ACEEE Topic Brief
American Council for an Energy-Efficient Economy

Cost-Effectiveness Tests: Overview of State Approaches to Account for Health and Environmental Benefits of Energy Efficiency

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Energy Efficiency's Health and Environmental Benefits

The value of utility demand-side energy efficiency programs extends beyond energy savings. Although efficiency has multiple benefits, states fail to include or undervalue many of the nonenergy benefits that accrue to utilities, program participants, and society when evaluating cost effectiveness. Some of the most significant omissions are the health and environmental benefits that energy efficiency generates. These include the avoided cost of utilities' compliance with environmental regulations, improved air quality and other benefits to the environment, better public health, and the improved health of program participants. Even though utilities may feature environmental and health benefits in their marketing, innovative programs that have these benefits are less likely to be implemented if cost-effectiveness tests do not take them into account.

Avoided Utility Environmental Compliance Costs

Utilities incur costs when complying with state and federal environmental regulations. These can originate at the state or federal level and may seek to limit criteria pollutants, greenhouse gas emissions (GHGs), toxins, and water effluents and use (Woolf et al. 2017). Some of these regulations allow power plants to submit tradable permits or "allowances" to comply with market-based cap-and-trade programs that reduce air pollution. Others may require the installation of particular pollution control technologies. By reducing energy consumption, efficiency programs reduce pollution and may result in avoided compliance costs for sulfur dioxide (SO_2), nitrogen oxide (NOx), and carbon dioxide (CO_2) (Lazar and Colburn 2013).

Societal Environmental Benefits

By reducing the need to generate, transmit, and distribute electricity, energy efficiency brings additional value above and beyond the environmental benefits of utility compliance. Fossil-fueled power plants emit a long list of air pollutants that can be toxic to animals, plants, fish, and birds. They also contribute to climate change and harm water quality and aquatic systems (UCS 2017). Coal ash ponds, coal mining, and nonconventional natural gas production are other examples of activities causing environmental harm that energy efficiency can curtail by avoiding the need to burn fossil fuel (EIA 2018; EPA 2018b).

Societal Health Benefits

Environmental harms, including the amount of pollution in the air, are directly linked to negative impacts on public health. Power plants emit mercury, particulates (PM_{10} and $PM_{2.5}$), ground-level ozone (smog), and CO_2. Each of these pollutants takes a toll on public health. The improvements in air quality that energy efficiency provides reduce the frequency and severity of public health harms (ACEEE and PSR 2015). For example, efficiency helps avoid the

incidences and costs of hospital admissions, premature deaths, respiratory and cardiac illnesses, and missed work days (Hayes and Kubes 2018).

PARTICIPANT HEALTH BENEFITS

Energy efficiency programs can have direct impacts on participants' health and safety by improving indoor environments. Poorly sealed building envelopes make it easier for pests and moisture to infiltrate; both can harm respiratory health through mold growth and the introduction of allergens and disease. Leaky windows and poor insulation can lead to drafts and extreme temperature variations in a home during summer and winter months; these can trigger asthma attacks and exacerbate other respiratory illnesses (Denson and Hayes 2018). Efficiency measures can help avoid medical and hospital costs for conditions like thermal stress and asthma attacks (E4TheFuture 2016). They can also mitigate symptoms of other respiratory illnesses such as chronic obstructive pulmonary disease (COPD) and bronchitis. Program participants can realize even greater health benefits when energy efficiency measures are paired with heath interventions.

Overview of Cost-Effectiveness Tests

States have been calculating the costs and benefits of utility-administered energy efficiency programs for decades. Table 1 lists the most widely used cost-effectiveness tests as described in the California Standard Practice Manual (CPUC 2011). It indicates where various types of health and environmental benefits could theoretically be included in these tests; in practice, states often do not include them.

