Building America Analysis Methods and Tools

Standing Technical Committee Meeting

February 29, 2012

Building America Residential Energy Efficiency Stakeholder Meeting
Austin, Texas

Housekeeping

- E-mail Ben Polly, ben.polly@nrel.gov to be added to committee E-mail list

- Open committee: Invite others!

- Next call:

  Tuesday, April 17, 1:00 – 2:00 PM (ET)

Today's Agenda

1. Committee Purpose and Goals (10 min)
2. **Brainstorming Session (30 min)**
3. Strategic Plan (20 min)
    1. Overview
    2. Progress Update
4. Next Steps and Discussion (15)

Introductions

Audience Poll:

- Familiar with Building America?

- Attending a meeting of this committee for the first time?

Building America

- Department of Energy (DOE) funded
- Industry-driven research program
- National labs and building science teams
- Real-world, innovative solutions for new and existing homes
- Significant energy and cost savings
  - 30–50% energy savings

Building America Program Goals

From: www.eere.energy.gov/building_america/program_goals.html:

"…conduct research to develop market-ready energy solutions that improve efficiency of new and existing homes in each U.S. climate zone, while increasing comfort, safety, and durability."

What are BA STC's?

Purpose: Identify and track gaps/barriers that must be resolved to achieve BA program goals.

- Each committee maintains a Strategic Plan document
- Strategic Plans describe and prioritize gaps/barriers
- "2-pager" descriptions developed for highest priority gaps/barriers
- Help shape direction of BA research efforts

What are BA STC's?

Cover seven topic areas:

- **Analysis Methods and Tools**
- Automated Home Energy Management
- Building Envelope
- Hot Water
- Implementation
- Space Conditioning
- Test Methods and Protocols

Analysis Methods and Tools STC

Overall Goal:

Resolve gaps/barriers that limit the widespread use of Building America analysis methods and tools to make **accurate, consistent, transparent, documented, cost-effective, and time-effective predictions of:**

- **energy use and savings** (including BA program metrics),
- **costs,**
- **comfort,**
- **safety, and**
- **durability**

in each U.S. climate region, at a whole-building (integration) level, for new construction and existing homes, for single and multi-family buildings, and for emerging and mature energy efficiency technologies.

Brainstorming Gaps/Barriers

- New attendees offer a fresh perspective

- Rules:

  -All ideas are welcome!

  -Limit discussion of gaps/barriers previously identified by committee

Brainstorming Gaps/Barriers

Capability

What key technologies cannot be modeled by current tools?

Brainstorming Gaps/Barriers

Accuracy

In what ways do analysis methods need to be more accurate?

Brainstorming Gaps/Barriers

Field Data and Audits

Are there any gaps related to the collection, transfer, storage, and input of information for analysis tools?

Brainstorming Gaps/Barriers

Simulation Protocols

Are there any gaps related to methods for defaulting and calculating inputs?

Brainstorming Gaps/Barriers

New Methods and Tools

Are there types of important analysis questions that cannot be answered by current tools?

What types of new analysis tools are needed?

Brainstorming Gaps/Barriers

Others?

Any other gaps?

Strategic Plan Overview

Identified 78 gaps/barriers in the following categories:

- Validation and Testing (6)
- Existing Methods and Tools (52)
- New Methods and Tools (3)
- Field Data and Audits (5)
- House Simulation Protocols (11)
- Other (1)

