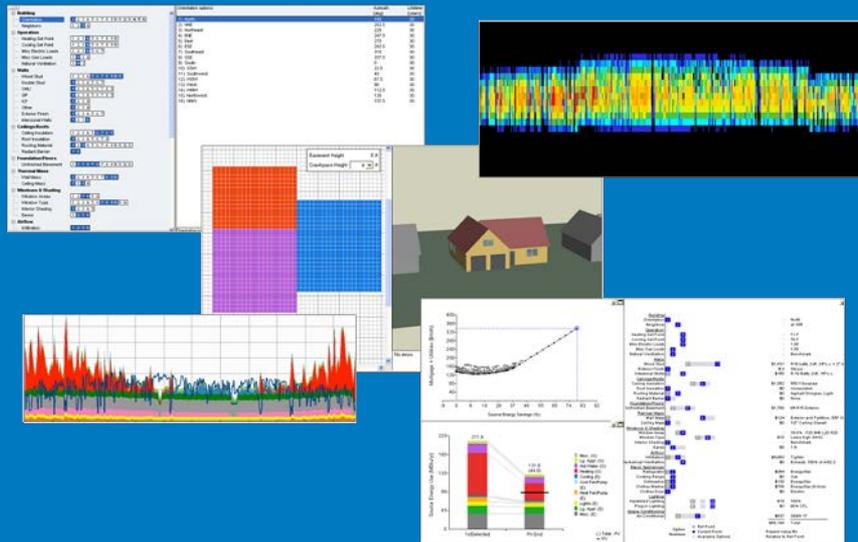
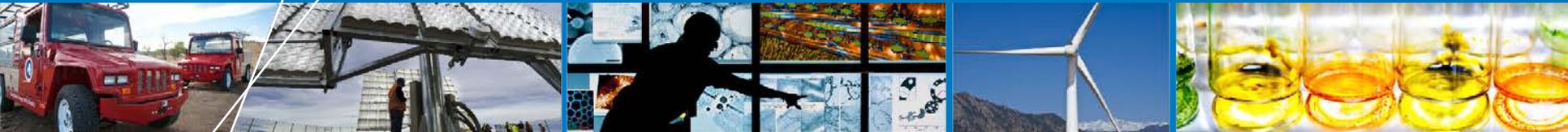


BEopt Optimization Tool National Residential Efficiency Measures Database



**Scott Horowitz
Noel Market**

3/18/2015

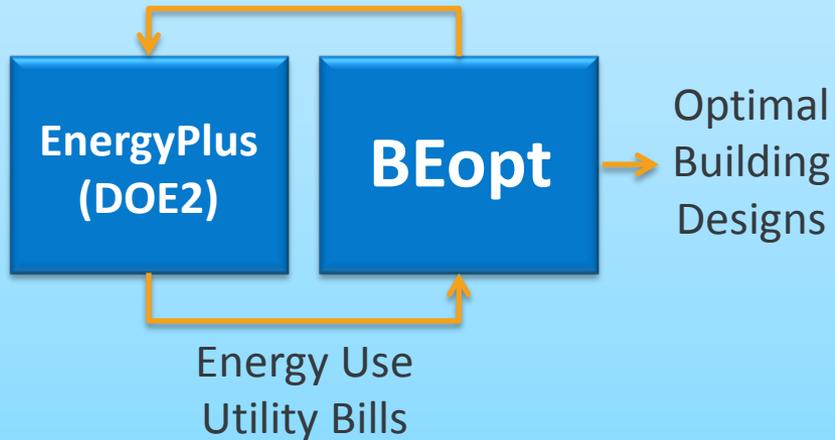
beopt.nrel.gov

What is BEopt?

(beopt.nrel.gov)

Plug-and-Play Software

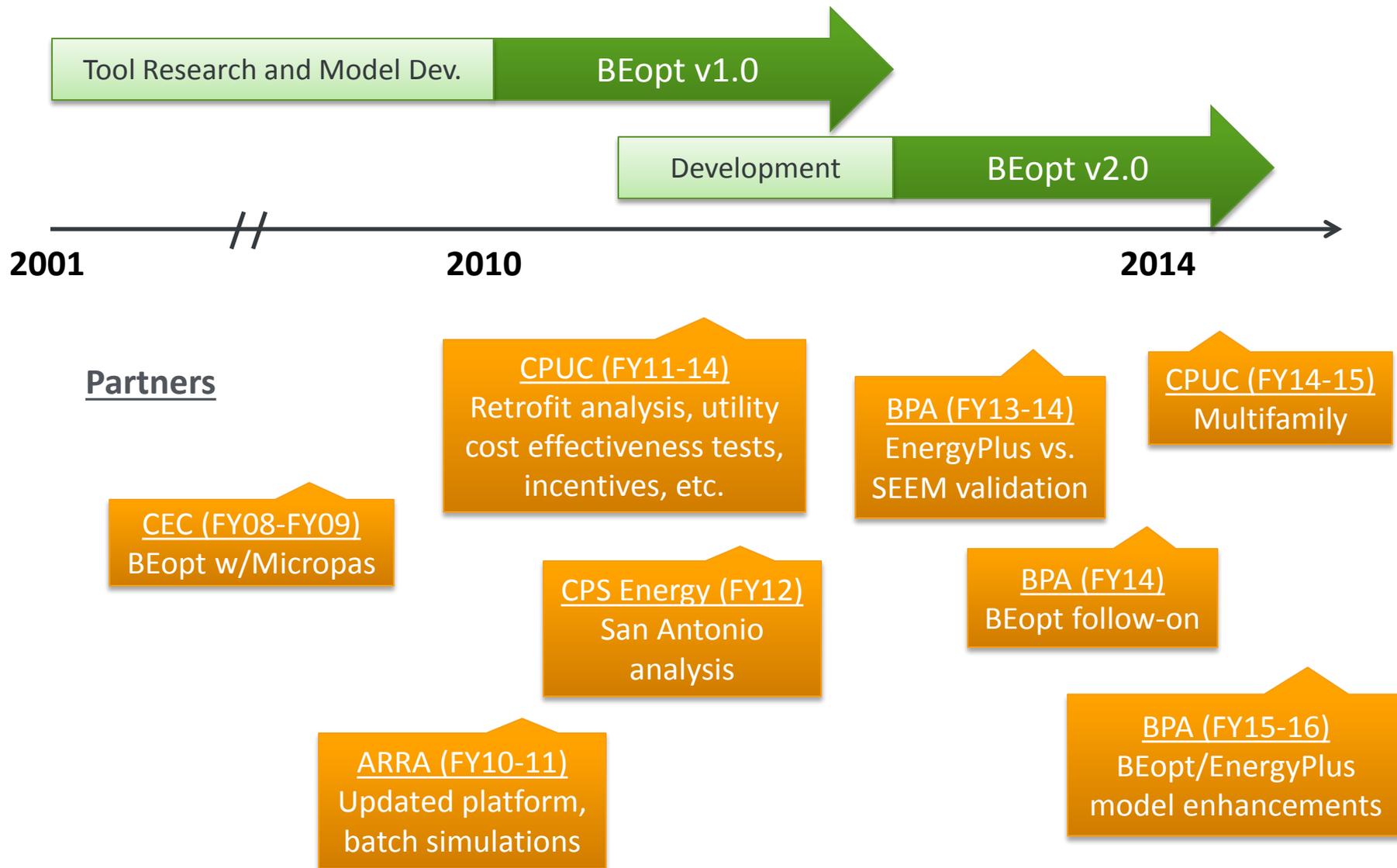
Heating
Cooling
Lighting
Appliances
Other Efficiency
PV/SHW