Table 1. Health and environmental benefits that could be included in traditional cost-effectiveness tests

Cost-effectiveness screening test	Costs and benefits included	Avoided utility environmental compliance costs	Societal environmental benefits	Societal health benefits	Participant health benefits
Total Resource Cost (TRC) Test	Costs and benefits to utility system and impacts on program participants	✓			✓
Societal Cost Test	TRC Test impacts plus impacts on society	✓	✓	✓	✓
Utility/Program Administrator Cost Test (UCT)	Costs and benefits that affect utility system operation and provision of electric and gas services to customers	✓			
Participant Cost Test	Costs and benefits to program participants				✓
Rate Impact Measure (RIM)	UCT costs and benefits plus estimates of utility lost revenues created by energy efficiency programs	✓			

Source: Woolf et al. 2017, summarized from Appendix A.

In addition to the traditional cost-effectiveness tests, the National Standard Practice Manual (NSPM) developed in 2017 describes a new, more policy-focused approach to cost-effectiveness analysis (Woolf et al. 2017). Included in the NSPM is the Resource Value Framework, a set of core principles and a systematic process that jurisdictions can use to develop their own primary cost-effectiveness tests. It lays out a process that states and others can follow to incorporate their policy objectives into cost-effectiveness testing, including, where appropriate, energy efficiency's health and environmental benefits.

State Approaches

A number of states have incorporated health and environmental benefits in their cost-effectiveness tests to some extent.[1] They vary in the types of benefits and values they include and the methods they use to estimate these benefits. Some monetize the value of health and environmental benefits based on jurisdiction-specific studies or estimates from other utilities or jurisdictions. Others substitute proxies for monetized values. Proxies can take the form of a percentage adder applied to monetized benefits, a savings multiplier (e.g., $/MWh), a customer adder ($/customer), or a measure multiplier ($/measure). States can also use other substitute methods to inform cost-effectiveness decisions when impacts are difficult to put into monetary terms or to address through proxies; these include quantitative and qualitative information, alternative thresholds, and sensitivity analyses (Woolf et al. 2017). Figure 1 shows the states we have been able to identify that incorporate health and environmental benefits into their cost-effectiveness tests.

[1] Several states are in the process of updating cost-effectiveness practices, including the treatment of health and environmental benefits. These ongoing updates are not reflected in this research.