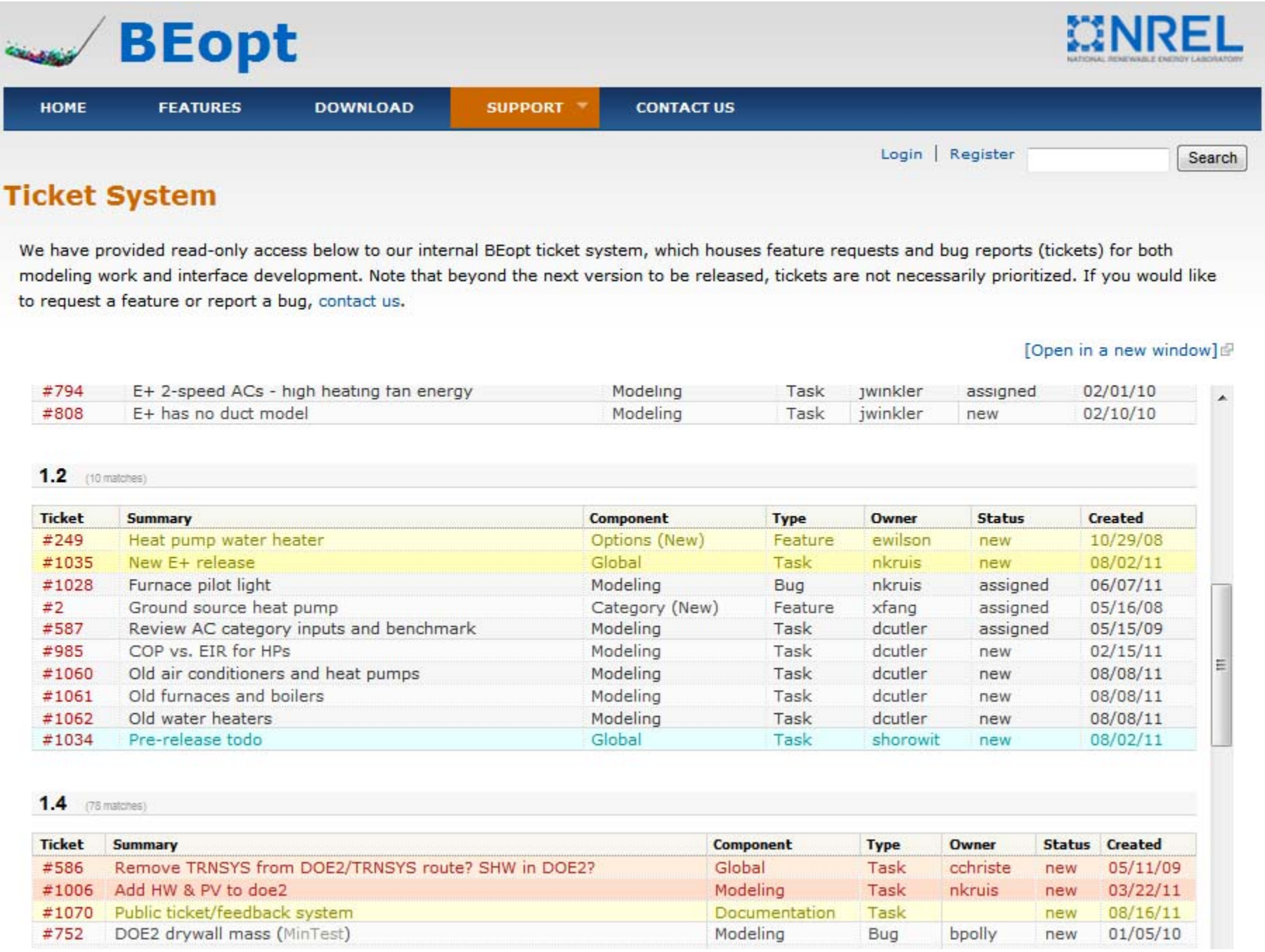
Two new gaps/barriers have been added since last prioritization

Strategic Plan Overview

- Most gaps/barriers are related to "Existing Methods and Tools" (capability)

- BEopt-specific gaps/barriers are tracked at a high-level in an appendix of the Strategic Plan

- Also tracked here: http://beopt.nrel.gov/trac



BEopt

NREL

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Ticket System

We have provided read-only access below to our internal BEopt ticket system, which houses feature requests and bug reports (tickets) for both modeling work and interface development. Note that beyond the next version to be released, tickets are not necessarily prioritized. If you would like to request a feature or report a bug, contact us.

[Open in a new window]

#794	E+ 2-speed ACs - high heating fan energy	Modeling	Task	jwinkler	assigned	02/01/10
#808	E+ has no duct model	Modeling	Task	jwinkler	new	02/10/10

1.2 (10 matches)

Ticket	Summary	Component	Type	Owner	Status	Created
#249	Heat pump water heater	Options (New)	Feature	ewilson	new	10/29/08
#1035	New E+ release	Global	Task	nkruis	new	08/02/11
#1028	Furnace pilot light	Modeling	Bug	nkruis	assigned	06/07/11
#2	Ground source heat pump	Category (New)	Feature	xfang	assigned	05/16/08
#587	Review AC category inputs and benchmark	Modeling	Task	dcutler	assigned	05/15/09
#985	COP vs. EIR for HPs	Modeling	Task	dcutler	new	02/15/11
#1060	Old air conditioners and heat pumps	Modeling	Task	dcutler	new	08/08/11
#1061	Old furnaces and boilers	Modeling	Task	dcutler	new	08/08/11
#1062	Old water heaters	Modeling	Task	dcutler	new	08/08/11
#1034	Pre-release todo	Global	Task	shorowit	new	08/02/11

1.4 (78 matches)

Ticket	Summary	Component	Type	Owner	Status	Created
#586	Remove TRNSYS from DOE2/TRNSYS route? SHW in DOE2?	Global	Task	cchriste	new	05/11/09
#1006	Add HW & PV to doe2	Modeling	Task	nkruis	new	03/22/11
#1070	Public ticket/feedback system	Documentation	Task		new	08/16/11
#752	DOE2 drywall mass (MinTest)	Modeling	Bug	bpolly	new	01/05/10

10/15/11 screenshot: http://beopt.nrel.gov/trac

Strategic Plan Overview

1. Sensitivity Analysis
2. In Situ Furnace Performance
3. Validation Methodology—Accuracy Tests Based on Existing Empirical Data Sets
4. In Situ Air-Conditioner Performance
5. In Situ Water Heater Performance
6. High Efficiency Air-Conditioners and Heat Pumps
7. Wall Cavities
8. Multifamily Window-to-Wall Ratio
9. Ground Source Heat Pumps
10. Heat Pump Water Heaters
11. Data Transfer Standard
12. Storm Windows
13. Enhancing Documentation, Training, and Education for Building America Analysis Tools
14. Supplemental Dehumidification Modeling