Features:

- New construction and retrofit
- Single-family and (soon) multifamily
- Design, parametric, optimization
- Detailed cost database
- Rapid building drawing tool
- Detailed utility rates
- PV compensation
- PV/efficiency incentives
- Demand response
- HPXML export
- Schedule wizard
- Output visualization
- Batch simulations
- Library manager
- ...

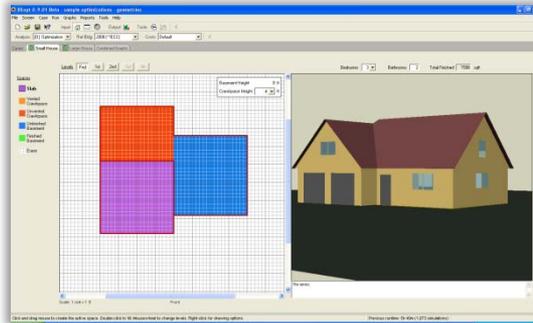
BEopt Timeline



BEopt GUI

Input

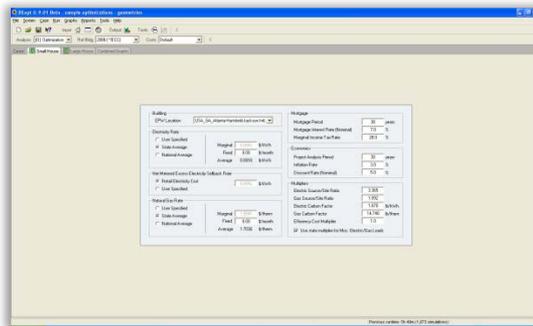
Geometry



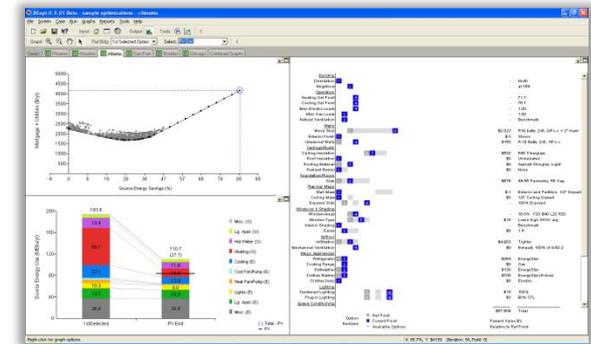
Output



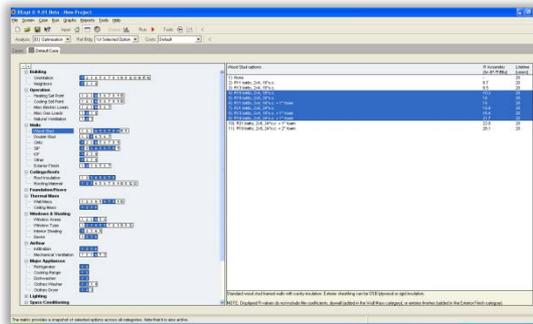
Site



Run



Options



BEopt Input - Geometry

drawing tool for quick/accurate detailed building geometry

The screenshot displays the BEopt software interface for building geometry input. The interface is divided into several sections:

- Levels:** A row of buttons for selecting levels: Fnd, 1st, 2nd, 3rd, 4th, and Roof. The 'Fnd' button is currently selected.
- Statistics:** Located at the top right, showing 'Beds' set to 3, 'Baths' set to 2, and 'Total Finished' area of 2680 sqft.
- Spaces:** A legend on the left side with color-coded boxes:
 - Slab (Purple)
 - Crawlspace (Orange)
 - Unfinished Basement (Blue)
 - Finished Basement (Green)
 - Erase (Grid icon)
- Attached Walls:** A legend on the left side with checkboxes:
 - Left-Facing
 - Right-Facing
 - Back-Facing
- Grid and Drawing Area:** A large grid where a building footprint is drawn. The footprint consists of a green 'Finished Basement' area on the left, a purple 'Slab' area on the right, and an orange 'Crawlspace' area on top of the slab. A red border outlines the entire footprint. A small panel in the top right of the grid shows 'Crawlspace Height' set to 4 ft and 'Basement Height' set to 8 ft.
- 3D View:** On the right side, a 3D perspective view of a yellow house with a brown roof and blue windows, corresponding to the footprint on the grid.
- Scale and Orientation:** At the bottom left, it says 'Scale: 1 cell = 1 ft'. At the bottom center, it says 'Front'.
- Bottom Bar:** At the bottom right, there are four small icons representing different views (Home, Front, Back, etc.) and the text 'No errors.'

BEopt Input - Geometry

drawing tool for quick/accurate detailed building geometry

Levels: Fnd, 1st, **2nd**, 3rd, 4th, 5th, 6th

Wall Height: 8 ft

Scale: 1 cell = 2 ft

Front

No errors.

Spaces

- Living - Unit 16
- Open to Below
- Unfinished Attic
- Finished Attic -- Unit 16
- Vaulted Ceiling
- Garage Roof
- Porch Roof / Overhang
- Flat Roof / Deck
- Erase

Units

Add Unit Copy Right

#	Beds	Baths	Finished (sqft)
Total	48	32	10000
13	3	2	625
14	3	2	625

BEopt Input - Site

weather, financing, utility rates, incentives, etc.

Building

EPW Location  

Terrain

Natural Gas Hookup

Economics

Project Analysis Period years

Inflation Rate %

Discount Rate (Real) %

Material Cost Multiplier

Labor Cost Multiplier

Mortgage

Down Payment %

Mortgage Interest Rate %

Mortgage Period years

Marginal Income Tax Rate, Federal %

Marginal Income Tax Rate, State %

Other

Incentives PV Efficiency

Demand Response

Project Info

Building Name

Street Address

City

State

Zip

Country

Notes:

Electricity

Utility Rates

Simple Detailed

User Specified Fixed \$/month

State Average Marginal \$/kWh

National Average Average \$/kWh

Fuel Escalation (Real) %/year

PV Compensation

Net Metering Feed-in Tariff

Annual Excess Sellback Rate

Retail Electricity Cost \$/kWh

User Specified

Energy Factors

Source/Site Ratio

Carbon Factor lb/kWh

BEopt Input - Options

operation, envelope, equipment options from Measures Database

The screenshot shows the BEopt software interface. On the left is a tree view of building categories, and on the right is a list of insulation options.