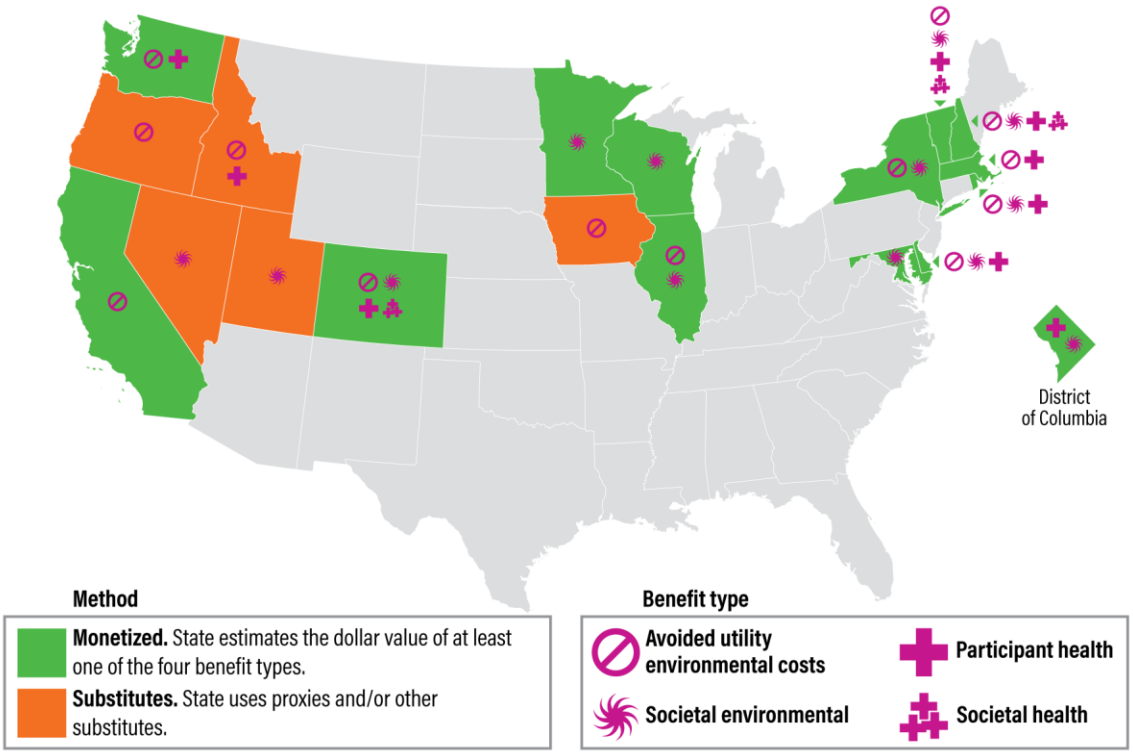

Figure 1. States that account for health and environmental benefits in cost-effectiveness tests

Table 2 below presents the states we have identified that account for health and environmental benefits using various approaches, methods, and primary tests. Out of the 19 states we researched, 13 accounted for avoided environmental compliance costs, 13 for societal environmental benefits, 9 for participant health benefits, and 3 for societal health benefits. Most of the 19 states rely on the Total Resource Cost or the Societal Cost Test for their primary test. Every state that includes environmental benefits—either utility or societal—uses avoided emissions as the primary environmental factor, with most states monetizing these benefits. While nine states account for particular participant health impacts, only three monetize them. Societal health benefits are usually adduced in general without being specified, and all three of the states that account for these impacts estimate them through a proxy rather than monetizing them.

Opportunities

While the states included in table 2 account for a variety of health and environmental benefits, we recommend several strategies to increase the inclusion of these impacts.

Take advantage of existing cost-effectiveness tests and develop new ones. States should more fully account for health and environmental benefits in cost-effectiveness testing. All traditional cost-effectiveness tests allow for the inclusion of at least one category of health and environmental benefits, but states still are not including them. Even though actual values may be jurisdiction-specific, states should take advantage of the full potential of existing tests. States can also draw on the NSPM to incorporate their policy objectives into a systematic process, including health and environmental benefits where appropriate.

Quantify more of the health benefits. To more fully account for the health impacts of energy efficiency, states can quantify the societal health benefits of avoided emissions, including reductions in premature deaths, respiratory and cardiac illnesses, hospital admissions, and missed work days. Most states that account for health benefits rely on a proxy rather than monetizing the benefits. As Massachusetts did, they can help quantify these benefits by conducting jurisdiction-specific studies, or they can rely on studies from other jurisdictions.[2] These studies can account for variability in the efficiency measures offered, the condition of buildings, the health and welfare of program participants, and weather patterns that transport pollutants harmful to public health. Several tools are also available to help states monetize avoided health harms.[3] Where monetization is not possible, using proxies and other methods is preferable to assuming these benefits do not exist at all.

Build on existing resources and conduct further research. Existing resources provide a framework for quantifying health and environmental benefits. These include the jurisdiction-specific studies that several states have conducted and the methods that states are already using to include health and environmental benefits in their cost-effectiveness tests. However additional research is needed to better account for the variety of benefits across jurisdictions and customer types.

[2] Wilson et al. (2016) summarize the findings from 40 studies that assess the health and environmental impacts of energy efficiency to building occupants.

[3] See EPA's AVoided Emissions and geneRation Tool (AVERT) (www.epa.gov/statelocalenergy/avoided-emissions-and-generation-tool-avert), CO-Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool (www.epa.gov/statelocalenergy/co-benefits-risk-assessment-cobra-health-impacts-screening-and-mapping-tool), and Environmental Benefits Mapping and Analysis Program: Community Edition (BenMAP-CE) (www.epa.gov/benmap).

