Analysis of State Approaches to Cost-Effectiveness Testing

Efficiency Vermont R&D Project: Cost-Effectiveness Screening Tests

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Contents

Executive Summary

Cost-effectiveness testing provides the framework for assessing benefit-cost analyses of energy resources, such as energy efficiency programs. Benefit-cost analysis determines the cost-effectiveness of investments by comparing the benefits and costs of individual or multiple types of resources with each other and with alternative resources to determine whether the benefits exceed the costs over the lifetime of the investments under consideration.[1] If a resource's benefits are greater than the cost of investing, the resource is considered cost-effective.

This paper analyzes how selected benefits and costs of energy efficiency, flexible load management, and electrification distributed energy resources (DERs) are treated in cost-effectiveness tests in jurisdictions across the United States and discusses how this research could inform Vermont's energy efficiency utility (EEU) cost-effectiveness practices.[2] Valuing the true costs and benefits of DERs is important for ensuring accurate recognition and implementation of programs that have the greatest positive impact.

SELECT APPROACHES TO COST-EFFECTIVENESS TESTING

Valuation of Greenhouse Gas Costs

As electric grids across the United States become greener, and the carbon intensity of grids declines, jurisdictions are beginning to consider how electric grid decarbonization will impact the emissions reduction benefits associated with efficiency measures and other distributed energy resources. This project found California to be the only state to significantly modify cost-effectiveness practices in response to greening grids and expected growth of distributive energy resources.

Currently, no jurisdiction accounts for the externality costs of embodied carbon, or life-cycle emissions, in efficiency cost-effectiveness screening. California is the first, and so far, only, state to include the impacts of high-GWP gases from fugitive emissions in avoided cost screening.

Non-Energy Impacts

Non-energy impacts (NEIs) are the impacts produced by energy efficiency beyond energy and demand savings. The easiest NEIs to quantify are more frequently included in cost-effectiveness screening. Harder-to-quantify NEIs can be difficult to estimate and are applied differently across jurisdictions. Sixteen jurisdictions, including Vermont, account for at least one harder-to-quantify or low-income NEI in primary cost-effectiveness testing.

Flexible Load Management

Load management resource impacts can be benefits or costs depending on the timing of deployment and the nature of the load shift. Benefits can be allocated in measure and program

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[1] *National Standard Practice Manual, For Benefit-Cost Analysis of Distributed Energy Resources*. National Energy Screening Project. August 2020. See NSPM Summary at page i.

[2] For simplicity, the word "state" is used to include states, the District of Columbia, and commonwealths within the United States.

characterizations in technical reference manuals. Notably, California's cost-effectiveness tool for demand response programs employs a different approach in which avoided capacity and transmission and distribution costs are modified to reflect the individual constraints or advantages of demand response programs.

No standard practice exists for quantifying and including NEIs in load management programs. NEIs applied in load management screening could include the same impacts as those used when screening efficiency measures, or could include NEIs specific load management, such as increased customer control over bills.

Electrification

The participant and societal costs and benefits of electrification measures, if implemented strategically, can be similar to those of electric efficiency measures.[3] NEIs associated with strategic electrification measures generally overlap with those of electric efficiency.[4] Transitioning to hourly profiles for cost-effectiveness testing more accurately reflects electrification measures' energy and greenhouse gas (GHG) emissions impacts.

States do not appear to be screening electric transportation efficiency or transportation electrification programs through the traditional cost-effectiveness screening tests for ratepayer-funded electric energy efficiency programs.[5] This is assumed to be due to a difference in funding sources—in general, the funding streams for clean transportation programs are not electric efficiency ratepayer dollars but state revenues allocated through legislation or third-party funding attained through grants or external partnerships. Alternative cost-effectiveness tests, however, have been developed for allocating funding among clean transportation programs.

Exceptions to Cost-Effectiveness Testing

Some states exempt certain programs from cost-effectiveness given their significant, but unquantifiable, contribution to NEIs, market transformation, or state policies. California has taken the approach of exempting efficiency programs from cost-effectiveness farther than any other state, segmenting the state's investor-owned utility efficiency program into resource acquisition, market support, and equity portfolios; only the resource acquisition portfolio is required to be cost-effective.[6]

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[3] *National Standard Practice Manual for Benefit-Cost Analysis of Distributed Energy Resources*. National Energy Screening Project. August 2020. See Table S-7. Potential Benefits and Costs of DERs: DER Host Customer and Table S-8. Potential Benefits and Costs of DERs: Societal, on pages xi-xii.