Category (points to 'Wood Stud' in the tree view)

Options (points to the list of insulation options)

Option	R-Assembly [h-ft ² -R/Btu]	Framing Factor [frac]	Install G
2) Uninsulated, 2x4, 16 in o.c.	3.6	0.25	
3) Uninsulated, 2x6, 24 in o.c.	3.7	0.22	
4) R-7 Fiberglass Batt, Gr-3, 2x4, 16 in o.c.	8.3	0.25	
5) R-7 Fiberglass Batt, Gr-2, 2x4, 16 in o.c.	8.7	0.25	
6) R-7 Fiberglass Batt, Gr-1, 2x4, 16 in o.c.	8.9	0.25	
7) R-11 Fiberglass Batt, Gr-3, 2x4, 16 in o.c.	9.6	0.25	
8) R-11 Fiberglass Batt, Gr-2, 2x4, 16 in o.c.	10.1	0.25	
9) R-11 Fiberglass Batt, Gr-1, 2x4, 16 in o.c.	10.5	0.25	
10) R-13 Fiberglass Batt, Gr-3, 2x4, 16 in o.c.	10.3	0.25	
11) R-13 Fiberglass Batt, Gr-2, 2x4, 16 in o.c.	10.9	0.25	
12) R-13 Fiberglass Batt, Gr-1, 2x4, 16 in o.c.	11.4	0.25	
13) R-15 Fiberglass Batt, Gr-3, 2x4, 16 in o.c.	10.9	0.25	
14) R-15 Fiberglass Batt, Gr-2, 2x4, 16 in o.c.	11.7	0.25	
15) R-15 Fiberglass Batt, Gr-1, 2x4, 16 in o.c.	12.2	0.25	
16) R-19 Fiberglass Batt, Gr-3, 2x6, 24 in o.c.	14.4	0.22	
17) R-19 Fiberglass Batt, Gr-2, 2x6, 24 in o.c.	14.6	0.22	
18) R-19 Fiberglass Batt, Gr-1, 2x6, 24 in o.c.	15.5	0.22	
19) R-21 Fiberglass Batt, Gr-3, 2x6, 24 in o.c.	14.6	0.22	
20) R-21 Fiberglass Batt, Gr-2, 2x6, 24 in o.c.	16.1	0.22	
21) R-21 Fiberglass Batt, Gr-1, 2x6, 24 in o.c.	17.2	0.22	
22) R-13 Cellulose, Gr-3, 2x4, 16 in o.c.	10.3	0.25	
23) R-13 Cellulose, Gr-2, 2x4, 16 in o.c.	10.9	0.25	

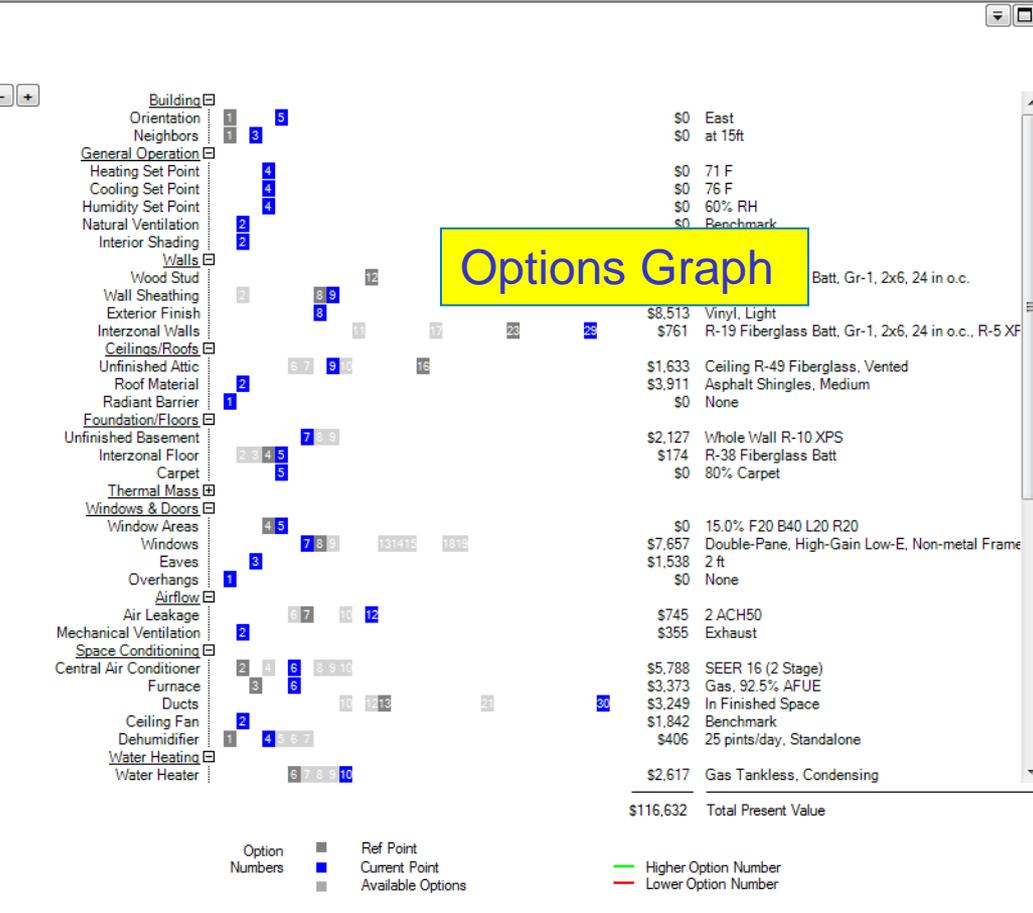
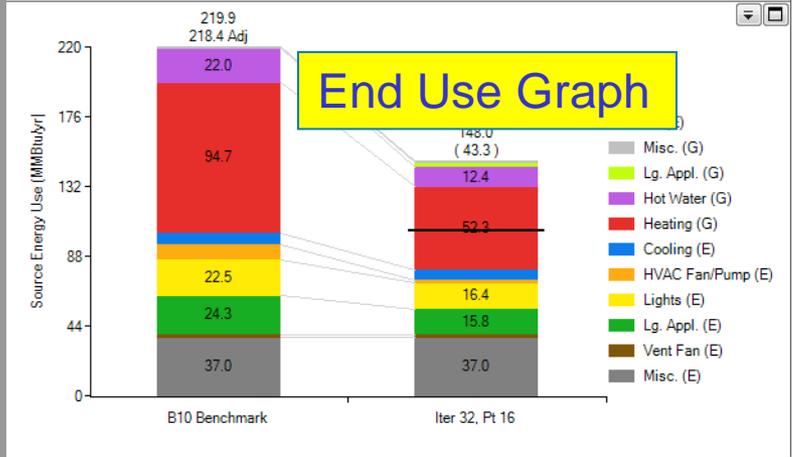
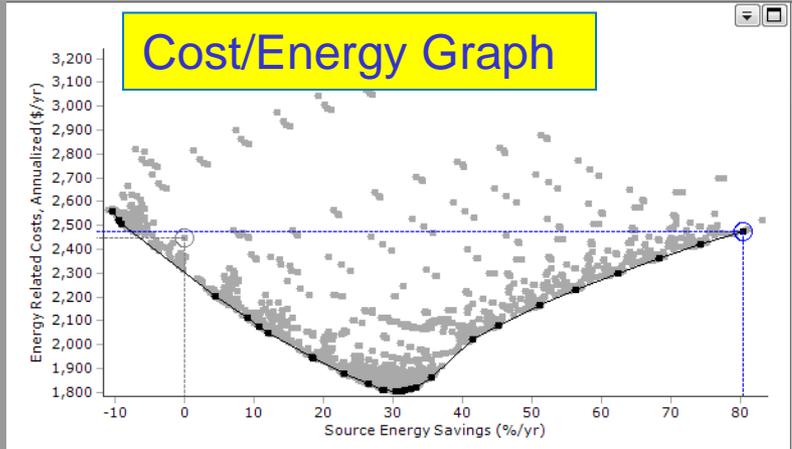
Wood stud walls are standard wood stud framed walls with cavity insulation.
When batt insulation must be compressed to fit within the cavity (e.g. R19 in a 5.5' 2x6 cavity), R-values reflect this effect.

