# Better Buildings

# Energy Efficiency Cost-Effectiveness Tool (v2.0)

# Frequently Asked Questions


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# Frequently Asked Questions

**Contents**



## Question 1. What is the purpose of the tool and why was it created?

Cost-effectiveness analysis is a fundamental step in the design and evaluation of energy efficiency programs. For example, regulated utilities must demonstrate cost effectiveness to obtain program approval from the state public utility commission. However, the estimation of cost effectiveness can be complicated and there are few publicly available, transparent and user-friendly tools available for conducting this type of analysis. Further, they are not designed to address a reasonably full portfolio of residential programs. This tool seeks to fill this void.

This Excel-based tool supports the development and analysis of several common types of residential energy efficiency programs using industry-standard methods. Policy makers, regulators, utilities, energy efficiency program managers, architects and engineers may find the tool useful as a relatively simple platform for exploring savings opportunities; designing or scaling up programs; or testing scenarios, such as possible changes in fuel prices, measure costs or measure lifetimes. The user can build up a program based on up to five “project types” (or measures implemented) and identify the number of projects over a program cycle. The tool reports cost-effectiveness metrics of the program, including program budgets, and allows the user to conduct sensitivity analyses for key inputs.

## Question 2. How can the tool help me with my program design?

The tool assesses the cost effectiveness of an existing or proposed program from the perspective of various stakeholders, such as program participants, a utility or society at large. A user can alter the measures and their share in the overall measure mix to arrive at programs that are cost effective across multiple perspectives, target specific savings opportunities or address other market objectives. Users

also can adjust some of the inputs to test the robustness of program cost effectiveness to changes in avoided costs or financial assumptions. Once you have entered the required inputs in the tool, the tool will calculate information to help support energy efficiency initiatives including program funding.

### Question 3. What are avoided costs?

Avoided costs are the forecasted economic benefits of energy savings — the costs that would have been incurred if the energy efficiency activity had not been implemented.[1] For example, energy efficiency programs can avoid wholesale power purchases. Avoided costs are the foundation of energy efficiency program cost-effectiveness calculations.

Energy efficiency professionals who offer services such as energy audits, heating and air-conditioning system upgrades, and whole-home retrofits typically calculate how quickly utility bill savings would pay back the cost of the recommended energy efficiency measures. But in the context of energy efficiency programs funded by utility customers, the utility and its regulator or board need to understand the programs' cost effectiveness to the utility and all ratepayers, in addition to the participants.

### Question 4. What cost-effectiveness tests are used?

Cost-effectiveness tests calculate the costs and benefits of energy efficiency from different economic interests or "perspectives." Table 1 presents the five standard cost-effectiveness tests.

**Table 1. Five standard cost-effectiveness tests**

| Cost test | | Key question answered | Summary approach |
|---|---|---|---|
| Total Resource Cost | TRC | Will the total costs of energy in the utility service territory decrease? | Comparison of program administrator and customer costs to utility resource savings |
| Participant Cost Test | PCT | Will the participants benefit over the measure life? | Comparison of costs and benefits of the customer installing the measure |
| Utility/Program Administrator Cost Test | UCT/PACT | Will utility bills increase? | Comparison of program administrator costs to supply side resource costs |
| Ratepayer Impact Measure | RIM | Will utility rates increase? | Comparison of administrator costs and utility bill reductions to supply side resource costs |
| Societal Cost Test | SCT | Is the utility, state, or nation better off as a whole? | Comparison of society's costs of energy efficiency to resource savings and non-cash costs and benefits |

*Source: 2008 National Action Plan for Energy Efficiency guide to "Understanding Cost Effectiveness of Energy Efficiency Programs" and the California Public Utilities Commission's Standard Practice Manual.*

[1] The glossary provides a more detailed description: http://betterbuildingssolutioncenter.energy.gov/.

Each cost test is conducted using a set of benefits and costs. Table 2 lists the benefit and cost components for each test.

