BEopt Optimization Tool
National Residential Efficiency Measures Database

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beopt.nrel.gov
What is BEopt? (beopt.nrel.gov)

**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**

- **Tool Research and Model Dev.**
- **BEopt v1.0**
  - Development
  - **BEopt v2.0**

**2001 // 2010 // 2014**

**Partners**

- **CEC (FY08-FY09)**
  - BEopt w/Micropas

- **ARRA (FY10-11)**
  - Updated platform, batch simulations

- **CPUC (FY11-14)**
  - Retrofit analysis, utility cost effectiveness tests, incentives, etc.

- **CPS Energy (FY12)**
  - San Antonio analysis

- **BPA (FY13-14)**
  - EnergyPlus vs. SEEM validation

- **BPA (FY14)**
  - BEopt follow-on

- **BPA (FY15-16)**
  - BEopt/EnergyPlus model enhancements

- **CPUC (FY14-15)**
  - Multifamily
BEopt GUI

**Input**

- Geometry
- Site
- Options

**Output**

- Run
BEopt Input - Geometry

drawing tool for quick/accurate detailed building geometry
BEopt Input - Geometry

drawing tool for quick/accurate detailed building geometry
BEopt Input - Site

weather, financing, utility rates, incentives, etc.
BEopt Input - Options

~1000 options (in ~100 categories)
BEopt Output

Cost/Energy Graph

End Use Graph

Options Graph

results for multiple designs, selected individual designs
Minimum-cashflow designs at various energy-savings levels
The Path to Zero Net Energy

Source Energy Savings (%)

- 0% utility bills
- 100% utility bills
- Energy savings relative to base
- Energy-related cash flow

Mortgage Incr. + Utility Bills ($/year)

- Cash flow
- Mortgage
- Utility bills

1100
The Path to Zero Net Energy

Mortgage Incr. + Utility Bills ($/year)

Source Energy Savings (%)

- cash flow
- mortgage
- utility bills

Mortgage increment to pay for efficiency
Reduced energy costs
The Path to Zero Net Energy

Source Energy Savings (%)

- cash flow
- mortgage
- utility bills

Mortgage Incr. + Utility Bills ($/year)

$efficiency > $PV
The Path to Zero Net Energy

Source Energy Savings (%)

Mortgage Incr. + Utility Bills ($/year)

- cash flow
- mortgage
- utility bills

0% energy costs
The Path to Zero Net Energy
Validation

- Reference Building
- More Efficient Building Designs
- Zero Net Energy
- PV

- Graph showing Total Annual Cost ($/yr) vs. Source Energy Savings (%).
Validation

Exhaustive Enumeration: (~750,000 simulations)

Parametrics

Sequential Search:

Optimization (~750 simulations)

Source Energy Savings (%)

Total Annual Cost ($/yr)
BEopt Website – http://beopt.nrel.gov
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:

<table>
<thead>
<tr>
<th>Before-Component</th>
<th>After-Component</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas, 68% AFUE</strong></td>
<td><strong>Gas, 98% AFUE</strong></td>
<td><strong>Measure Cost</strong></td>
</tr>
<tr>
<td><strong>Properties:</strong></td>
<td></td>
<td>Units</td>
</tr>
<tr>
<td>• AFUE: 0.68 Btu/Btu</td>
<td>• AFUE: 0.98 Btu/Btu</td>
<td>$/kBtu</td>
</tr>
<tr>
<td>• Fuel Type: gas</td>
<td>• Fuel Type: gas</td>
<td></td>
</tr>
<tr>
<td>• Max Supply Temp: 120.0 degrees F</td>
<td>• Max Supply Temp: 120.0 degrees F</td>
<td></td>
</tr>
<tr>
<td><strong>Lifetime:</strong></td>
<td><strong>Lifetime:</strong></td>
<td></td>
</tr>
<tr>
<td>• 20 Years</td>
<td>• 20 Years</td>
<td></td>
</tr>
</tbody>
</table>

**Performance Standards:**
- Exceeds Federal Standard 1992
- Exceeds Energy Star 2006
- Exceeds Federal Standard 2015

<table>
<thead>
<tr>
<th>Measure Cost</th>
</tr>
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<tbody>
<tr>
<td>Units</td>
</tr>
<tr>
<td>$/kBtu</td>
</tr>
<tr>
<td>$</td>
</tr>
</tbody>
</table>
Measures Database – Application

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