranged from ~$2-$140/year, worst was combi boiler with 12 gal DHW tank.
  - Low use transient performance: tank systems come to set point temperature within seconds, tankless can take over 30 seconds to achieve steady state, combi boilers also take a while due to the use of a mixing valve at the outlet. There are some issues to resolve.
- Field testing was conducted at 300 homes in Minnesota. Pre-retrofit monitoring looked at total gas and electrical use. Existing units, which were predominately single-stage furnace and natural draft tank water heater, were replaced with combination systems, all of which were condensing, and additional monitoring was installed to capture delivered energy at one-second intervals. Cost and utility bill analysis will be conducted on all 300 sites. Following are some of the preliminary data on the first 26 installations.
  - Average install costs were ~$6,000 for tankless and ~$7,000 for storage tank systems.
  - Average site savings were about 100 therms, 10% of gas space heating bill, normalized to average outdoor air temp.
  - Post-retrofit results are comparable to that of an existing 93% AFUE furnace that was monitored.
- Field testing was performed on two multifamily units in New York that had been retrofitted with combination water heating systems using tankless units with small buffer tanks. Rinnai condensing tankless units were used; each were equipped with 12 gallon electric storage and Rinnai ECM hydronic air handlers. The buffer tank was removed on

one of the systems after the THW inlet strainer started clogging (poor water quality in area), and it was hypothesized that the tank may be at fault. This allowed for a side-by-side performance comparison of the system with and without a buffer tank. Key findings include the following:

- THW combination systems with a buffer tank cost about $350 more than a condensing furnace + THW and $2000 less than a combi system with boiler and indirect water heater. Removing the buffer tank drops the cost about $400. Operating costs are very similar.
- The tankless system without the buffer tank had almost 10 times as many cycles per day than that with the tank.
- The system with the buffer tank provided a much tighter range of supply temperatures, leaving the mixing valve, 100-140°F vs 60-140 °F for the other system. The system without the tank also experienced a much wider supply air temperature range for space heating.
- Cheap electric storage tanks were used that had Al anode rods, which degraded very quickly.
- Water quality was very poor in this area and a large pre-strainer was added to the system to help reduce particulates introduced to the system.

What remains?

- Lack of contractor experience with combination systems. Can contractor familiarity drive prices down? Need better guidance.
- Laboratory data is not sufficient without actual performance data in real homes.
- Is EF the best input to use in hot water energy modeling?
- New EF ratings coming in 2015: how will they fare under field conditions?
- Need for further cost reduction through application of smaller buffer tank, less expensive circulator, and less expensive pre-strainer.
- Use field data to gain a better understanding of occupant behavior to compensate for the difference in performance with and without a buffer tank.
- Use field data to gain a better understanding of actual DHW and space heating efficiency.
- Analyze actual installed efficiency and energy savings.

4.2 Session 2 – Insulating Existing Foundations

This session included the following presentations:

- Patrick H. Huelman, NSTAR: Technical Challenges and Opportunities
- Sam Breidenbach, Cocoon: Assessing Priorities
- Steve Schirber, TDS Custom Construction: An Industry Perspective

The following summarizes the session:

What gap/barrier were you addressing?

- Subgrade assemblies are very risky to insulate because of:
  - Combustion safety.
  - Foundation moisture.
  - Radon (and other soil gases).
  - Biologicals (mold, dust mites, etc.).
  - Garage gases (if attached).
  - Uncontrolled negative pressures in basements (beyond stack).
  - Uncontrolled below-grade moisture transport (liquid and vapor).
- Foundations get wet from three sides by all four moisture transport mechanisms: bulk water, capillarity, diffusion, and air flow.
  - Foundations can only dry to the inside, generally by diffusion only.
- Foundations must be kept dry from all sides or come up with an approach that promotes inward drying better than outward wetting.
- Large heat loss through basement walls and large number of uninsulated basements in cold climates = large opportunity.
- For contractors, the biggest challenges are moisture and mold and liability that entails.
  - Remodeling is the "wild, wild west."
  - What is the consumer buying and why? Consumers often assume the contractor will "put in the right stuff" with regard to performance.

What did you do to address it?

- See presentations for construction details.
- See presentations for contractor case studies and pictures.
- In 2011, NSTAR launched an exploration of methods to insulate the exterior of existing homes by:
  - Identifying alternative approaches that could be used.
  - Investigating means, methods, and materials.
  - Determining how many homes would be conducive to each approach.
- Possible approaches include:
  - Full depth insulation.
    - With waterproofing and drainage.
    - Without waterproofing.

    - Partial depth.
        - With waterproofing.
        - Without waterproofing.
    - Upper foundation.
        - Without waterproofing.
- Work is ongoing.

What remains?