Strategic Plan Overview

1. Sensitivity Analysis
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9. **Ground Source Heat Pumps**
10. **Heat Pump Water Heaters**
11. **Data Transfer Standard**
12. Storm Windows
13. Enhancing Documentation, Training, and Education for Building America Analysis Tools
14. **Supplemental Dehumidification Modeling**

Committee Strategic Goals

Goal 1: Improve the **accuracy** of AMATs to reduce risks associated with buying, selling, and financing energy efficiency in residential buildings.

Goal 2: Enhance the **capabilities** of AMATs to predict the energy, cost, comfort, safety, and durability impacts of energy efficiency technologies, so industry, government, and researchers can evaluate the benefits and tradeoffs between individual technologies and packages of technologies to develop aggressive energy savings solutions for the market.

Goal 3: Establish **field data collection procedures and house simulation protocols** that optimize cost and accuracy tradeoffs to increase the credibility and profitability of analysis efforts in the field.

Strategic Plan—Progress Update

- Chair presented Strategic Plan at BA Planning Meeting October 28th
- Meeting summary report now available online
- Chair and 2-pager authors completed responses to feedback in early February

Strategic Plan—Progress Update

Today's updates:

- Heat Pump Water Heaters
- High Efficiency ACs and HPs
- Supplemental Dehumidification
- Accuracy Tests
- Data Transfer Standard

BEopt 1.2 (E+ and DOE-2.2) released 1/2012

Gap: HPWH Modeling

Resolved: BEoptE+ 1.2 includes HPWH model

- Based on NREL laboratory evaluations
- Limited validation with field data

Remaining additional needs include:

- Modeling ducted HPWHs
- Simplified (spreadsheet-based) HPWH model? (CARB)
- HPWH performance in enclosed/semi-enclosed spaces (BA-PIRC)
- Additional field validation of HPWH model and DHW Event Schedule Generator draw profiles

Related issues:

- Better draw profiles for testing and rating HPWHs (ASHRAE SPC 118.2)
- How are HPWHs operated by occupants? (CARB, BA-PIRC)
- Better understanding/modeling unconditioned basement humidity, for HPWHs in basements

Gap: High Efficiency ACs and HPs

Resolved: BEopt 1.2 includes significant improvements to AC and HP models

- Updated model inputs using current manufacturer data
- Simplified user inputs
- Consistent trends across SEER levels
- Centralized variable-speed air-conditioner and heat pump option

Remaining additional needs include:

- Field validation of variable-speed equipment models
- Modeling mini-split heat pumps
  - Experimental performance data
  - Point-source cooling and heating equipment
  - Occupant operation of MSHPs

Gap: Supplemental Dehumidification

Resolved: BEoptE+ 1.2 includes a whole-house dehumidifier model

- Based on NREL laboratory evaluations

Remaining additional needs include:

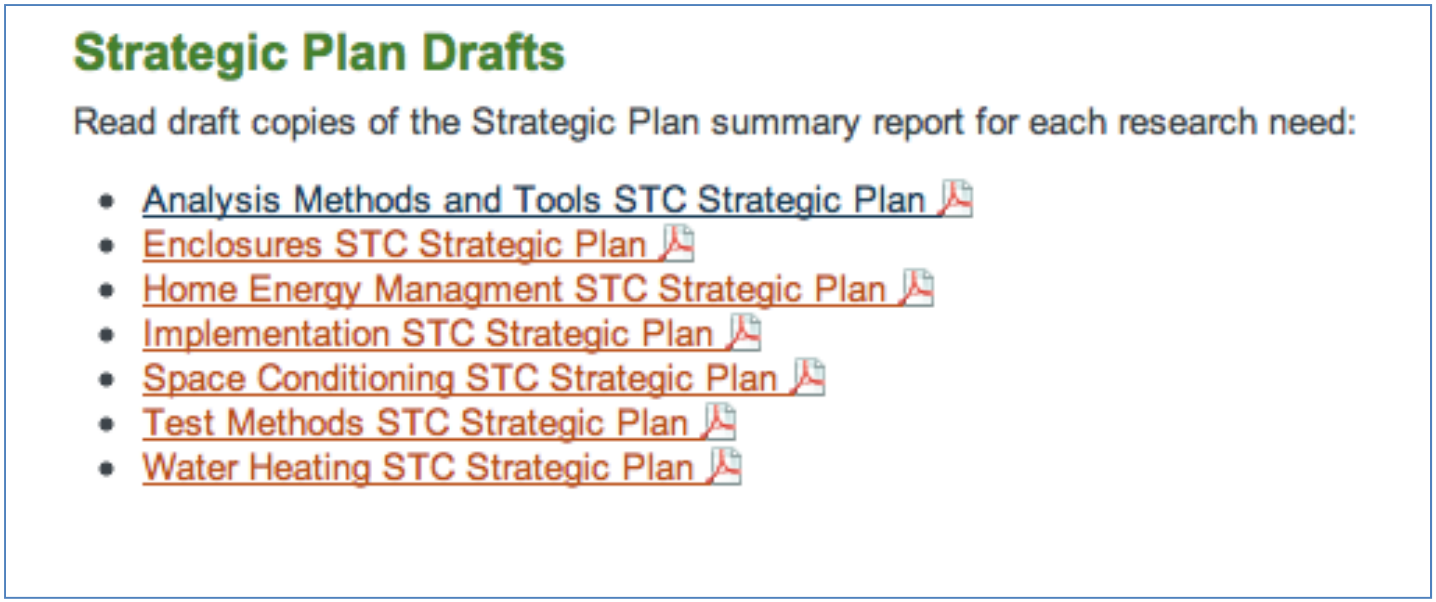
- Point-source dehumidification equipment (basement dehumidifiers)
- Central equipment with supplemental dehumidification control
- Desiccant-based dehumidification equipment
- Validation of E+ moisture balance modeling