Gr = Grade of batt installation quality (1, 2, or 3) as described in RESNET's "2006 Mortgage Industry National Home Energy Rating Systems Standards."

~1000 options (in ~100 categories)

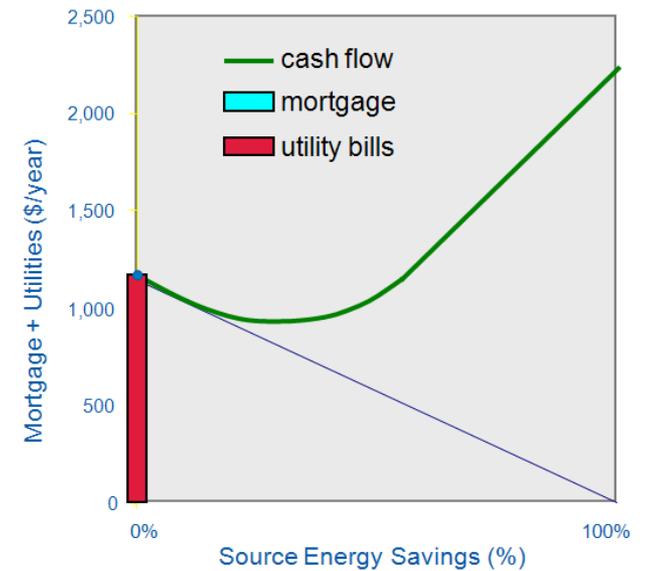
BEopt Output

results for multiple designs, selected individual designs

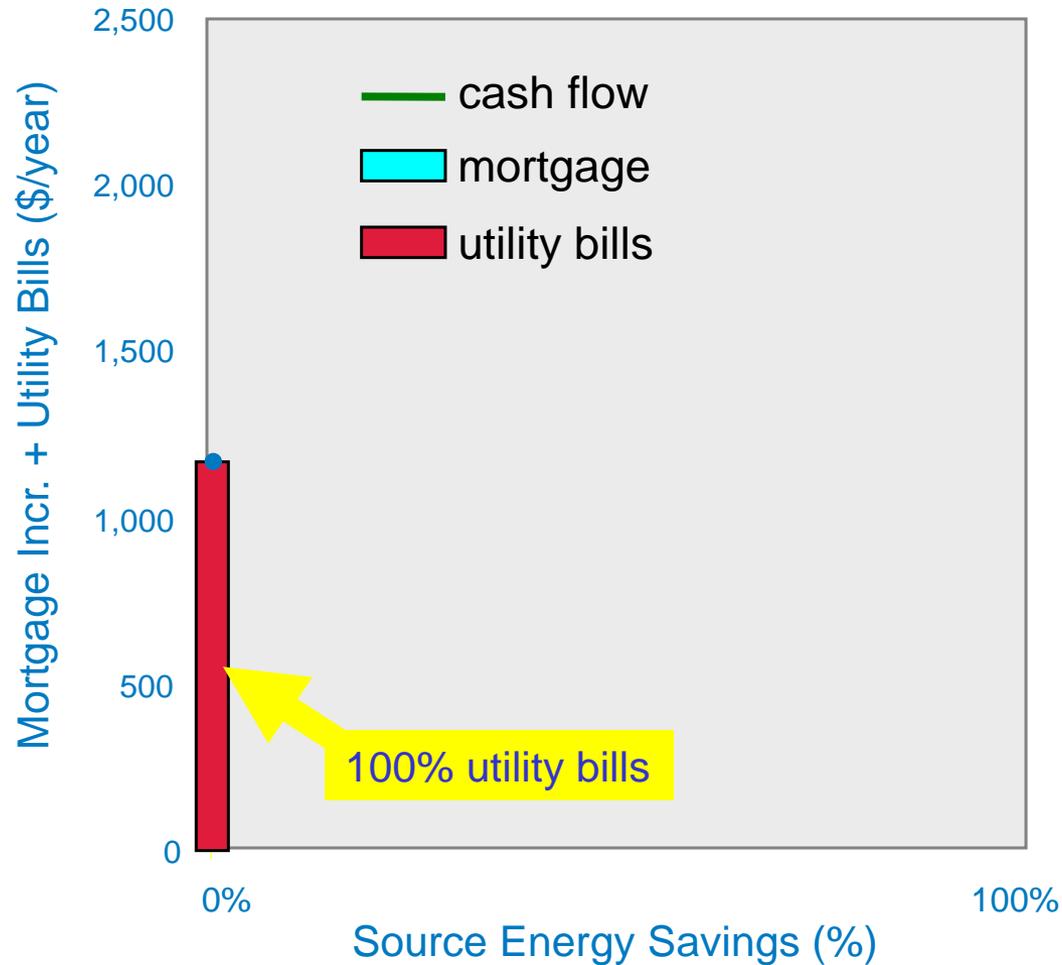


The Path to Zero Net Energy

Minimum-cashflow designs at various energy-savings levels



The Path to Zero Net Energy

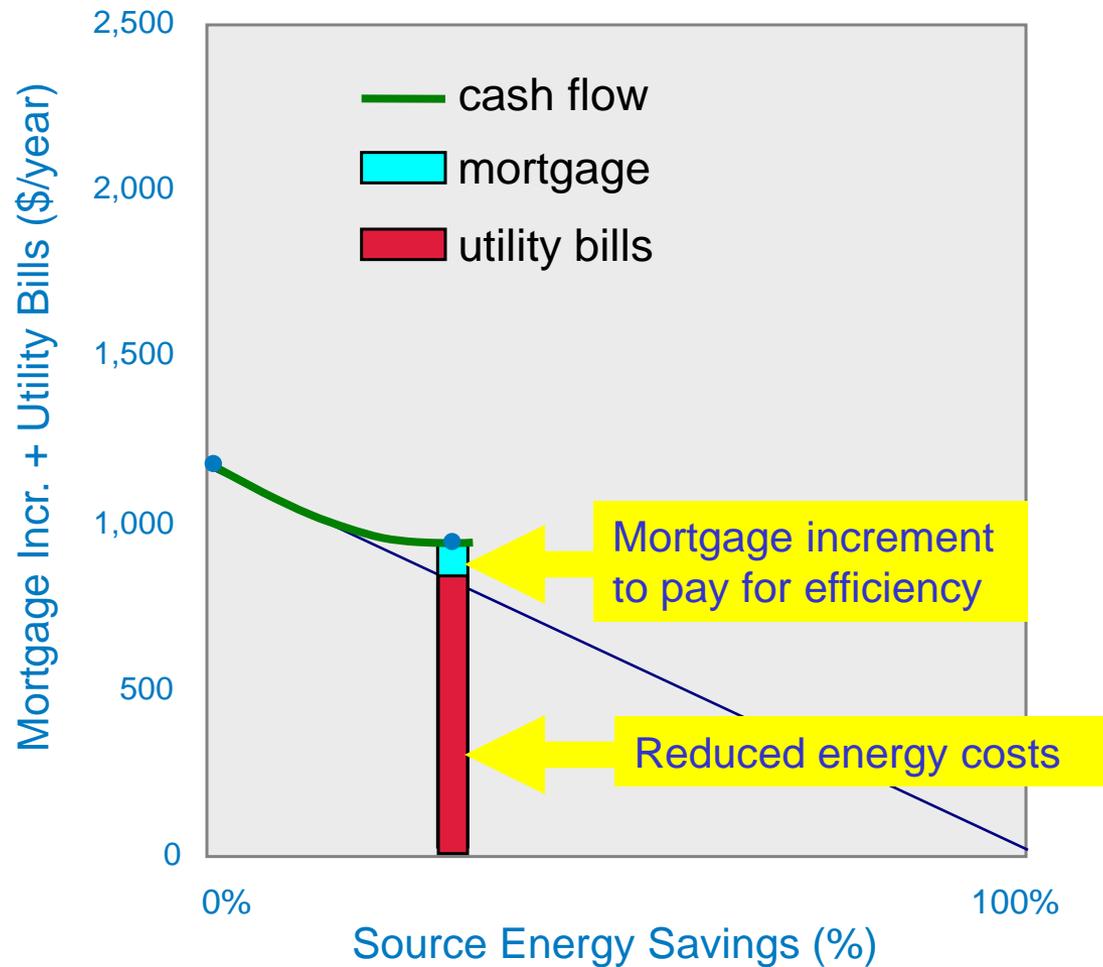


energy-related cash flow

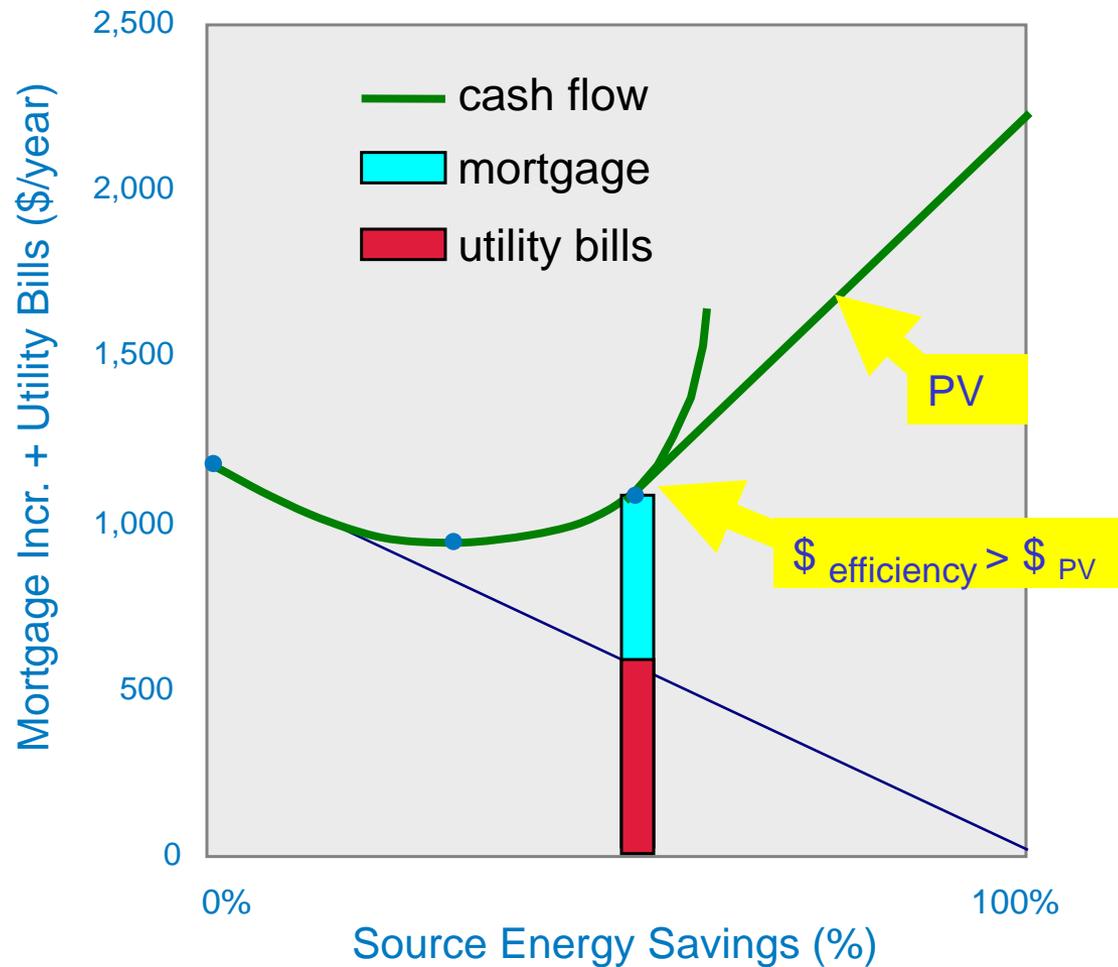
100% utility bills

energy savings relative to base

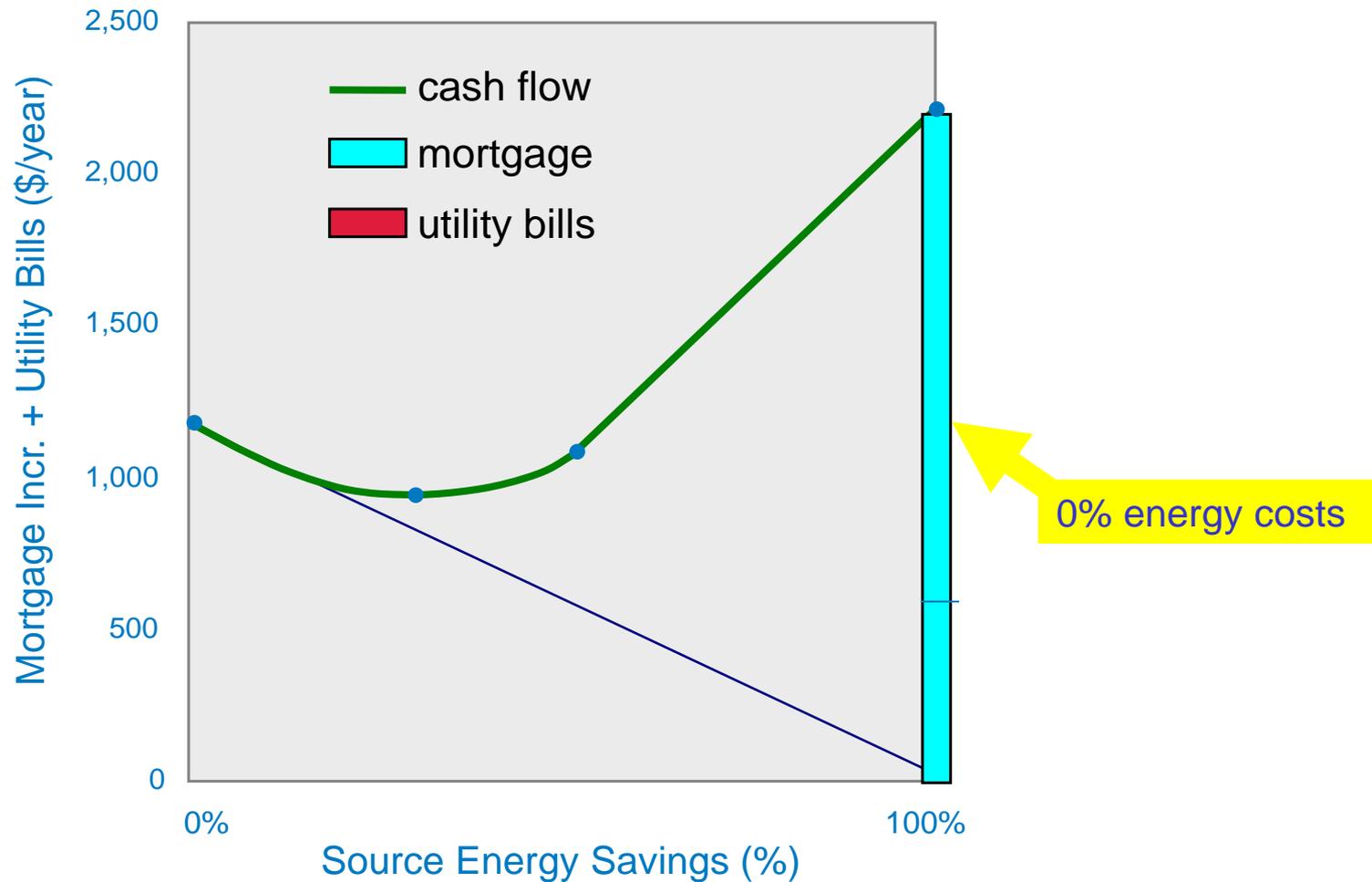
The Path to Zero Net Energy



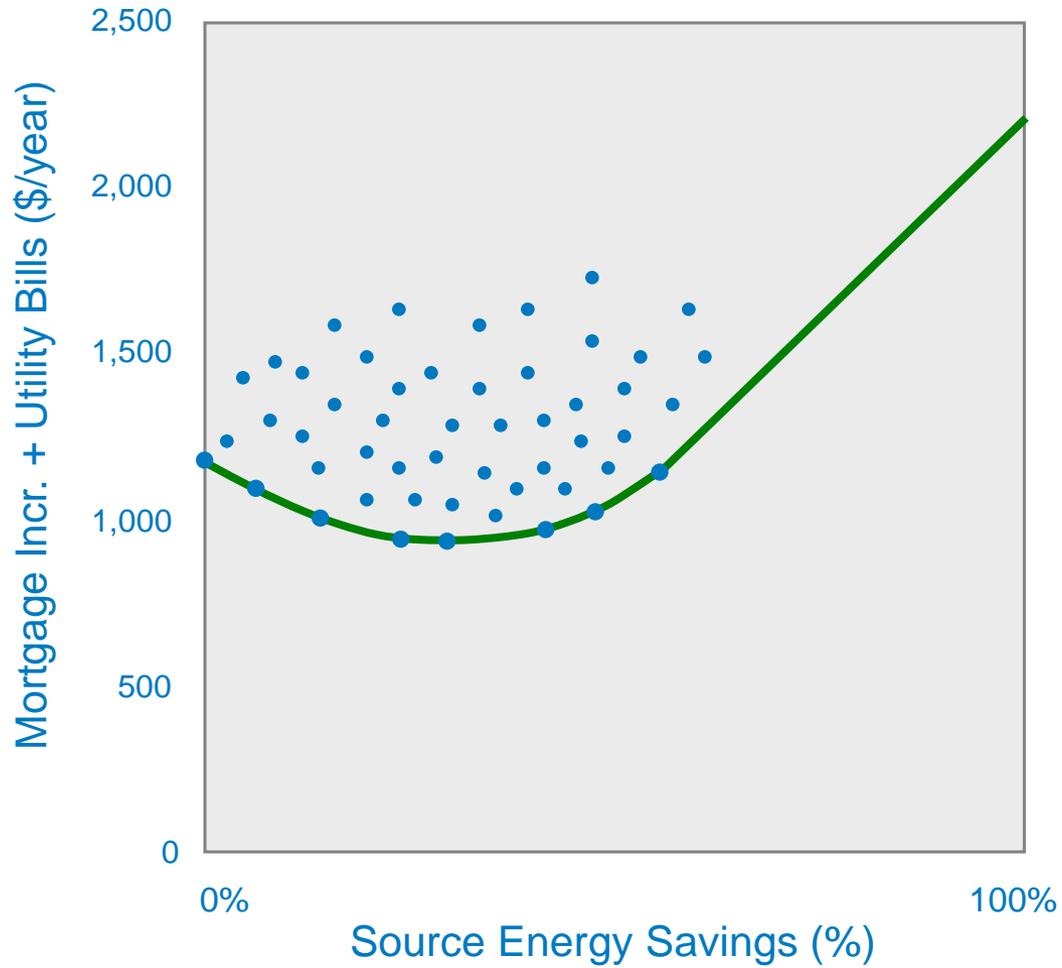
The Path to Zero Net Energy



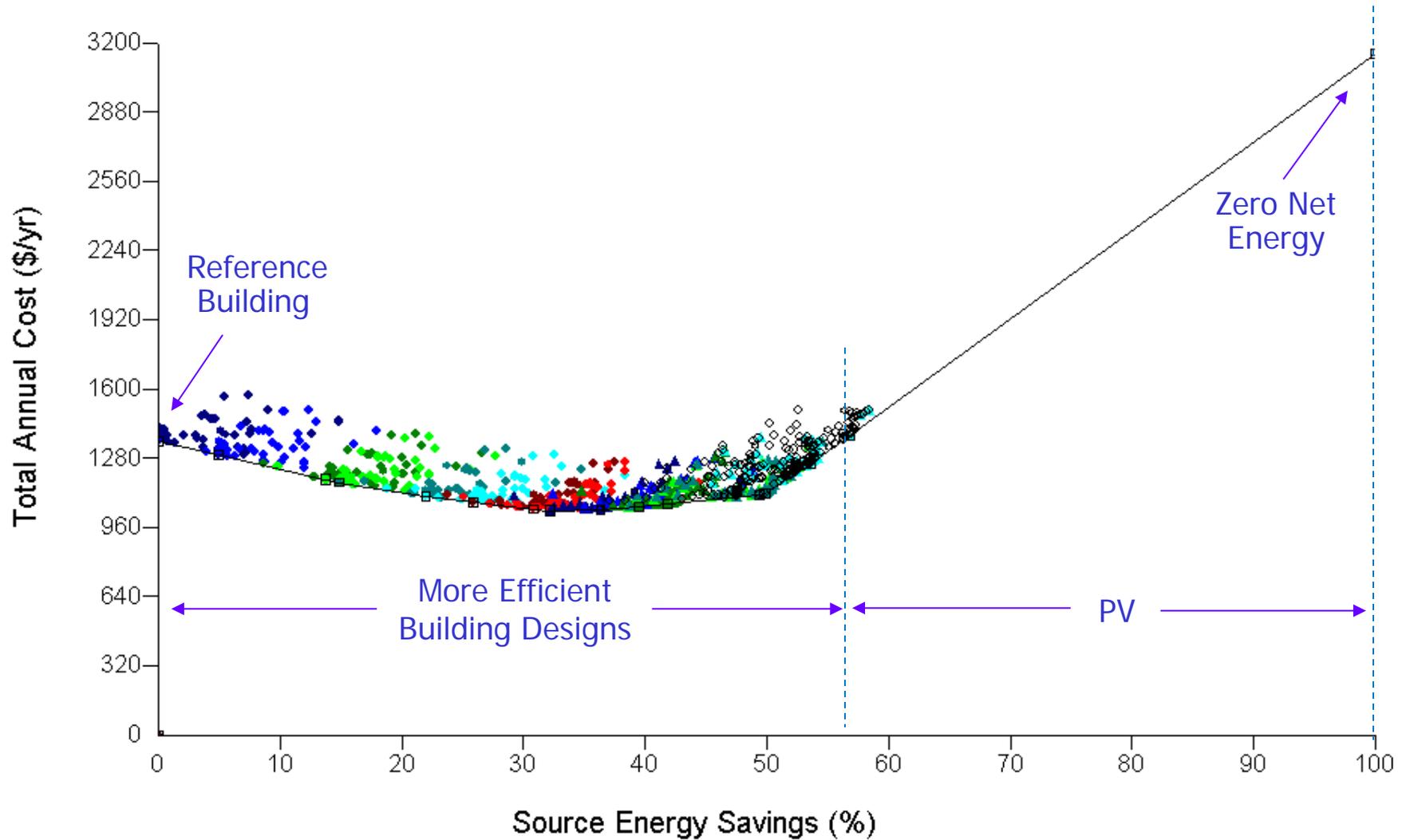
The Path to Zero Net Energy



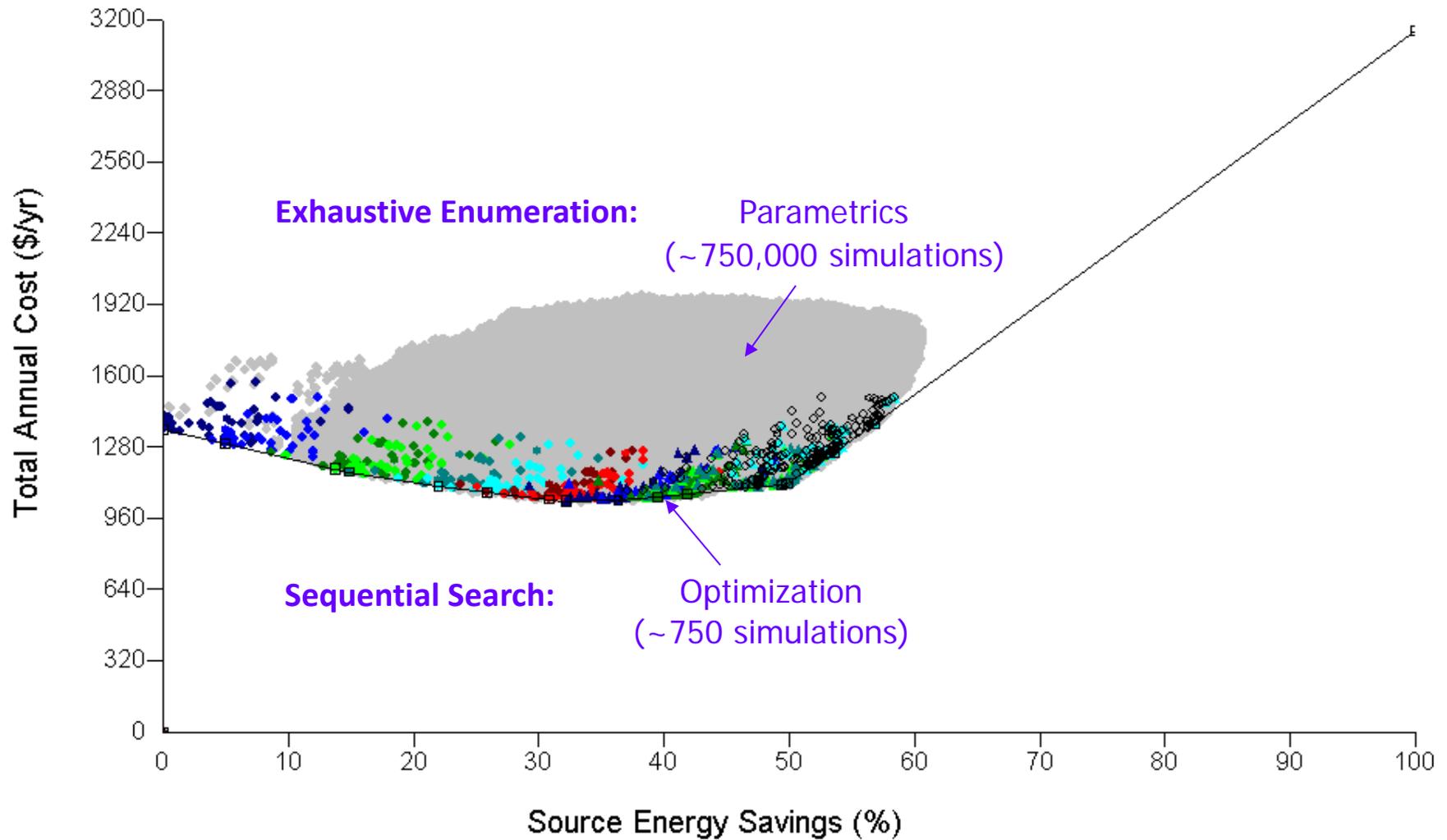
The Path to Zero Net Energy



Validation



Validation



BEopt Website – <http://beopt.nrel.gov>

The screenshot displays the BEopt website interface. At the top, the BEopt logo and NREL logo are visible. The navigation menu includes HOME, FEATURES, DOWNLOAD, FORUM, SUPPORT, and CONTACT US. A search bar and login/register options are also present.

Home

BEopt Version
The BEopt™ (efficiency pack)
BEopt can be used for energy sweeps, and