- When insulating interior subgrade walls, existing material properties and boundary conditions are highly variable and unknown, so we need to focus on:
    - Development of a water separation plane.
    - Balancing R-value and vapor diffusion characteristics.
    - Evaluating safe moisture storage.
- Below-grade heat transfer models are both crude and cumbersome, especially for deep basements.
    - University of Minnesota with ORNL and NREL are working on the problem.
- There are currently no validated and user-friendly below-grade hygrothermal models in the United States.
    - ORNL will be doing work in this area for FY2012.
- Boundary conditions are not well characterized, especially for existing homes.
- Most homeowners and many contractors don't recognize the risks associated with basement remodeling, especially with interior insulation.
- Is uncontrolled dampness and mold growth behind interior insulation:
    - A building materials liability?
    - A building performance liability?
    - An indoor air quality liability?
    - A contractor liability?
- For contractors:
    - Contract Language: Oftentimes different language developed for different situations—difficult.
    - Other barriers include aligning technical details with specific situations; no two jobs are alike, information out there has to be combined with specific information.
    - Below-grade spaces are great business opportunities. There is a propensity for contractors to get involved before they really know what they are doing; BA can provide tools for them to know how to do it the right way.

- Homeowners may not understand the difference between the competing bids; we need to be able to sell value.
- Codes have a way to go to catch up with the building science.
- There is a ton of information and case studies, but this can be information overload. They don't have a clearinghouse, a one-stop shop, for how to be certain that what they are getting from disparate shops and agencies is going to provide them a package that they can put their name onto.
- Could provide "low, medium, high" level of risk quotes to the homeowner with the different estimated costs. Speaker thinks there are simple ways to do this but ultimately the contractor has to work this out and be comfortable with the risks they are taking.
- Can we educate the consumer sufficiently?
- Is there a prescriptive/performance path for basements?
- Can a path be adapted to all situations?
- How do we train/educate professionals to know which path to follow and how to adapt it to varying conditions?

4.3 Session 3 – Minisplit Systems – Do They Work?

This session included the following presentations:

- Brady Peeks, Northwest Energy Works: Ductless Heat Pump Applications in Factory-Built Housing
- Michael Lubliner, Luke Howard, David Hales, Washington State University Energy Program: Building America and Ductless Heat Pumps in the Pacific Northwest

The following summarizes the session:

What gap/barrier were you addressing?

- Use of minisplit heat pumps to retrofit existing electric heated homes.
- Zonal challenges when replacing ducted electric furnaces with ductless heat pump (DHP) units.
- How well a single DHP system maintains consistent temperature throughout house.

What did you do to address it?

- Study of 11 DHP retrofits in Pacific Northwest. The results were highly variable.
- Other studies in Pacific Northwest: FSEC, Ecotype, heat pump storage of Pratt, Bonneville power administration, EPRI, PNNL.
- BA-PIRC work:
  - Studied five test homes with existing electric resistance furnace.
  - Disabled electric component beyond what is needed to back up DHP.

  - Reduced furnace blower consumption.
  - Test/improve control strategies.
    - Cycle furnace to transport air to back bedrooms.
- Northwest Energy Efficient Manufactured Home (NEEM) Test Homes.
  - Compared hybrid DHP vs. similar electric zonal home.
    - One had supported heating load.
    - Portland site heating system worked.
      - Apparent COP varied from three to four, fantastic!
      - Only $400 added to hour over electric furnace.
      - Comparable to GSHP performance.
      - Electric resistance heat was typically under 10Wh.
- NEA retrofit study underway, pre/post-utility bill analysis ongoing.
- Purdue lab study on MSHP report available. Showed COP of 3-5.
- Part load performance is good; not seeing penalties one would expect.

What remains?

- Developing best practice guidelines.
  - If this becomes a standard utility rebate measure, need to provide guideline with add on benefits.
- Bringing options to market.
- Still lack robust cooling system performance data from ongoing studies.
- HSPF and SEER ratings are not well suited for DHPs, need alternate rating?
- How much of the electric furnace can be displaced with DHP and/or central heat pump?
- How well do the DHP or EF maintain acceptable indoor temperature for thermal comfort?
- What are the pros and cons of various approaches to DHP air distribution mixing that improve thermal comfort and reduce back-up electric resistance heat?
  - Fan recycler w/EE ducts (tight/inside).
  - Through interior wall supply fan.
  - Stage DHP with central system without zoned stats.
  - Make the envelope tighter, home smaller to improve temperatures.
  - Add more indoor units.

- Risks to utility cost-effectiveness and market acceptance:
  - Resistance heat “offset” and impact of occupant behavior/controls.
  - Single vs. multiple head DHP: first cost vs. annual energy savings.
  - Zonal temperature distribution (floor plan, door closures).
  - Impact of AC availability (customers like, but added cooling to utility).
  - Need HVAC/builder/consumer training and education for success.
- Highest priority issues:
  - Continue field/billing/occupant research on BA communities and case studies (PIRC).
  - Technical support to HVAC and utility stakeholder (PIRC/ASHRAE/ACEEE/ACI).
  - Offset central ducted electric furnace in new and retrofit manufactured homes (PIRC/HUD/WX).
  - Sizing of single vs. multihead DHP for design and annual performance (BA/NIST/ACCA).
  - Comfort and cost-effectiveness; single head vs. multihead systems (BA/NIST/Ecotope).
  - DHP multizone model to offset resistance heat (Ecotope/NREL/BA).
  - Support lab testing of new equipment (Ecotope/NREL/NEEA/AHRAE).
- Possible risks going forward include:
  - Long-term performance and impact of measurement and operation issues.
  - Electric vs. gas utilities fuel switching (source vs. site conflict of utility vs. customer).
  - Limited BA funds to implement (best to partner with others to leverage funds).