**Table 2. Costs and benefits by cost-effectiveness test**

| Cost/benefit parameter | TRC | PCT | RIM | PAC | SCT |
|---|---|---|---|---|---|
| Electricity avoided costs | Benefit | | Benefit | Benefit | Benefit |
| Natural gas avoided costs | Benefit | | Benefit | Benefit | Benefit |
| Societal non-energy benefits | | | | | Benefit |
| Installed equipment costs | Cost | Cost | | | Cost |
| Program administration costs | Cost | | Cost | Cost | Cost |
| Utility incentives/tax credits | | Benefit | Cost | Cost | |
| Federal incentive/tax credits | Benefit | Benefit | | | Benefit |
| Electric bill savings | | Benefit | Cost | | |
| Gas bill savings | | Benefit | | | |

## Question 5. What types of data inputs does the tool require?

Table 3 describes the types of information required for each cost-effectiveness test. Table 4 describes the specific inputs required for the cost-effectiveness test calculations.

**Table 3. Input information categories by type of cost-effectiveness test**

| Input type | TRC | PCT | RIM | PAC |
|---|---|---|---|---|
| Avoided cost | x | | x | X |
| Financial information | x | x | x | x |
| Incentives and credits to consumers | x | x | | x |
| Bill impacts | | x | x | |
| Retrofit cost information | x | x | | |
| Program information | x | | | x |
| Energy savings and impact information | x | x | x | x |

**Table 4. Specific inputs for cost-effectiveness calculations**

| Input type | Typical units | Potential data sources |
|---|---|---|
| **Utility avoided cost information** | | |
| Annual or seasonal energy cost projections, which can be specified for off-peak and on-peak periods | $/MWh | Utility, commission filings, market data |
| Generation, transmission and distribution capacity value | $/kW-year | Utility, commission filings, market data |
| Avoided natural gas and other fuel costs | $/therm | Utility, commission filings, market data |
| **Financial information** | | |
| Utility discount rates (nominal) | % | Utility, commission filings, market data |
| Inflation rate (used to convert real utility rate escalation into nominal escalation) | % | U.S. EIA, U.S. BEA |
| Participant discount rate | % | Reflects borrowing rates |
| Societal discount rate | % | Utility, commission filings |
| **Incentives & credits to consumers** | | |
| Utility, state, or federal upfront incentives or tax credits | $ | Utility or state energy office, DSIRE database |
| **Bill impact information** | | |
| Gas rates | $/therm | Utility |
| Electricity rates | $/kWh | Utility |
| Utility rate escalation (real) | %/year | Utility |
| **Retrofit cost information** | | |
| Gross measure cost for whole system retrofit | $ (total per home) | Program-specific |
| Individual measure cost (e.g., duct sealing) | $ per measure | Program-specific |
| Operating and maintenance | $ per measure | Program-specific |
| **Program information** | | |
| Administrative costs: overhead and G&A | $ (total for program) | Program-specific |
| Marketing and outreach costs | $ (total for program) | Program-specific |
| EM&V costs | $ (total for program) | Program-specific |
| Number of homes in program | -- | Program-specific |
| Net-to-gross information | 0 < NTG < 1 | Program-specific |
| **Energy savings and impact information** | | |
| Annual electricity savings per measure | kWh per year | * |
| Annual gas savings per measure | Therms per year | * |
| Measure life (how long savings are sustained) | Years | * |
| Shape of measure | Dimensionless | * |
| Percent gas savings (monthly) | % | * |

**Sources for energy savings include public reports, building energy simulation tools, measurement-based information, and savings estimates from other similar programs.*

## Question 6. Where can I find the data required by the tool?

The user guide for the cost-effectiveness tool provides information on potential data sources. Some of those suggestions for locating the inputs in Table 4 are augmented below.

Measure level energy savings and load shape information. The tool requires the user to enter annual energy savings (e.g., kWh per year) for a particular type of measure (e.g., lighting, duct sealing). The energy efficiency load shape information that the user enters defines how these savings are spread across different time periods over the year. The load shape is important because energy savings are more valuable when they avoid higher priced energy and also help avoid the construction of new distribution, transmission and generation infrastructure.

Many sources exist for these types of inputs. Ultimately, users must determine the best source for their purposes. For example, a recent evaluation and measurement report for utility energy efficiency programs may have this information. Other public sources include technical reference manuals[2] or databases such as California's Database for Energy Efficient Resources,[3] which presents estimated savings by measure or groups of measures. Similar sources often also contain measure costs, including installation costs.