[4] Id at 10-11.

[5] Utilities, such as Xcel Energy in Colorado, that offer EV charging management offerings under demand response programming may screen these load management programs through their demand side management cost-effectiveness test(s). For example, see 2021/2022 Demand-Side Management Plan, Electric and Natural Gas. Public Service Company of Colorado. Colorado Public Utilities Commission Proceeding No. 20A-0287EG. March 16, 2021. See page 246.

[6] "Decision 21-05-031 – Assessment of Energy Efficiency Potential and Goals and Modifications of Portfolio Approval and Oversight Process." California Public Utilities Commission. Rulemaking 13-11-005. May 20, 2021. See pages 10-17.

Researching innovative cost-effectiveness practices and fine-tuning existing protocols will remain important for optimizing distributed energy resources for the benefit of customers, utilities, and society.

RECOMMENDATIONS

Efficiency Vermont provides the following recommendations to support discussions and decisions regarding efficiency cost-effectiveness testing in Vermont:

- Engage stakeholders regarding the feasibility of hourly avoided costs and savings to value resources and inform future investments.
- Concurrent to exploring hourly avoided costs and savings, consider complementary metrics, such as the TSB, to fully realize the opportunities that hourly costs and savings present.
- Continue to monitor the emissions impact of efficiency as electric grids continue to decarbonize and quantify the value of efficiency to decarbonization of the entire system, such as the reduced need for distribution infrastructure associated with electrification.[7]
- Continue to monitor whether and how jurisdictions begin accounting for embodied carbon costs.
- Continue to monitor how other states value NEIs in cost-effectiveness testing. Economic benefits and air quality benefits of efficiency, both of which are highly aligned with Vermont's policy goals, are particular NEIs that Efficiency Vermont can continue quantifying given the substantial size of these two benefits, and their alignment with the state's policy goals. Efficiency Vermont could analyze whether the EEUs' current screening test (and approach to quantifying NEIs) fully accounts for economic and air quality benefits, or if current practices are instead undervaluing such societal benefits.
- Incorporate support for policy goals into cost-effectiveness testing, in a more direct and quantifiable way, providing Efficiency Vermont and its regulators greater information on the benefits and impacts of Efficiency Vermont's services. Tests that incorporate policy goals could be used to supplement primary cost-effectiveness testing.

APPENDIXES

Appendix A of this report provides state-level summaries of cost-effectiveness practices related to avoided environmental externality costs, hard-to-quantify NEIs, low-income NEIs, and reduced risks/uncertainty.

Appendix B provides general and state-specific resources to further explore states' cost-effectiveness practices.

[7] This recommendation is sourced from [Wisconsin's Greening Grid, Effects of Carbon Intensity Changes on the Valuation of Energy Efficiency."] Prepared for Focus on Energy by Cadmus. January 14, 2021. See page 2.

Introduction

A jurisdiction's cost-effectiveness tests provide the framework for conducting benefit-cost analyses of energy resources, such as energy efficiency. Benefit-cost analysis assess the cost-effectiveness of investments by comparing the benefits and costs of individual or multiple types of resources with each other and with alternative resources in order to determine whether the benefits exceed the costs over the lifetime of the investments under consideration.[8] If a resource's benefits are greater than the cost of investing, the resource is considered cost-effective.