4.4 Session 4 – The Latest News About Heat Pump Water Heaters (HPWH)

This session included the following presentations:

- Dr. Ron Domitrovic, EPRI: Field Evaluation of New Residential Products
- Robb Aldrich, CARB: Initial Findings of Draw Profile Effect on HPWH Efficiency
- Eric Wilson, NREL: Development of a HPWH Model for Hourly Building Energy Simulation

The following summarizes the session:

What gap/barrier were you addressing?

- Assess HPWH technology by measuring efficiency.
- Provide credible data on the performance and reliability of HPWHs.

- Assess user satisfaction in a residential setting.
- Existing analysis tools cannot accurately model HPWHs with reasonable runtime.

What did you do to address it?

- EPRI testing 40 units per utility in multiple climate zones.
  - Treatment and control sites measured in parallel until March 2012.
  - Occupants instructed to operate HPWH normally year round.
  - Occupants permitted to adjust water temperature and operating modes as desired.
  - Control sites are ~10%-20% of treatment sites.
  - HPWHs installed in various locations (attic, garage, conditioned space).
  - Preliminary results:
    - Average COPs ranging from 1.3 to 1.9.
    - Increasing COP with warmer months.
    - Negligible impact on coincident peak demand in winter.
    - Majority of customer respondents were satisfied with new HPWH performance.
    - Less than half noticed difference relative to previous water heater, some noted favorable differences.
- CARB testing HPWHs in early 2000s, clearly there were problems with technology. Currently evaluating 14 installations.
  - Performance = f (ambient temp, total hot water consumption, draw patterns/concentrations).
  - More frequent, concentrated draws trigger the backup electrical resistance element.
  - New generation of HPWHs looks pretty good.
  - Have good handle on when/where HPWHs make sense.
  - Avg. savings ~$430/year compared to electric resistance heater at $0.17/kWh.
  - Incremental cost (relative to electrical resistance) = $1400-$2700.
- NREL developed HPWH for use with hourly simulation tools.
  - Modeling is important because:
    - Realistic performance of HPWHs depends on many factors; cannot assume energy factor rating performance.
    - System interactions: heating and cooling loads in house, space conditions impact HPWH performance.
    - Helps to manage risks of accuracy, run-time, occupant satisfaction.

  - Explore effects of tank location, volume, set-point, use patterns.
  - Optimize measure and trade-offs.
- Modeling Issues:
  - Tank stratification: typically an isothermal tank is assumed; new model employs two tanks in series approach (to simplify stratification).
  - Draw profile: varied draw profile employed in model.
  - Performance maps: generic normalized performance map used.
  - HPWH sizing: no existing model for HPWH sizing; BEopt models on a percentage of unmet showers approach (in more innovative forms of water heaters like HPWHs, it is possible to use all the water in the tank. At that point, BEopt measures how much more hot water *should* be there for the homeowners to be comfortable in a metric called "un-met showers.)
- Results:
  - Calibrated TRNSYS model to match energy use data within +/- 5% using 12 cases.
  - Water heating source energy savings vs. electric varied from ~15% to 75%, depending on city/climate.
- Lessons learned:
  - Rated EF for HPWHs not good indicator of performance.
  - Don't use "smooth" BA HSP draw profile for HPWH testing.
  - Control logic matters.
  - Sizing HPWHs for adequate HW delivery: many factors.

What remains?

- How exactly does performance vary with consumption patterns?
- How to model performance changes effectively?
- How much better is a bigger tank?
- Do we need a better handle on space conditioning interactions? Is ducted HPWH better?
- Longer-term questions of maintenance and durability remain unanswered.
- Better draw profiles for HPWH modeling/testing.
- Performance in enclosed spaces.

4.5 Session 5 – Hydronic Heating Control Strategies

This session included the following presentations:

- Jordan Dentz, Hugh Henderson, ARIES: Hydronic Heating Retrofits for Multifamily Buildings
- Peter Ludwig, CNT Energy: Steam System Balancing and Tuning
- Lois Arena, CARB: Condensing Boiler Research Results

The following summarizes the session:

What gap/barrier were you addressing?

- Current systems often rely only on an outdoor temperature reset strategy with limited indoor controls and no zone or apartment level control. Two examples of inefficient operation include regulating temperature by opening windows and having full heat mode as the default control failure mode.
- Steam heating is an inefficient older technology used from 1900 to 1930 but still present in many buildings (70,000 of 470,000 multifamily units in Chicago). Failure of existing controls result in overheating, which is typically alleviated by opening windows. Previous studies show 5% to 15% savings from control improvements requiring mainly time and effort to fix problems. Steam equipment is relatively inexpensive but few contractors target work in this area.
- For condensing boilers with outdoor reset and baseboard distribution:
    - Lower than rated efficiency.
    - Most simulation tools cannot model.
    - Contractors lack guidance for design, control, and commissioning.
    - Safety features decrease efficiency.
    - Response time is very slow (as much as 2 hours for a 5°F setback, although works well at maintaining a set temperature).