Related issues:

- Supplemental humidification

Strategic Plan—Progress Update

- Updated version of DRAFT Strategic Plan was uploaded to the BA website



Strategic Plan Drafts

Read draft copies of the Strategic Plan summary report for each research need:

- Analysis Methods and Tools STC Strategic Plan
- Enclosures STC Strategic Plan
- Home Energy Managment STC Strategic Plan
- Implementation STC Strategic Plan
- Space Conditioning STC Strategic Plan
- Test Methods STC Strategic Plan
- Water Heating STC Strategic Plan

11/14/11 screenshot

Strategic Plan—Progress Update

- Major revisions to Strategic Plan occur after BA meetings
- Chair will review topics identified today and add to online spreadsheet
- These topics will be considered, along with previous topics, in next round of prioritization

Next Steps

Action items:

- For new attendees: E-mail ben.polly@nrel.gov to be added to STC E-mail list
- Add new topics identified today to online spreadsheet (Chair)

Next Call:

Tuesday, April 17, 1:00 – 2:00 PM (ET)

Questions?

Extra Slides

Committee Strategic Goals

Goal 1: Improve the accuracy of AMATs to reduce risks associated with buying, selling, and financing energy efficiency in residential buildings.

Goal 2: Enhance the capabilities of AMATs to predict the energy, cost, comfort, safety, and durability impacts of energy efficiency technologies, so industry, government, and researchers can evaluate the benefits and tradeoffs between individual technologies and packages of technologies to develop aggressive energy savings solutions for the market.

Goal 3: Establish field data collection procedures and house simulation protocols that optimize cost and accuracy tradeoffs to increase the credibility and profitability of analysis efforts in the field.

ID	Topic	Survey Score	Category
10	General--HVAC equipment autosize feature (BEopt specific)	5.08	Existing Methods and Tools
25	Pre-retrofit--HVAC sizing (BEopt specific)	5.00	Existing Methods and Tools
45	Multi-family--If modeling one unit in a multi-family or one home sharing a wall with another, the ability to model party walls through which no heat transfer occurs (BEopt specific)	5.00	Existing Methods and Tools
6	Sensitivity Analysis: Analysis is needed to determine most influential models and associated inputs.	4.91	Validation and Testing
22	Pre-Retrofit--Old furnaces (general)	4.90	Existing Methods and Tools
2	Validation Methodology: Accuracy tests based on existing empirical data sets are needed.	4.82	Validation and Testing
21	Pre-Retrofit--Old air conditioners (general)	4.82	Existing Methods and Tools
23	Pre-Retrofit--Old water heaters (general)	4.80	Existing Methods and Tools
50	Savings Calculations--Energy savings for different SEER rated AC systems (BEopt specific)	4.80	Existing Methods and Tools
52	Cost Selector/Option Editor--Increase the number of wall systems that can be added to the library (BEopt specific)	4.80	Existing Methods and Tools
29	Current Technologies--High-SEER air conditioners (general)	4.75	Existing Methods and Tools
49	Savings Calculations--Reference building profiles for IECC 2009 (BEopt specific)	4.75	Existing Methods and Tools
24	Pre-Retrofit--Empty cavity walls (general)	4.73	Existing Methods and Tools