The user may also estimate the savings using a building simulation tool, such as EnergyPlus[4] or an optimization program such as BEopt.[5] The challenge that the user may run into when entering this information is how to characterize a representative or "typical" savings level. The variability of savings of different measures can be significant based on such factors as operating hours, structure type and climate. But the primary purpose of the cost-effectiveness tool is program design, not to tell a specific homeowner what their energy savings will be for a specific building. The tool is designed to deliver a higher level analysis, rather than site-specific engineering or feasibility analysis.

The tool contains preloaded 8,760 hourly load shapes, based on shapes obtained from California public sources. Users can define their own load shapes using a simulation tool, for example, and can enter these customized shapes into the cost-effectiveness tool.

Utility data, including avoided costs, discount rates and cost of capital. This information is available from the utility or, for regulated utilities, the state commission that oversees them. Example documents with this information include recently submitted utility filings for energy efficiency programs, integrated resource plans, or general rate case proceedings that address the utility's cost of capital. A benefit of using these sources is that they represent the utility's assessment of its costs, so your analysis will use the same inputs the utility uses.[6]

Another option is to use market data. For example, on- and off-peak avoided energy costs can be obtained from published market data, such as ICE Futures. The U.S. Energy Information Administration publishes long-term estimates of future natural gas costs. In regions with restructured electricity

[2] See forthcoming report by Berkeley Lab for the SEE Action Network, *Guidance on Establishing and Maintaining Technical Reference Manuals for Energy Efficiency Measures*, http://www4.eere.energy.gov/seeaction/.
[3] www.deeresources.com
[4] http://apps1.eere.energy.gov/buildings/energyplus/
[5] http://beopt.nrel.gov/
[6] For Connecticut, for example, the Conservation Load Management Program is a useful source: http://www.ctenergyinfo.com/2013_2015_CLM%20PLAN_11_01_2012_FINAL.pdf. In California, E3 prepares 8,760 hourly avoided cost data: http://ethree.com/public_projects/cpuc4.php.

markets that include capacity markets, published auction data can be used for the value of generation. Elsewhere, costs for a new combined-cycle natural gas power plant can be used. T&D capacity value is not always reported in utility filings for energy efficiency programs. These values are utility-specific, but typical values range from $30-$40/kW-year. Some states use published T&D capacity values from other utilities. If the goal is to develop a rough estimate of T&D values, using published sources from other utilities may be close enough.

Utility discount rates also are utility-specific. The same sources that provide information on utility avoided costs will typically contain utility discount rates. Typically, real discount rates range from 5 percent to 6 percent (excluding inflation). This term may be referred to as the *weighted average cost of capital (WACC)*. The user should be careful to understand whether they are looking at the discount rate in nominal or real terms, adjust as needed and enter into the cost-effectiveness tool appropriately. (The tool requires nominal discount rates.)

## Question 7. How might I suggest the resulting residential program or portfolio to a partner utility or regulatory commission?

Ultimately, this question is unique to each utility and commission. You are the best judge of how to effectively make your proposal to stakeholders. However, here are a few suggestions for developing your strategy:

- Understand existing energy efficiency program offerings, particularly as they relate to the residential submarkets that you are targeting and how your program might complement or improve upon existing offerings.
- Keep the dual role between the utility and commission in mind: The utility formulates and implements programs; the commission considers the program funding request, the alignment of the portfolio with public policy and the degree of equity in the savings opportunities available across customer classes, among other issues.
- Provide a background memo about your program – e.g., anticipated number of measures installed each year, number of projects completed, energy and bill savings achieved, etc.

### Further Reading

The State and Local Energy Efficiency Action (SEE Action) Network and its predecessor, the National Action Plan for Energy Efficiency – two initiatives involving utilities, regulators and other stakeholders and facilitated by the U.S. Department of Energy and the Environmental Protection Agency — provide a useful set of information on energy efficiency program design, funding, and implementation and evaluation.

The following guides may be particularly helpful:

*Guide to resource planning with energy efficiency*
*http://www.epa.gov/cleanenergy/documents/suca/resource_planning.pdf*
*Understanding cost effectiveness of energy efficiency programs*
http://www.epa.gov/cleanenergy/documents/suca/cost-effectiveness.pdf
*Energy efficiency program best practices*
http://www.epa.gov/cleanenergy/documents/suca/napee_chap6.pdf