What did you do to address it?

- Strategies investigated included new wireless temperature sensors for space and zone level control and boiler plant reset.
- In one study, improvements were planned in two phases: (1) boiler controls with wireless indoor and outdoor sensors, and (2) radiator zone valves for local control, adaptive intelligent boiler reset, night setback, and 3-way mixing valves to keep boiler return temperatures at 140°F. Preliminary savings figures for these measures are in the range of 15% to 20%.
- Ten test buildings with 15 to 30 units were chosen for this study with single pipe systems where boilers were in good shape but heating in the building was noticeably uneven. Initial improvement efforts focused on replacing radiator vents. Initial results show difficulty in providing an even distribution of heat throughout the building.

What remains?

- Understanding baseline operation (met through detailed site audit).
- Impact with and without nighttime setback.
- Performance of various reset control strategies.
- Lack of measured data to assess extent of inefficiencies (met through Web-enabled data acquisition).
- Language barrier between manufacturers and researchers and difficulty controlling both boiler and mixing valves.
- Better strategies to improve response time and comfort.

4.6 Session 6 - Exterior Insulation Breakthroughs

This session included the following presentations:

- Achilles Karagiozis, Owens Corning: Moisture Performance of Exterior Insulated Wall Assemblies
- Chris Schumacher, BSC: Exterior Insulation and Overcladding Retrofits
- Jay Crandell, ARIES, Vladimir Kochkin, NAHB-RC: Wind Pressure Performance Evaluation and Building Code Improvements For Energy Efficient Exterior Wall Assemblies Including Continuous Insulation Collaboration Between IBHS, NAHB RC, VSI, ACC, And FSC

The following summarizes the session:

What gap/barrier were you addressing?

- Very few really understand moisture properties.
- Rigid sheathing has become commonplace in many regions for new construction.
    - Perceived benefits.
        - Increased thermal, infiltration, and moisture performance.
        - Easier to do than interior insulation.
    - Perceived problems.
        - Moisture management.
        - Unproven structural performance.
- Wind pressure resistance of multilayered walls with exterior rigid foam.
    - Performance characteristics.
    - Capacity.
    - Limitations.
    - Design method.
    - Design specification.

- Current code very conservative; wind load is in reality distributed through wall layers.

What did you do to address it?

- Moisture is a transient phenomenon; stop relying on dew point.
- WUFI is the most used model and it has been validated; good agreement with 1D and 3D wall.
- Location is a huge influence: oceanfront vs. mountain.
  - Cannot make recommendations based on maps.
- Need to look at more than average weather conditions; need to look at transient conditions.
- Field tests to look at moisture within the wall.
  - Side-by-side wall assembly with and without exterior sheathing.
  - Created intentional bulk water leak (wetting paper).
  - Wall with sheathing showed superior performance.
  - Re-ran experiment without intentional leak.
- Concerns about gravity loads hanging off exterior insulation have been researched:
  - Passed under realistic loading conditions.
- NAHB doing laboratory wind loading testing:
  - Wind has great amount of variability—dynamic pressure—hard to simulate/create for lab testing.
  - Pressure is distributed between wall layers (pressure equalization).
  - Gypsum is resisting large portion of the load under suction tests.
  - Location of air barrier(s) impacts the distribution of load between wall layers.
- Code advancements with respect to exterior foam:
  - New vinyl siding wind pressure rating requirements in 2009/2012 IRC Section R703.11.2 for use over foam sheathing.
    - Consistent with wind pressure and pressure equalization factor (PEF) testing to date for application with foam sheathing.
    - Same provisions proposed for 2015 IBC.
  - New ANSI standard FS 100.
    - Wind pressure rating requirements for foam sheathing products.
    - Nearing completion (public ballot phase).
    - Proposed for 2015 I-codes (in progress).

  - Other related topics (e.g., fastening requirements for cladding over foam sheathing).

What remains?

- Need for more research in the area of hygrothermal modeling.
- Need to know more about hygric redistribution of various assemblies.
- More work needed to determine allowable deflections of exterior foam.
- Durability during construction is a concern, especially for mobile/modular test homes.
- Wind testing:
  - Assembly test method modifications to better correlate with wind-tunnel performance.
  - Confirm effects of wall assembly variants (different sheathings, sidings, air sealing, etc.).
  - Development of PEF modeling approach.
  - Implement for design of high performance multilayered wall systems and other applications.
- What is best practice?
  - What is lowest cost that meets the code?
  - The best approach is to start with what you are doing now.