ID	Topic	Survey Score	Category
30	Current Technologies--Ability to model air conditioners and heat pumps with performance ratings other than defaults (BEopt specific)	4.73	Existing Methods and Tools
67	Multi-family window to wall ratio: Minimal data for window to wall ratio in multi-family buildings. Current equation needs work.	4.73	House Simulation Protocols
51	Savings Calculations--Monthly energy use over specific time periods (BEopt specific)	4.70	Existing Methods and Tools
31	Current Technologies--Ground-source heat pumps (general)	4.67	Existing Methods and Tools
35	Current Technologies--Two-stage ACs or modulating furnaces/boilers (general)	4.64	Existing Methods and Tools
32	Current Technologies--Heat pump water heaters (general)	4.62	Existing Methods and Tools
62	Data Collection Standard: Standards and protocols for data collection and exchange (data fusion, data mining, and data granularity) are needed to better predict savings and improve tools.	4.62	Field Data and Audits
27	Retrofit Measures--Storm windows (general)	4.60	Existing Methods and Tools
77	Education/Training: Comprehensive, updated and evaluated training materials are needed to help train engineers on the use of the DOE modeling tools.	4.57	Other
53	Cost Selector/Option Editor--Allow for easier sharing of costs and options - save cost and option data with actual .bpj file? (BEopt specific)	4.56	Existing Methods and Tools
54	Cost Selector/Option Editor--Allow for easier sharing of costs and options - import partial libraries (BEopt specific)	4.56	Existing Methods and Tools

ID	Topic	Survey Score	Category
33	Current Technologies--Mini-split ACs and heat pumps (general)	4.55	Existing Methods and Tools
36	Current Technologies--Dehumidifiers (BEopt specific)	4.55	Existing Methods and Tools
70	Air Conditioner/Furnace Watt Draw: The 0.365 W/cfm used for ANSI/AHRI Standard 210/240 is not representative of values found in the field.	4.50	House Simulation Protocols
73	CFL vs. LED Lighting: LEDs have a lower efficacy than CFLs, according to the HSP, therefore LEDs put out less lumens than CFLs, and the lumen level is maintained at a certain level, thus resulting in more LEDs than CFLs, which consumes more energy.	4.50	House Simulation Protocols
1	Validation Methodology: Additional comparative tests are needed.	4.45	Validation and Testing
13	General--Different wall assemblies in BEopt (BEopt specific)	4.45	Existing Methods and Tools
26	Retrofit Measures--Costs (general)	4.44	Existing Methods and Tools
55	Cost Selector/Option Editor--Allowing for comparison for different system types in Optimization Mode (BEopt specific)	4.44	Existing Methods and Tools
5	Calibration: A standard method to calibrate software is needed (utility bills, smart meter data).	4.40	Validation and Testing
60	Customer interaction and feedback tools--better tools are needed (e.g., create a standardized homeowner survey and online database for inputting/collating results?)	4.40	New Methods and Tools
14	Heat Transfer--Better infiltration modeling (BEopt specific)	4.38	Existing Methods and Tools
48	Savings Calculations-- Add Benchmark costs for comparison (BEopt specific)	4.38	Existing Methods and Tools
68	Hot Water Draw Profiles for Modeling HPWHs: HW draw profiles (continuous, low volume) cause HPWH models to perform better than they would with realistic draws.	4.36	House Simulation Protocols

ID	Topic	Survey Score	Category
47	Savings Calculations--Incorporation of tiered rate structures and time of use rates for utility cost calculations (general)	4.33	Existing Methods and Tools
43	Multi-family--"multi-family housing (duplexes, townhouses, apartment buildings) should be included - not just single family new and retrofits." (BEopt specific)	4.31	Existing Methods and Tools
19	Heat Transfer--Energy recovery (BEopt specific)	4.30	Existing Methods and Tools
56	Cost Selector/Option Editor--Allow for any order of options in the library for Optimization Mode (BEopt specific)	4.30	Existing Methods and Tools
72	MEL Assumptions: MEL annual figures may not scale correctly for small homes (studios) and apartments.	4.30	House Simulation Protocols
15	Heat Transfer--Infiltration heat recovery (general)	4.27	Existing Methods and Tools
39	Current-Technologies--Combination space and domestic hot water heaters (BEopt specific)	4.27	Existing Methods and Tools
69	Air Conditioner Performance: Field studies have shown that air conditioners do not operate at rated performance due to a number of defaults including improper installation, lack of commissioning, etc. Specifically, poor performance can be attributed to improper refrigerant charge, low air flow, high duct pressure drops, and oversized units. In California, credit is provided under the energy code for measuring and verifying correct installation, and if not, the EER used in modeling is degraded accordingly. This may more realistically represent the energy use of systems.	4.25	House Simulation Protocols
34	Current Technologies--Evaporative cooling technologies (general)	4.20	Existing Methods and Tools
46	Dual Fuel--"Accurate modeling of dual fuel" (general)	4.20	Existing Methods and Tools
71	Thermal Bypass: Many national energy efficiency programs (ENERGY STAR, LEED for homes) and local programs require a thermal bypass inspection to minimize thermal bypass and ensure specific thermal performance from insulation. There is no mechanism in the HSP to credit performance of these homes over others (more detailed models or degradation factors are needed).	4.20	House Simulation Protocols