State by State Details

Table 2. Health and environmental benefits in cost-effectiveness tests by state

State	· Primary test · Assessment level	Avoided utility environmental compliance costs		Societal environmental and/or public health benefits		Participant health benefits	
		Method	Value and impacts included	Method	Value and impacts included	Method	Value and impacts included
California	TRC Portfolio	Monetized	CO_2, NOx, and particulate matter (PM_{10}).		N/A		N/A
Colorado	State-specific, modified TRC Program	Monetized and proxy	Avoided CO_2, SO_2, and NOx emissions. See most recent Electric Resource Plan for values.	Proxy	10% adder applied to sum of other quantifiable benefits for electric and 5% adder for gas.	Proxy	10% adder applied to sum of other quantifiable benefits for electric, 5% adder for gas
District of Columbia	SCT Portfolio		N/A	Monetized	Electric externality value of $0.0477764/kWh. 5% adder may be applied to utility benefits if calculating nonenergy benefits is excessively expensive. Environmental externalities include air and water pollution, greenhouse gas emissions, and cooling water use.	Proxy	Adder equal to 5% of the utility benefits may be used if calculating nonenergy benefits is excessively expensive. Impacts include health and safety, and reduced work absences.
Delaware	TRC Program	Monetized	Avoided environmental compliance costs, where such costs can be directly tied to changes in energy use.	Quantitative and qualitative	Utilities address in their plans. Based on low end of avoided costs for NOx and SO_2 from DPL IRPs (2012 and 2014) and reported PJM emissions rates for 2014–2015, emissions de-rated by 75%, and inflated to 2016$. Does not include compliance costs for NOx/SO_2.	Monetized	$182 per home (annual) applied to low-income weatherization programs. Participant health and safety benefits do not include avoided death value. Based on national WAP evaluation that includes occupant survey of random sample of weatherized single-family homes pre- and post-weatherization vs. comparison group.

State	· Primary test · Assessment level	Avoided utility environmental compliance costs		Societal environmental and/or public health benefits		Participant health benefits	
		Method	Value and impacts included	Method	Value and impacts included	Method	Value and impacts included
Idaho	UCT, TRC	Proxy	Utilities use 10% conservation benefit adder to calculate cost effectiveness of DSM programs including low-income weatherization programs.		N/A	Proxy and quantitative and qualitative	Combine more readily quantifiable nonenergy benefits (e.g., health, safety, and repair measures) with 10% adder for hard-to-measure nonenergy benefits. Likely underestimates value of health, safety, and repair measures. Provides transparent one-to-one ratio of benefits to investments. Only included in TRC. Utilities can claim $1 of nonenergy benefits for each dollar of federal funds invested in health, safety, and repair measures.
Illinois	TRC Portfolio	Monetized	Most recent utility plans include reasonable estimates of financial costs likely to be imposed by future regulations and legislation on emissions of greenhouse gases.	Monetized	See most recent utility plans and reports for values. Ameren IL 2018–2021 plan includes value of $16.50 per MWh in 2016 dollars. Accounts for environmental impacts from CO_2.		N/A
Iowa	SCT Portfolio, program, project, measure	Proxy	10% externality factor applied to avoided capacity costs for electric and 7.5% for natural gas. Utility may propose a different externality factor but must document its accuracy (none have to date).		N/A		N/A
Maryland	TRC, SCT Sub-portfolio		N/A	Monetized	Quantify business-as-usual valuation of nonenergy avoided air emissions (CO_2, NOx, SO_2) benefits with value of $0.002/kWh for SCT.		N/A

State	· Primary test · Assessment level	Avoided utility environmental compliance costs		Societal environmental and/or public health benefits		Participant health benefits	
		Method	Value and impacts included	Method	Value and impacts included	Method	Value and impacts included
Massachusetts	TRC Program	Monetized	Refer to most recent regional study for values. Avoided costs used are according to AESC 2018 report, including cost of complying with Regional Greenhouse Gas Initiative (RGGI), NOx and SO_2 reduction policies, and state environmental rules.		N/A	Monetized	See most recent Statewide TRM for list of values. Measures avoided costs associated with health-related impacts resulting from installed measures. Includes asthma, cold- and heat-related thermal stress, missed days of work, deaths, and fire damage.
Minnesota	SCT Customer segment		N/A	Monetized	Environmental damages include SO_2, particulates, carbon monoxide, N_2O, lead, and CO_2. See utility-specific reports for environmental damage costs by location, including urban, metropolitan fringe, and rural. Values include federal Social Cost of Carbon (SCC).		N/A
Nevada	TRC Program		N/A	Proxy	10% adder applied to SCT accounts for indirect benefits such as those arising from avoided environmental externalities such as emissions.		N/A