5 Track B – Critical Guidance for Peak Performance Homes Sessions

5.1 Session 1 – Ventilation Strategies in High Performance Homes

This session included the following presentations:

- Max Sherman, LBNL: Why We Ventilate
- Brett Singer, LBNL: Formaldehyde in New Homes: Ventilation vs. Source Control
- Robb Aldrich, CARB: Effective, Low-Cost, Whole-Building Ventilation for Existing Homes

The following summarizes the session:

What gap/barrier were you addressing?

- Is there a benefit to ventilating?
- What is the current best practice?

What did you do to address it?

- Conduct a hazard and risk analysis.
  - Compare measured concentrations to standards.

- Contaminant standards are questionable (backed by data, but based on political criteria).
- DALY (disability adjusted life loss) = YLL + YLD (years lost to death, years lost to disability) big chart of DALYs lost per 100k people (contaminants on Y, log population on X).
- Most important: particles (PM 2.5) (10^3) (can have significant outdoor contribution).
- Solution is to sequester need for ventilation in the first place: PM2.5 (filtration), no open combustion appliances, low emitting materials, then dilution ventilations.

- Address concerns of formaldehyde in new homes.
  - Study in new homes in New Mexico and California comparing concentrations to air exchange rates.
  - Change environmental conditions.
  - Found that higher air exchange rates generally reduced formaldehyde concentration.
- Case study approach in Clark County.
  - Awareness of new systems is important.
  - Emission suppressed at low air exchange rate and a lower concentration of pollutants as the air exchange rate increases in each home.

What remains?

- How much dilution ventilation is needed to satisfy humans?
- More research needs to be conducted on homes with high and low emitting materials over a long period of time.

5.2 Session 2 – Combustion Safety in Tight Houses

This session included the following presentations:

- Larry Brand, PARR: An Overview of Gas Industry Research on Combustion Safety
- Brett Singer, LBNL: Model-Based Assessment of Combustion Safety Diagnostic Procedures
- Jim Fitzgerald, Center of Energy and Environment: 10,000 Homes Prove Performance

The following summarizes the session:

What gap/barrier were you addressing?

- What is the current best practice for combustion safety in tight homes?

What did you do to address it?

- Research current codes (National Fuel Gas Code, International Fuel Gas Code, Uniform Plumbing Code).

  - Require volume of combustion air as calculated, safety inspection, and vent installation consistent with tables.
  - The National and International Fuel Gas Code has taken us a big step in the right direction.
- Short-term testing vs. continuous testing – impacted by weather vs. expense.
  - Goal is a diagnostic tool.
- Case Study: Airport Sound Program: tightening 3,000 homes; combustion safety a side experiment.
  - Go back to 3,000 homes and do safety tests/fix combustion.
  - Design safety into next 5,000 homes.
  - Basic approach: tighten, add ventilation, test, add more ventilation if necessary.
  - Testing included flue carbon monoxide, vented appliance worst-case combustion spillage, measure mechanical room worst-case pressure for design purposes.
  - Program data indicates a higher rate of warm weather spillage fails.
  - BPI interim guidance: Provide a spill switch to interrupt fuel supply if spillage occurs.
  - Solution: address combustion safety issues before tightening.

What remains?

- The highest priority issue remaining to be solved is disconnects between code language, manufacturer installation instructions, and recommendations by field inspectors.
- Possible risks going forward include differing recommendations not based on building science research.
- What is the acceptable probability/frequency of spillage?
- Should we assess for current conditions (installed exhaust/occupants) or assume average?

5.3 Session 3 – Building America Implementation STC

This session is discussed in the Standing Technical Committee section.

5.4 Session 4 – Implementation Program Case Studies

This session included the following presentations:

- Karl R. Rábago, Austin Energy: Best Practices for Utility Incentive Programs
- Mark Berman, ARBI: Building America Perspective and Overlay to the Home Energy Upgrade California Approach
- Krista Sprenger, Lend Lease America and Duncan Prahl, IBACOS: Community-Scale Energy Improvements

The following summarizes the session:

What gap/barrier were you addressing?

- What are the best practices for large-scale energy efficiency implementation programs?
    - What is the best way to recruit homeowners to participate in energy upgrade programs?
    - What are the sustainable retrofit business models?
    - How to quantify overall savings with data mining and aggregate results?

What did you do to address it?

- Utility incentive programs: Best Offer Ever Program.
    - High volume program, offered 0% loan financing.
    - Existing weatherization workforce transitioned to HPWES.
    - 568 retrofits, 10x typical participation rate.
    - Takeaways.
        - Engage early and stay focused.
        - Act quickly.
        - Communicate often.
        - Quicker rebate payment to homeowners.
- BetterBuildings Program – Energy Update California: compare various business models.
    - Single contractor for geographic area – Sonoma.
    - Two contractors – L.A. County.
    - Solutions: When financed monthly for 30 years, cost is very sensitive to interest rates, but makes financial sense currently. On-bill financing is best bet.
    - Most clients respond to performance (and therefore cost savings) guarantees.
    - Professional sales staff can quadruple sales vs. experienced building scientists.
- Community scale improvements: Lend Lease Program.
    - Military Housing Privatization Initiative (MHPI).
    - Approach: behavior modification, green retrofit, renewable.
    - Most houses need help with air sealing and insulating attics, duct repair/sealing, adding higher efficiency HVAC equipment, adding gas tankless water heaters, and energy management.