ID	Topic	Survey Score	Category
20	Heat Transfer--Multiple wall-types in BEopt (BEopt specific)	4.18	Existing Methods and Tools
57	Humidity Control--Allow for humidity control in BEopt (BEopt specific)	4.18	Existing Methods and Tools
63	Cost effective and accurate "Drive-by-Audit": is needed and the most important home attributes to accurately model should be identified (e.g., blower door or no blower door?).	4.18	Field Data and Audits
11	General--Retrofits changing size of home (BEopt specific)	4.17	Existing Methods and Tools
3	Validation Methodology: Tuning BESTEST-EX based on empirical based accuracy tests is needed.	4.14	Validation and Testing
65	Auditor Handbook: is needed to ensure consistency between different energy auditors.	4.09	Field Data and Audits
7	General--Internal temperature distribution (general)	4.08	Existing Methods and Tools
8	General--Mean radiant temperature (general)	4.08	Existing Methods and Tools
38	Current-Technologies--Hydronic systems (heating and cooling) (general)	4.08	Existing Methods and Tools
17	Heat Transfer--Foundation heat loss (general)	4.07	Existing Methods and Tools
37	Current Technologies--Air-to-water heat pump (general)	4.00	Existing Methods and Tools
16	Heat Transfer--Accounting for insulation performance degradation over time (general)	3.92	Existing Methods and Tools
28	Retrofit Measures--Window films (general)	3.90	Existing Methods and Tools
66	Many aspects of take back are not addressed: After a home has been retrofit, there are many forms of take back than can occur (e.g., heating and cooling set point, hot water use from low flow shower heads, and lighting use). The HSP lacks the ability to address many of these occurrences due to lack of data.	3.90	House Simulation Protocols

ID	Topic	Survey Score	Category
18	Heat Transfer--Slab heat loss (BEopt specific)	3.82	Existing Methods and Tools
64	Self Assessment Tools: there is a need for accurate, whole-house analysis that is doable by the average homeowner.	3.82	Field Data and Audits
76	Lighting: There is a need to better-understand the relationship between occupants and lighting.	3.82	House Simulation Protocols
59	Macro/community scale model: A model is needed for neighborhood/community scales to identify how much energy savings are available for certain homes to reach an overall goal.	3.77	New Methods and Tools
75	MELs: There is a need to better-understand the relationship between occupants and MELs.	3.77	House Simulation Protocols
74	Occupant Behavior: There is a need to validate assumed standard occupant use profiles.	3.69	House Simulation Protocols
4	Validation Methodology: A custom empirical validation facility is needed.	3.67	Validation and Testing
44	Multi-family--If modeling an individual unit rather than the whole MF building, the ability to model a central plant and its interaction with the individual unit. (general)	3.64	Existing Methods and Tools
61	Bridge between current whole building energy simulation tools and CFD technology--is needed to better understand the physical details of forced and buoyancy-driven air flow patterns within building enclosures, along with the resulting impact on associated heat flow, temperature, and moisture distributions.	3.47	New Methods and Tools
12	General--Window placement (BEopt specific)	3.46	Existing Methods and Tools
58	Site--Ability to draw neighbors in BEopt (BEopt specific)	3.36	Existing Methods and Tools
9	General--Furniture/interiors (general)	3.25	Existing Methods and Tools
41	Emerging Technologies--Electrochromic windows (general)	3.08	Existing Methods and Tools
40	Current Technologies--Micro CHP systems (general)	3.00	Existing Methods and Tools
42	Emerging Technologies--PCMs (phase change materials) (general)	3.00	Existing Methods and Tools

Multifamily Window-to-Wall Ratio

- **Short-term.**
- **Gap/barrier:** Need to better-characterize window-to-exterior-wall ratios (WWR) for multifamily buildings, including townhomes and duplexes, so that the ratios specified by the Building America Benchmark will be more realistic.

Sensitivity Analysis

- **Short-term (ongoing).**
- **Gap/barrier:** Sensitivity analysis is needed to estimate the inputs that have the most influence on software predictions and recommendations.

Storm Windows

- **Short-term.**
- **Gap/barrier:** Many of the building energy analysis tools that are commonly used for research and design purposes do not enable the inclusion of storm windows in the analysis.

Supplemental Dehumidification Modeling

- **Short-term.**
- **Gap/barrier:** Modeling capabilities needed in analysis tools.

Accuracy Tests Based on Existing Empirical Data Sets

- **Mid-term.**
- **Gap/barrier:** Empirical test suites are needed to assess and improve accuracy of analysis tools.

Data Transfer Standard

- **Mid-term.**
- **Gap/barrier:** Presently, no widely-adopted data transfer standard exists for the home performance industry.

Enhancing Documentation, Training, and Education for BA Analysis Tools

- **Mid-term.**
- **Gap/barrier:** Existing documentation, training, and education materials for BA energy analysis tools could be enhanced.
  - BEopt, BA Analysis Spreadsheets, DHW Event Schedule Generator.

http://beopt.nrel.gov

(October 15, 2011)

Download Software

The latest release of BEopt is **version 1.1** (March 29, 2011).