BEopt provides results as size, architecture, and equipment options
BEopt uses energy simulation software, as we

General Training Videos

Software Help

A series of training software, as we

[Single pdf file] [Open in a new window]

Basic

- Intro
- Background
- Quick
- General
- Geometry
- Options
- Site Information
- Output
- Miscellaneous

Forum

Contents | [Index](#)

Welcome to the BEopt forum. BEopt developers will monitor the forum and try to respond to questions as time allows, but all users are encouraged to participate in the discussions. You can also view the forum using the [flat forum view](#).

Please consider attaching your BEopt project file (*.BEopt) if you have a question specific to your analysis.

Publications

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

General

- Using the BEopt Automated Residential Simulation Test Suite to Enable Comparative Analysis Between Energy Simulation Engines (2014)
- 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 & Case Studies

- Kaupuni Village: A closer look at the first net-zero energy affordable housing community in Hawai'i (2012)
- Design and Evaluation of a Net Zero Energy Low-Income Residential Housing Development in Lafayette, Colorado (2012)
- A Method for Determining Optimal Residential Energy Efficiency Retrofit Packages (2011)
- Ducts in the Attic? What Were They Thinking? (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)
- Habitat for Humanity Zero Energy Home: A Cold-Climate Case Study for Affordable Zero Energy Homes (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)

About the Database

All Measures

- Airflow
- Ceilings/Roofs
- Foundation/Floors
- Lighting
- Major Appliances
- Miscellaneous
- Space Conditioning
- Walls
- Water Heating
- Windows & Doors

Application Developer Tools

- Change Log
- Data Dictionary
- XML File Download
- Simulation Protocols

Glossary

Help

Submit Comments

Submit Data

The National Residential Efficiency Measures Database is a publicly available, centralized resource of residential building retrofit measures and costs for the U.S. building industry.

With support from the U.S. Department of Energy, NREL developed this tool to help users determine the most cost-effective retrofit measures for improving energy efficiency of existing homes. Learn more [about the database](#).

By accessing the database, the user agrees to the [terms and conditions of use](#).

[View Data Now](#)

Supporting Resources

The following resources provide more information about the data and allow you to download the data.

- [Data dictionary](#)