What remains?

- How to convert a very incentivized program into a long-term, self-sustaining program?

- How to accurately predict and achieve energy savings-based historical utility bills and a minimal amount of information about the actual characteristics of the house and sub system (i.e. HVAC system) performance?

5.5 Session 5 – Field Testing from Start to Finish

This session included the following presentations:

- Lieko Earle, NREL: Field Test Best Practices – A Resource for Practical Residential Building Science
- Paul Norton, NERD, Greg Barker, Mountain Energy Partnership: Analysis Driven Field Testing

The following summarizes the session:

What gap/barrier were you addressing?

- How to conduct a field test that outputs new, useful data and conclusions to the industry.

What did you do to address it?

- Created Field Test Best Practice (FTBP) tool.
    - Modular content.
    - Three dimensional approach to organization.
    - Challenge: cannot endorse brands.
- Established the analysis-driven field test approach.
    - You can improve your analysis significantly if you wrap the analysis around the testing, pre-test analysis.
        - Literature search is a classic step, but just as important are the best models or analysis approaches available.
        - Project goals: have the big picture in mind. How do you plan to change the world? And, then the detailed research questions flow from the project goals.
        - Pre-test analysis: first and foremost, this helps determine the use of the field test. By doing the modeling in advance, it informs all the answers. Develop a mathematical representation; determine feasibility of the idea; determine what needs to be measured and controlled to compare to the model. What time scale is required for the tests and measurements? Is the performance sensitive to occupant behavior?
        - Field testing: as you design, you are asking yourself, how will the data be analyzed? “Begin with the end in mind.” Pay attention to the data. The most important time to pay attention is as you connect the sensor.
        - Post-test analysis: compare the model and measurements. Use measurements to improve the model. Tests tell you things, but they tell

you things about specific houses, specific equipment. But, if you have confidence in your model, you can generalize the results.

What remains?

- More content is needed for the FTBP tool. BA stakeholders can help develop content for various modular content chunks.
- Usability feedback testing and prioritize future content additions.

5.6 Session 6 – Humidity Control and Analysis

This session included the following presentations:

- Jon Winkler NREL: Laboratory Performance Testing of Residential Dehumidifiers
- Armin Rudd, BSC: Residential Humidity Control Strategies

The following summarizes the session:

What gap/barrier were you addressing?

- Manufacturer data is insufficient to simulate a dehumidifier's performance over its expected range of operating conditions.
    - Need to understand operating performance of existing and emerging supplemental dehumidification equipment (Space Conditioning STC).
    - Supplemental dehumidification modeling (Analysis Methods and Tools STC).
- How to control indoor humidity year-round, just like temperature. Challenge is when there is a need for dehumidification, but cooling equipment doesn't run.
- Low load homes have less sensible gain but similar latent gain; how to address?

What did you do to address it?

- Tested six residential dehumidifiers in a laboratory setting.
    - One interesting finding is that almost all measured performance metrics exceeded the rated/reported values.
    - General performance curves were identified that approximate performance at all points within 6% error, so annual energy estimates using the generic model are reasonable. These curves are implemented in BEopt 1.2.
- Literature review summary.
    - Moisture load due to air exchange decreases with decreased infiltration, even with added ventilation.
    - Many manufacturers are addressing dehumidification in their cooling appliances.
    - From ASHRAE RP-1449 research (preliminary results), it appears moving ducts into conditioned space is a trigger for needing supplemental dehumidification. This is because the duct location inside the thermal envelope significantly decreases the A/C sensible load, so the A/C runtime drops. Therefore, it removes less latent load, resulting in higher humidity levels.

  - Possible solution: make the existing cooling or heat pump equipment also do the dehumidification.

What remains?

- ENERGY STAR v3.0 changes will encourage consumers to purchase larger capacity dehumidifiers. This likelihood of significant oversizing motivates cyclic testing, since cyclic operation is expected to be more likely in high performance homes. The energy tradeoffs of increased efficiency (which comes with larger capacity dehumidifiers) vs. cyclic degradation and latent degradation should be explored.
- Latent loads from below-grade are not yet modeled.
- Better understanding of dehumidification design load.
- Better understandings of humidity control impacts of sensible heat gain reduction in mixed-humid climates.

6 Track C – Market-Driven Research Solutions Sessions

6.1 Session 1 - Building America Outreach Initiatives

This session included the following presentations:

- Sam Rashkin, DOE: Customer Focused Deployment: Builders Challenge Version 2 and the Building America Resource Tool
- Michael Baechler, PNNL: Building America Publications
- Stacy Hunt, BARA: Public-Private Sector Media Partnerships

The following summarizes the session:

What gap/barrier were you addressing?

- Making the results of BA research accessible to our stakeholders.