It brings a number of new features including:

- Modeling window types by facade
- Modeling overhangs by facade and floor level
- Modeling variable crawlspace height (1.5 - 5 ft)
- Additional economic calculations in the output report
- Undo/redo functionality in the drawing area
- Improved duct model for conduction (BEoptE+)
- Faster simulation speed (BEoptE+)

See the changelogs below for the complete list of changes.

BEopt (DOE2/TRNSYS)

The DOE2 version of BEopt is faster than the EnergyPlus version, but has fewer modeling capabilities.

- BEopt 1.1 setup file (21mb .exe)
- DOE2.2 version 47g (12mb .zip). There is no setup file, the zip just needs to be extracted. If you have not already filled out and submitted a DOE2 license agreement form, you will need to do so in order to install the software.
- Changelog

BEoptE+ (EnergyPlus)

The EnergyPlus version of BEopt is slower than the DOE2 version, but has more modeling capabilities.

- BEoptE+ 1.1 setup file (15mb .exe)
- EnergyPlus 6.0.0 setup file
- Changelog

Weather Files

Both versions of BEopt ship with a handful of EPW weather files. You can also download all US TMY3-based EPW weather files (242 mb .zip; extracts to 1.53gb) or individual weather files.

BEopt

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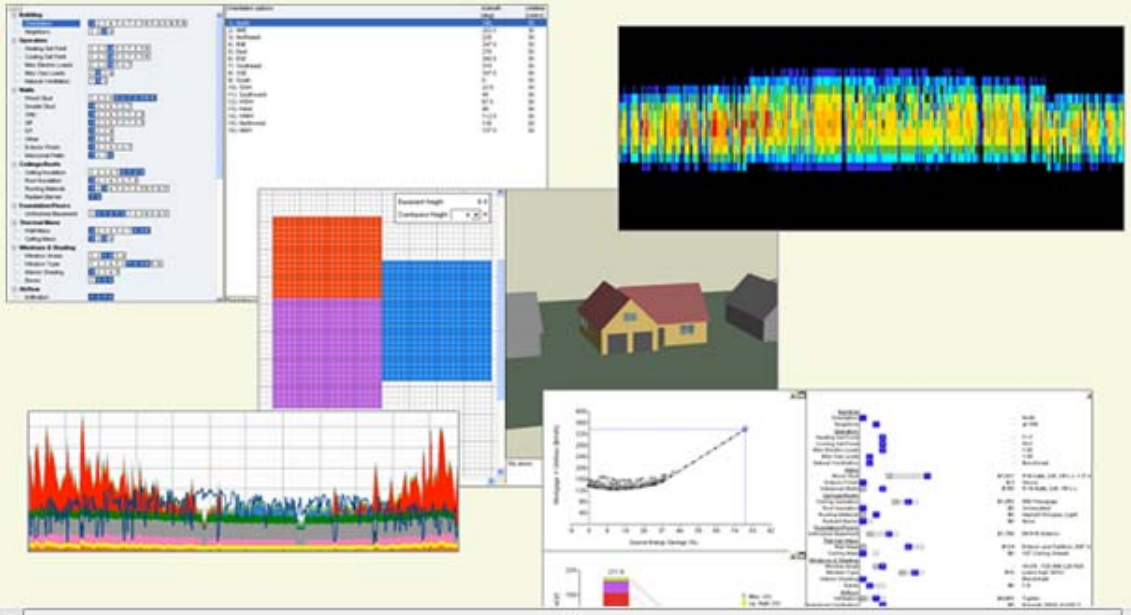
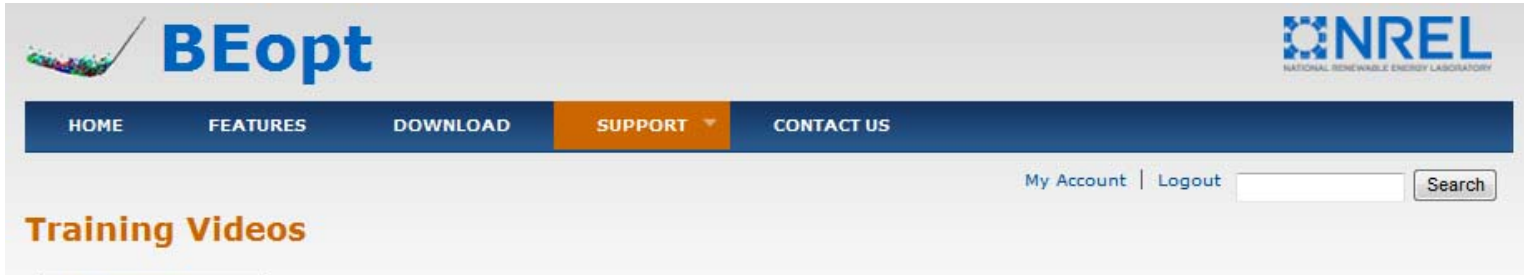
BEopt 1.1 Help