This paper analyzes how selected benefits and costs of energy efficiency, flexible load management, and electrification distributed energy resources (DERs) are treated in cost-effectiveness tests in jurisdictions across the United States, and discusses how this research could inform Vermont's energy efficiency utility (EEU) cost-effectiveness practices.[9]

BACKGROUND ON COST-EFFECTIVENESS TESTING

Primary versus secondary tests

Jurisdictions commonly have both primary and secondary cost-effectiveness tests. A primary test informs whether a program administrator should fund or otherwise support a measure, program, or portfolio (depending on the level of screening).[10] Secondary cost-effectiveness tests are typically used to enhance regulators' or program administrators' overall understanding of resource impacts to inform resource prioritization, evaluate marginally cost-effective or non-cost-effective resources, encourage consistency across resources, and consider other effects on customers.[11]

Vermont employs the societal cost test as its primary cost-effectiveness test for screening energy efficiency resources, and administers the utility cost test (UCT) as a secondary test when calculating the ratio of total electric benefits to costs, pursuant to performance requirements.[12]

Perspectives of cost-effectiveness tests

Cost-effectiveness tests results differ according to the benefits and costs included in the cost-effectiveness analysis. The *National Standard Practice Manual (NSPM)* provides a comprehensive

[8] *National Standard Practice Manual, For Benefit-Cost Analysis of Distributed Energy Resources*. National Energy Screening Project. August 2020. See NSPM Summary at page i.
[9] For simplicity, the word "state" is used to include states, the District of Columbia, and commonwealths within the United States.
[10] *National Standard Practice Manual, For Benefit-Cost Analysis of Distributed Energy Resources*. National Energy Screening Project. August 2020. See NSPM Summary at page xxii.
[11] Id.
[12] Vermont's electric energy efficiency utilities (EEUs) are required to ensure that the overall electric benefits are greater than the costs incurred to implement and evaluate the EEU and the energy efficiency charge, with a UCT benefit/cost ratio equal to or greater than 1.2.

framework for assessing the cost-effectiveness of resources, and outlines the following perspectives for traditional cost-effectiveness tests[13]:

- **Participant Cost Test (PCT)**: includes the benefits and costs experienced by program participants
- **Ratepayer Impact Measure Test (RIM Test)**: includes the benefits and costs that will affect utility rates, including utility system benefits and costs, plus lost revenues
- **Societal Cost Test (SCT)**: includes the benefits and costs experienced by society
- **Total Resources Cost Test (TRC Test)**: includes the benefits and costs experienced by the utility system, plus benefits and costs to program participants
- **Utility Cost Test (UCT)**: includes the benefits and costs experienced by the utility system; also known as the Program Administrator Cost Test (PACT)

Most states that utilize cost-effectiveness testing for energy resources have adopted variations of the UCT, SCT, and TRC test for their primary cost-effectiveness test, and made modifications to these tests to incorporate additional benefits.[14]

Quantification of Impacts

Most traditional cost-effectiveness tests for efficiency programs consider resources' impacts to the regulated utility system—such as avoided generation costs (energy and capacity), avoided transmission and distribution costs, and program administration costs. The values of these utility impacts differ across jurisdictions for a variety of reasons, notably differences in energy and capacity supply prices, cost of utility and regional infrastructure investments, policy mandates and priorities, and program administrator goals and organizational structure.

Benchmarking the quantification and incorporation of these utility impacts into cost-effectiveness testing is not a focus of this project. Rather, this project seeks to understand how jurisdictions' cost-effectiveness tests quantify and incorporate participant and societal impacts that are aligned with policy priorities such as greenhouse gas (GHG) reduction or are hard to quantify such as non-energy impacts.[15] How states are generally incorporating such impacts into screening practices is summarized below.

ENVIRONMENTAL EXTERNALITIES

States generally employ one of the following approaches to account for environmental externality costs avoided by electric energy efficiency in cost-effectiveness screening:

[13] *National Standard Practice Manual, for Benefit-Cost Analysis of Distributed Energy Resources*. National Energy Screening Project. August 2020. See pages 3-1 to 3-2.
[14] *National Standard Practice Manual, For Benefit-Cost Analysis of Distributed Energy Resources*. National Energy Screening Project. August 2020. See page 3-2.
[15] In effect, greenhouse gas reduction is a non-energy impact. Given the importance of greenhouse gas reduction, and repeated treatment of greenhouse gas reduction as separate from other non-energy impacts in the regulatory arena, this paper discusses greenhouse gas reduction as a separate impact apart from other NEIs.