State	· Primary test · Assessment level	Avoided utility environmental compliance costs		Societal environmental and/or public health benefits		Participant health benefits	
		Method	Value and impacts included	Method	Value and impacts included	Method	Value and impacts included
New Hampshire	TRC Program	Monetized	Cost of carbon compliance included in Synapse's 2015 AESC Update avoided cost values.	Proxy	Part of 10% adder may include societal environmental and public health benefits.	Proxy	Part of 10% adder includes improved health benefits for participants. In absence of state-specific nonenergy impact evaluations, proposed adder based on evidence of neighboring states' NEIs as % of total benefits of energy efficiency portfolios, neighboring states' NEI evaluations, and adder levels.
New York	SCT (Total Resource Cost plus CO_2 damage costs) Portfolio	Monetized	Avoided compliance costs of RGGI and SO_2 and NOx cap-and-trade markets reflected in locational-based marginal price (LBMP).	Monetized	Environmental externalities include CO_2. Value of avoided CO_2 based on Clean Energy Standard Tier 1 Renewable Energy Credit (REC) price or federal SCC net of RGGI clearing price. Utilities include SO_2 and NOx externalities to extent they are greater than reflected in LBMPs. To date, none have included.		N/A
Oregon	TRC Program	Proxy	Compliance with potential future state carbon policies in addition to 10% adder. Values vary by utility.		N/A		N/A

State	· Primary test · Assessment level	Avoided utility environmental compliance costs		Societal environmental and/or public health benefits		Participant health benefits	
		Method	Value and impacts included	Method	Value and impacts included	Method	Value and impacts included
Rhode Island	State-specific Portfolio	Monetized	Utility system costs associated with reasonably anticipated future state, regional, and federal greenhouse gas reduction requirements for electric and gas programs. May also include costs and benefits of other emissions and their generation or reduction through Least Cost Procurement. Values included in AECS 2018 study.	Monetized	SCC that is not embedded in projected energy market prices. Refer to most recent regional study for details.	Monetized	Health benefits include fewer colds and viruses, improved indoor air quality and ease of maintaining healthy relative humidity from weatherization included in TRM.
Utah	UTC, TRC		N/A	Proxy	10% adder to benefits to account for non-quantified environmental and nonenergy benefits of conservation resources over supply-side alternatives. PacifiCorp performs TRC test with and without adder.		N/A
Vermont	SCT Portfolio	Monetized	Societal Cost Test uses environmental compliance and externality values from Synapse's 2015 AESC Study. Externality values not used for TRC or UCT tests. Value is estimated at $100/ton of CO_2. Estimated marginal cost of carbon emissions abatement associated with RGGI.	Monetized and proxy	Environmental costs included in AESC 2018 study. Societal health benefits included in 15% benefits adder.	Proxy	15% adder to account for participant health impacts. Considered to be at low end of appropriate set of values for this adjustment since it almost certainly underestimates full range of impacts.

State	· Primary test · Assessment level	Avoided utility environmental compliance costs		Societal environmental and/or public health benefits		Participant health benefits	
		Method	Value and impacts included	Method	Value and impacts included	Method	Value and impacts included
Washington	TRC Measure	Monetized	Social cost of carbon. See recent utility plans for values.		N/A	Alternative thresholds	Measures identified through Weatherization Manual priority list are considered cost effective. Utilities may fully fund repairs, administrative costs, and health and safety improvements associated with cost-effective low-income conservation measures. Utilities may exclude low-income conservation from portfolio-level cost-effectiveness calculations. See recent utility plans for values.
Wisconsin	State-specific Portfolio		N/A	Monetized	Value of emissions avoided through program, including carbon dioxide, sulfur oxides, and nitrogen oxides. See evaluation report for specific values. SO_2 and NOx allowance price values from Cross-State Air Pollution Rule. CO_2 valued at $15/ton. EPA AVERT used for emissions estimates for electric.		N/A