Training Videos

1. **Getting Started With BEopt**
   - Background [2:43]
   - Using Help [0:56]
2. **Input**
   - Overview [2:59]
   - Geometry Input [7:21]
   - Site Input [3:37]
   - Options Input [6:21]
   - Reference Building [2:46]
3. **Running Simulations**
   - Run [2:19]
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   - Options Graph [3:16]
   - Cost/Energy Graph [5:59]
5. **Library Manager**
   - Cost Selector [5:51]
   - Option Editor [6:00]
6. **Retrofit Analysis**
   - Overview [4:42]
   - Life-Cycle Costing (Advanced) [5:32]
   - Cost Metric (Advanced) [2:50]
   - Energy Metric (Advanced) [2:56]
   - Site Input [0:52]
   - Geometry Input [0:28]
   - Options Input [1:44]
7. **Optimization**
   - Input [5:42]
   - Output [5:04]
   - Sequential Search (Advanced) [11:38]

Note: Videos from “BEopt Training Modules” (BARA)

Publications

Here is a list of BEopt and related publications organized by topic.

General

- New Version of BEopt Software Provides Analysis Capabilities for Existing Homes (2011)
- BEopt Software for Building Energy Optimization: Features and Capabilities (2006)
- BEopt: Software for Identifying Optimal Building Designs on the Path to Zero Net Energy (2005)

Analysis

- A Method for Determining Optimal Residential Energy Efficiency Retrofit Packages (2011)
- Using EnergyPlus to Perform Dehumidification Analysis on Building America Homes (2011)
- Ducts in the Attic? What Were They Thinking? (2010)
- Reconciling Differences Between Residential DX Cooling Models in DOE-2 and EnergyPlus (2010)
- Preliminary Assessment of the Energy-Saving Potential of Electrochromic Windows in Residential Buildings (2009)
- Searching for the Optimal Mix of Solar and Efficiency in Zero Net Energy Buildings (2008)
- Defining a Technology Pathway Leading to New Homes with Zero Peak Cooling Demand (2006)
- Analysis of Residential System Strategies Targeting Least-Cost Solutions Leading to Net Zero Energy Homes (2006)
- Optimal Building Designs on the Path to Zero Net Energy (2004)

Optimization

- Enhanced Sequential Search Methodology for Identifying Cost-Optimal Building Pathways (2008)
- A Sequential Search Technique for Identifying Optimal Building Designs on the Path to Zero Net Energy (2004)

Related

- Building America House Simulations Protocol (2011)
- Assessing and Improving the Accuracy of Energy Analysis for Residential Buildings (2011)
- Orienting the Neighborhood: A Subdivision Energy Analysis Tool (2008)

Ground Source Heat Pumps (GSHPs)

- **Long-term.**
- **Gap/barrier:** Several GSHP modeling limitations in existing software tools:
  - Questions regarding DOE-2 horizontal trench model.
  - Horizontal trench and DHW desuperheaters currently cannot be modeled in EnergyPlus.
  - Using manufacturer published EER/COP at rated conditions (AHRI/ASHRAE ISO 13256-1) does not properly address the in situ fan and pump operating energy consumption.
  - GSHPs currently not an option in BEopt.

Heat Pump Water Heaters

- **Mid-term.**
- **Gap/barrier:** Need accurate HPWH model that does not increase the runtime of annual hourly simulations by more than 50%.

High Efficiency ACs and HPs

- **Mid-term.**
- **Gap/barrier:**

1. Experimental performance data:
   A. Currently, manufacturer-provided data for variable speed equipment are not suitable for developing accurate performance-based models.
   B. Field testing is unlikely to cover the necessary range of operating conditions for model development; thus laboratory testing is needed.
   C. It is important to test a variety of systems to accurately represent the market landscape.
2. Component modeling: Can current building simulation tool air-conditioner models be extended to variable speed systems? If so, how accurately can variable speed systems be modeled using current approaches?
3. Point-source heating and cooling: Can/should MSHP systems be modeled using a single living zone building model?
4. Operation: How are MSHPs operated by occupants?

In Situ AC Performance

- **Mid-term.**
- **Gap/barrier:**
  - How can we best estimate the full range of performance parameters for air conditioners given a limited amount of information (e.g., climate, vintage, installation quality, name-plate information)?
  - How does air conditioner performance change over time and how can degradation be accurately modeled in simulations?

In Situ Furnace Performance

- **Mid-term.**
- **Gap/barrier:**
  - How can we best estimate the full range of performance parameters for furnaces given a limited amount of information (e.g., climate, vintage, fuel type, name-plate information)?
  - How does furnace performance change over time and how can degradation be accurately modeled in simulations?

In Situ Water Heater Performance

- **Mid-term.**
- **Gap/barrier:**
  - How can we best estimate the full range of performance parameters for water heaters given a limited amount of information (e.g., climate, vintage, fuel type, name-plate information)?
  - How does water heater performance change over time and how can degradation be accurately modeled in simulations?

Wall Cavities

- **Mid-term.**
- **Gap/barrier:** Need to identify models that accurately predict heat transfer through uninsulated cavities and implement the model output into BES programs.