What did you do to address it?

- Building public/private sector media partnership.
  - Cool Energy House.
  - Remodeler Communication Tools.
- Sam Rashkin's Building America Resource Tool.
  - Strong tie to/populated by BA Measure Guidelines.
- BA outreach efforts led by PNNL.
  - Redevelopment of BA website.
  - Repackaging of Builders Challenge program.
  - New approach to how case studies are developed:
    - Whole-house or proven performance that some level of energy efficiency has been achieved for new and existing homes.

      - Measure-specific case studies that offer evidence that a measure has proved effective.
    - Another activity is to support organizations (mostly nonprofit) that are proposing new standards and track public comments.
- Positive changes:
    - We are beginning to have a very strong message.
    - Becoming clear about the product offerings.
    - Information will be easier to access because of the Resource Tool.
    - Very clear commitment by DOE and the labs to provide support to translate research results to public.

What remains?

- Develop content to populate Resource Tool.
- Challenges to overcome:
    - Sheer bulk of information that comes out of the program.
    - Value proposition has been unclear.
    - Information has been very broad and not targeted.
    - Hard to access and hard to find what they are looking for.

6.2 Session 2 – Building America Case Studies

This session included the following presentations:

- John Friesenhahn, Imagine Homes, Glenn Cottrell, IBACOS: Achieving Higher Performance Cost Neutrality Through Building America: A Builder's Perspective
- Peter Ludwig: CNT Energy Savers Program Collaboration With Building America
- Roderick Jackson, ORNL: Residential Retrofits in the Southeast: A Performance Update

The following summarizes the session:

What gaps and barriers were addressed?

- n/a

What did you do to address it?

- IBACOS Imagine Homes Case Study lessons learned:
    - Challenges:
        - Getting the HOA to accept pv panels on the roof.

        Moving to ½ XPS foam on the exterior and tape; contractor was unfamiliar with using these products so a learning curve there.

- Successes:
  - Switching to ½ XPS foam is now part of the standard package of Imagine's homes.
  - Great building crews so few trade issues.
  - Pre-construction meeting with all involved to get buy in.
  - This energy option package is now offered to all buyers.
- CNT Energy Case Study.
  - Barriers to retrofitting buildings:
    - Current energy efficiency resources are over-complicated.
    - Appearance of a lack of information.
    - High transaction costs.
    - Limited workforce.
  - Lessons learned.
    - Building relationships with property owners and contractors is important.
    - Cost-effective upgrades (not necessarily the latest technology) should be communicated to building owners.
    - Quality installations are crucial.
    - Important to educate tenants, building owners, and maintenance staff.
- ORNL Residential Retrofits in the Southeast: A Performance Update.
  - Results:
    - Point of entry: timing of already doing renovations. How can we get information that they are doing repairs and promoting energy efficiency?
    - Unbiased expertise is highly valued; appreciated having researchers on site.
    - Quality of work is a major issue and who assures that work is done properly.

What remains?

- Barriers to retrofitting buildings:
  - Current energy efficiency resources are over-complicated.
  - Appearance of a lack of information.
  - High transaction costs.
  - Limited workforce.

- Questions remaining:
  - Are deep energy retrofits the right approach? Maybe use a phased approach.
  - Inconvenience to homeowners.
  - How do we cost-effectively commission retrofits?
  - How do we bring down the costs of deep energy retrofits?
- Pushing towards 50% savings and integration of newer technologies.

6.3 Session 3 - Technical Approach to Home Energy Management

This session included the following presentations:

- J.T. Thompson, GE: An Introduction to Brillion Technology
- Kurt Roth, Fraunhofer: Non-Intrusive Load Disaggregation

The following summarizes the session:

What gaps and barriers were addressed?

- How to control and identify miscellaneous electrical loads?
- How to enable smarter appliance control with new information exchange with grid?

What did you do to address it?

- GE is developing smart appliances that user doesn't need to "set up", reducing the need for user understanding and taking action.
- Fraunhofer discussed state of technology and use of non-intrusive load disaggregation monitoring equipment to determine distinct appliance loads.

What remains?

- Development of standards/protocols for demand response-enabled equipment.
- Overcome data privacy issues.
- People aren't aware of products.
- No good value proposition to consumers.
- Utilities don't allow businesses opportunity to use their technology.
- Need improved accurate load disaggregation algorithms for monitoring.

6.4 Session 4 - Valuing Energy Efficiency

This session included the following presentations:

- Benjamin Gromicko, InterNACHI: Kitchen Table Strategy: Home Inspectors Driving Demand for Home Energy Upgrades
- W. Laurence Doxsey, City of San Antonio: Financing Residential Retrofits
- Candace Cooke, Real Property Counselors, Inc.: Valuing Energy Efficiency

The following summarizes the session:

What gaps and barriers were addressed?

- Convincing the homeowner to buy energy efficiency upgrades.

What did you do to address it?