Sources: **California** Policy: CPUC 2017; Value: CPUC 2018, InTech Energy 2018; Method: CPUC 2013. **Colorado** Policy: Colorado General Assembly 2017, CO PUC 2017; Value: Public Service Company of Colorado 2016b, CO PUC 2008; Method: Public Service Company of Colorado 2018, 2016a. **District of Columbia** Policy: VEIC and DC DOEE 2017; Value: VEIC and DC DOEE 2017, Tetra Tech 2017; Method: Exeter Associates 2014. **Delaware** Policy: DE DEC 2017, DE EEAC 2018, DE SEU 2017; Value: Exeter Associates 2014, Hawkins et al. 2016, DE EEAC 2018; Method: Exeter Associates 2014, PJM 2016, DPL 2014. **Idaho**: Policy: ID PUC 2013, Northwest Power and Conservation Council 2010; Value: Idaho Power 2018, Rocky Mountain Power 2018a. **Illinois** Policy: Illinois General Assembly 2017; Value: Navigant 2018, ComEd 2017, Ameren 2017; Method: EIA 2016, EPA 2016. **Iowa** Policy: Iowa Administrative Code 2010; Value: Iowa Utilities Board 2018. **Maryland** Policy: MD PSC 2015; Value: Itron 2014; Method: Itron 2014. **Massachusetts** Policy: MA DPU 2013; Value: Synapse 2018, MassDEP 2018, MA PA 2015, MA PA 2018, Mass Save 2017; Method: Synapse 2018, Hawkins et al. 2016. **Minnesota** Policy: Minnesota State Legislature 2018; Value: MN PUC 2018, Xcel Energy 2018; Method: MN PUC 2018, EPA 2016. **Nevada** Policy: Nevada State Legislature 2017; Value: NV Energy 2018. **New Hampshire** Policy: NH Electric Utilities 2007, NH PUC 2018, NH PUC 2017; Value: New Hampshire's Electric and Natural Gas Utilities 2017; Method: Hornby et al. 2016. **New York** Policy: NY PSC 2016; Value: NYS DPS 2018, NYISO 2018; Method: NYISO 2018, EPA 2016, NYSERDA 2018. **Oregon** Policy: OR PUC 1993, OR PUC 1994, Energy Trust of Oregon 2017a; Value: OR PUC 2008, Energy Trust of Oregon 2011, Malmgren and Skumatz 2014; Method: Energy Trust of Oregon 2017b. **Rhode Island** Policy: RI PUC 2018;

Value: RI PUC 2017, National Grid 2018; Method: Hornby et al. 2015, Synapse 2018, Hawkins et al. 2016, NMR Group and Tetra Tech 2011. **Utah** Policy: UT PSC 2009, Northwest Power and Conservation Council 2010; Value: Rocky Mountain Power 2018b. **Vermont** Policy: VT PSB 2015; Value: VT PSB 2017, VT PSB 2015, Synapse 2018; Method: Hornby et al. 2015, Hornby et al. 2013, VT PSB 2012, Synapse 2018, where externality adjustments are located in Appendix B: VT (Columns t through w), Exhibit 4-14 (values reported under "CO_2 at $100/ton," pages 4–37), and Exhibit D-3 (values reported under "CO_2 at $100/ton") of the 2015 AESC Report. **Washington** Policy: Washington State Legislature 2018a, Washington State Legislature 2018b; Value: WA UTC 2018a, Pacific Power 2017; Method: WA UTC 2018b, Washington State Department of Commerce 2018. **Wisconsin** Policy: WI PSC 2014; Value: Cadmus Group 2018, Cadmus Group 2012; Method: EPA 2017, WI PSC 2015, EPA 2018a, PA Consulting Group 2009.

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