- [XML file download](#)
- [Simulation Protocols](#)
- [Glossary](#)
- [Guide for Application Developers](#) 
- [Development Document](#) 

“The purpose is ... to provide a nation unified database of residential building retrofit measures and associated costs.”

Measures Database – What's Available

- **Building component engineering properties**
- **Performance levels of building components (IECC code, ENERGY STAR, Federal appliance standards)**
- **Lifetimes of components**
- **Average and range of material and labor costs**
- **Combinations of reasonable efficiency measures (i.e. improves efficiency, meets code and Federal standards)**

Measures Database – Example

Replace Furnace:

Before-Component	After-Component	Cost									
<p>Gas, 68% AFUE</p> <p>Properties:</p> <ul style="list-style-type: none"> • AFUE: 0.68 Btu/Btu • Fuel Type: gas • Max Supply Temp: 120.0 degrees F <p>Lifetime:</p> <ul style="list-style-type: none"> • 20 Years 	<p>Gas, 98% AFUE</p> <p>Properties:</p> <ul style="list-style-type: none"> • AFUE: 0.98 Btu/Btu • Fuel Type: gas • Max Supply Temp: 120.0 degrees F <p>Performance Standards:</p> <ul style="list-style-type: none"> • Exceeds Federal Standard 1992 • Exceeds Energy Star 2006 • Exceeds Federal Standard 2015 <p>Lifetime:</p> <ul style="list-style-type: none"> • 20 Years 	