- **Abatement cost**: applies the highest cost society is willing to pay to abate, or lessen, the externality
- **Social cost of carbon (SCC)**: applies the monetary value of the net harm to society associated with adding GHG[16]
- **Generalized adder:** applies a percent increase to costs or benefits to account for environmental externalities

Externality costs in this section are defined to include the costs of greenhouse gas emissions (GHG or CO_2e) created as the result of energy production and consumption.[17] Excluded from this definition of externality costs are:

1. The costs of GHGs that are already captured in the price of electricity or fuel (also known as embedded costs)[18] and
2. Costs related to compliance with electric sector clean energy regulations or legislation, such as renewable portfolio standard requirements.[19]

Valuation of greenhouse gases

Table 1 below categorizes all states that account for environmental externality costs in either a primary or secondary cost-effectiveness test based on their approach. Appendix A provides further information on each state's approach.

[16] "Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide. Interim Estimates Under Executive Order 13990." Interagency Working Group on the Social Cost of Greenhouse Gases, United States Government. February 2021. See page 2.

[17] Greenhouse gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases (e.g., hydrofluorocarbons or HFCs). Other pollutants, such as particulate matter ($PM_{2.5}$), sulfur dioxide (SO_2), nitrogen oxides (NO_x), ammonia (NH_3), and volatile organic compounds (VOC), also cause negative externalities. These pollutants, generally, are more recognized for their impacts on human health than their climate impacts. Approaches to quantifying avoided externality costs from these pollutants are included in the Non-Energy Impacts section of this paper. However, some states include the quantification of externality costs from pollutants within their environmental externalities category (such as Vermont with NO_x).

[18] Embedded costs reflect the cost or price of greenhouse gases embedded in retail electric costs. For the states that participate in the Regional Greenhouse Gas Initiative (RGGI), an example is the RGGI price included in the retail price for electricity.

[19] Oregon requires utilities to consider potential future costs of carbon regulation in the UCT and TRC; these costs are not included in this section as these represent real or foreseeable compliance costs rather than externality costs.

Table 1. State Approaches to Quantifying Greenhouse Gas Environmental Externality Costs

	Method	Jurisdictions		
		TRC or Modified TRC	SCT	UCT
$	Abatement cost	CT*, NH**, **RI, CA, WI**	**VT, DC**	
$	Social cost of carbon	**CO, MA***, NJ, IL**	**MN, NY, MD,** CA	
%	Generalized adder	**WA,** WY	**IA,** NV	**UT**

Bold indicates a test is the state's primary test.
* Connecticut uses the TRC Test, with a GHG abatement cost, as the primary test for low-income weatherization programs.
** Avoided environmental externality costs are included in the secondary cost test put forth in NHSave's proposed, but recently rejected by the NH Public Utilities Commission, 2021–2023 statewide energy efficiency plan. See NHPUC Docket No. DE 20-092.
*** Massachusetts applies the SCC value from the 2021 Avoided Energy Supply Components (AESC) report to all measures except fossil fuel heating and cooling measures.

Of the nineteen states that account for environmental externalities in cost-effectiveness screening, seven utilize a carbon abatement cost approach. Abatement costs can be looked at from a carbon abatement technology or policy perspective. Connecticut, Rhode Island,[20] Vermont,[21] and the District of Columbia all utilize the global marginal abatement cost of carbon provided by the 2018 Avoided Energy Supply Components in New England report (AESC Report), based on the cost of carbon capture and sequestration technology. New Hampshire's recently rejected 2021–2023 statewide energy efficiency plan proposed to include a marginal abatement cost value from the AESC Report in its secondary state-specific cost-effectiveness test; it is unclear whether the proposal adopted the global or local perspective.[22] In a more technology-agnostic approach, California in its primary test (a modified TRC test) uses a "GHG Adder" to represent the cost of achieving the state's electric sector emissions reduction targets. California's approach is explored further below. Similarly, Wisconsin utilizes a market-based carbon price to value avoided CO_2 emissions in its primary cost-effectiveness test, a modified TRC test. Wisconsin's market-based carbon price reflects the marginal cost of abating an additional ton of pollutant emissions within the scope of market-based carbon pricing regulations.