- The housing inspector hired by the buyer during the purchase of the home has a great opportunity to educate and sell energy efficiency to the homeowner.
  - U.S. Department of Energy's Workforce Guidelines for Home Energy Professionals, which help inspectors (or contractors) explain to their clients the technical aspects of an inspection in simple, easy-to-read, clear-to-understand language and illustrations.
  - Need to convince homeowner to buy energy efficiency before bling. Majority of upgrades are purchased within the first year of homeownership.
- Development of finance programs for residential retrofits.
  - Interest rate buy down: good but low public interest and tough to qualify for.
  - Rebates/government backed programs (not sustainable).
- Broker appraiser perspective on valuing energy efficiency.
  - People want quick and easy flip, not comfort and long-term benefit.
  - Appraisers are pressured to get things done quickly in a repeatable and defendable manner.
  - A lot of Web-certified, incompetent appraisers in the industry.
- Valuing energy efficiency for utility rebate programs.
  - Cooking is large contributor to peak demand; energy efficiency has very little impact on this.
  - Utility controlled home energy management systems showing great success.
  - Community focused energy efficiency with a trusted utility leading the effort.

What remains?

- Those professionals (real estate agents, home inspectors, loan agents) that have early influence on home purchases need to be given education, materials, and communication/sales skills on residential energy efficiency.
- Free audits/market transformation.
- Main financing driver needs to come through ease of transaction from beginning to end.
- Better communication.
- No clear value stream.
- Running out of low hanging fruit.
- Utilities need a better understanding of housing stock.

- Better understanding of value stream map (Implementation STC #3).

6.5 Session 5 - Software Accuracy Issues in Poorly Insulated, Leaky Homes

This session included the following presentations:

- Steve Saunders, TexEnergy Solutions: Stories From Field Research and Lessons Learned From Comprehensive Energy Audits
- Philip Fairey, BA-PIRC: Winter Infiltration Results From the Frtf Laboratory
- Jon Winkler, NREL: Improving Air Conditioning and Heat Pump Modeling

The following summarizes the session:

What gaps and barriers were addressed?

- Existing models frequently over-predict savings.

What did you do to address it?

- From an energy auditor's perspective:
  - Market is damaged due to marketers repeatedly over-promising savings and not delivering.
  - Market is not dead because people keep coming back.
- Lab research currently underway to better categorize impacts of tight vs. leaky enclosure. Results include:
  - Moisture control critical issue:
    - Mild weather resulted in humidity control issues in both lab homes.
- Lab developed performance curve to improve air conditioning and heat pump modeling.
  - Addressed Analysis STC gap to continually update models to represent increases in air-conditioning technology with easy reference to equipment currently available on the market.
  - Conclusion #1: annual simulation results are not highly dependent on the selected performance curves.
  - Conclusion #2: SEER is highly affected by nominal tonnage for high efficiency equipment. Be careful of "Up to SEER…" marketing.
  - Conclusion #3: able to develop a set of rated performance inputs for generic AC units consistent across SEER levels; individual AC products can still be modeled using specific performance ratings as inputs.
  - Conclusions resulting in significantly simplified modeling inputs in BEopt, but are broadly applicable to other software tools.

What remains?

- Suggestions for ongoing research related to accuracy.
  - Improve predictability of energy audit forecast.

        - "Calibration" of pre-home utility bills .
            - Disaggregation.
            - Normalization.
    - Inspection and testing: reduce time for physical audit.
        - Speed of time test.
        - Field automation tools.
        - Input data simplification with fewer data points.
        - Automation of input.
    - Off-site analysis of audit data.
        - Can we control "over-shoot?"
        - HERS index validity: confidence on less than 130 HERS and impact of comparison.
        - Impact of changes in base load; HERS and energy use prediction and actual.
        - What is potential impact of time-of-use and demand response?
        - Utility bill escalation clause: create an intelligent, reasonable standard.
        - Software auto-generate "measure bundles."
    - Other suggestions:
        - Use digital data for QA?
        - Better quantified energy savings from measures.
        - Impact of year over year actual savings, including from HVAC maintenance.
        - On-bill finance for energy efficiency.
- Additional research needed on relative humidity levels in tight vs. leaky homes.

6.6 Session 6 - New Additions to Codes

This session included the following presentations:

- Jeremy Williams, DOE, Pam Cole, PNNL: What's New in Energy Codes?
- Chris Little, Center for Building Excellence at BASF: Insulation Strategies to Meet Upcoming Code and Above Code Programs
- Doug Lewin, SPEER: Harmonizing "Above Code" Codes
- David Karmol, International Code Council: Widely Disseminating Advanced Building Technology: Proposing Changes to ICC Model Codes

The following summarizes the session:

What gaps and barriers were addressed?

- Industry acceptance of new code additions.

What did you do to address it?

- Summary of code history and projections for future requirement was presented.
- Utility perspective on need for code-driven increased energy efficiency to prevent major energy crisis in some regions.

What remains?

- Clear messaging; energy efficiency and code programs are providing varied messages and leaving homeowners confused.
- Better data to support cost-effectiveness of code improvements.
- Codes need to be written so they don't hinder adoption of new, efficient technologies.

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