<p>Measure Cost</p> <table border="1"> <thead> <tr> <th data-bbox="1251 634 1398 679">Units</th> <th data-bbox="1398 634 1599 679">Range</th> <th data-bbox="1599 634 1760 679">Average</th> </tr> </thead> <tbody> <tr> <td data-bbox="1251 679 1398 725">\$/kBtuh</td> <td data-bbox="1398 679 1599 725">17 - 34</td> <td data-bbox="1599 679 1760 725">24</td> </tr> <tr> <td data-bbox="1251 725 1398 771">\$</td> <td data-bbox="1398 725 1599 771">680 - 1500</td> <td data-bbox="1599 725 1760 771">1100</td> </tr> </tbody> </table>	Units	Range	Average	\$/kBtuh	17 - 34	24	\$	680 - 1500	1100
Units	Range	Average									
\$/kBtuh	17 - 34	24									
\$	680 - 1500	1100									

Measures Database – Application

- Integrated in BEopt
- Data available as XML for software developers
- For more info visit <http://www.nrel.gov/ap/retrofits>

```
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  <tblAction>
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      <dEntryDate>2010-07-15</dEntryDate>
    </action>
    <action idActionTypeID="9" ActionID="712" idComponentTypeID="190">
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      <dEntryDate>2011-04-27</dEntryDate>
    </action>
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    </action>
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