[20] Rhode Island is transitioning from AESC's global to regional marginal abatement cost perspective.
[21] It is worth noting Vermont is in the midst of a new avoided proceeding (Vermont Public Utility Commission Case No. 21-2436-PET) that could result in Vermont switching from an abatement cost approach to a damage cost approach (i.e., one using the social cost of carbon) for valuing avoided greenhouse gas emissions.
[22] New Hampshire's PUC recently rejected the stakeholder-proposed NHSave's 2021–2023 statewide energy efficiency plan (see NHPUC Docket No. DE 20-092); the impact to New Hampshire's cost-effectiveness testing practices remains unclear.

Eight jurisdictions – California, Colorado, Illinois, Maryland, Massachusetts, Minnesota, New Jersey, and New York, use SCC values to represent the cost of environmental externalities. The SCC values employed in these states are based on values developed by the United States government Interagency Working Group (IWG) on the Social Cost of Greenhouse Gases. The SCC estimate includes all climate change impacts, "changes in net agricultural productivity, human health effects, property damage from increased flood risk and natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services."[23] Although these states have adopted IWG estimates, the SCC value used in screening differs considerably in magnitude across states depending on the discount rate applied and whether a state selects the "average" or "high impact" values for the SCC.

> SCT and the SCC
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> Three of the six jurisdictions that use the SCT as a primary test, and one of the two that use the SCT as a secondary test, employ the SCC when quantifying environmental externality costs.

Five states employ a third approach—generalized adders—to account for environmental externalities. Nevada includes a 10% conservation adder when performing its SCT, in addition to a separate non-energy benefit (NEB) adder, whereas Utah, Washington, and Wyoming consider environmental benefits within their 10% NEB adders. It is unclear whether the 10% adder Iowa applies when performing its SCT accounts solely for environmental externality costs or is also inclusive of NEBs.

Ten of the states that account for avoided environmental externalities in primary cost-effectiveness testing do so in a UCT, TRC, or modified TRC test. This is significant given that the UCT and TRC tests traditionally do not include societal impacts, indicating a precedent for states to incorporate a set of benefits broader than what is included in a traditional TRC perspective.

Application of the cost of greenhouse gases

The inputs used in cost-effectiveness screening reflect the costs avoided, or incurred, because of a demand resource. As electric grids across the United States become greener, and the carbon intensity of grids declines, jurisdictions are beginning to consider how electric grid decarbonization will impact the emissions reduction benefits associated with efficiency measures. This is a nascent topic within the regulated utility space, but interest is likely to grow in the coming years. Efficiency Vermont's research found California has significantly modified cost-effectiveness practices in response to greening grids; see the deep-dive below for more information. All other states encountered through Efficiency Vermont's research appear to continue to apply avoided externality costs through more traditional approaches, in which a given GHG cost is multiplied by the emissions rate of marginal generators.

Wisconsin stands out as a state that is actively contemplating this topic. Earlier this year, The Cadmus Group released a report analyzing the effects of grid carbon intensity reductions on the

[23] Id.

valuation of Focus on Energy's energy efficiency efforts.[24] Cadmus's analysis models the expected greening of Wisconsin's electric grid, and the resulting average annual grid carbon intensity and emissions, but finds the greener grid only modestly lowers the emissions savings associated with efficiency.[25] This is because fossil fuel generation still plays a significant role in the near term, and fossil fuel generators remain the marginal generators even as more renewable generation comes online. Cadmus believes fossil generation's greater flexibility and higher operating costs explain why fossil resources remain marginal as compared with renewables. Cadmus concluded "there is no urgency in adopting an alternative methodology for estimating the emissions impact from energy efficiency."[26]

The issue of valuing emissions avoided by efficiency within a decarbonized grid is highly complex, intertwined with energy procurement markets and econometric modeling. Although almost all states continue to employ the traditional, or standard, methodology of marginal emissions rates, this is an issue that is worth monitoring. Vermont can continue to invest in and review regional emissions forecasts and models.

State deep-dive: California

Valuation of greenhouse gases

California employs a modified version of the TRC as its primary cost-effectiveness test for DERs. California's modified TRC test includes an avoided cost monetized adder called the "GHG Adder," which the state uses to quantify the marginal cost of greenhouse gas abatement associated with achieving the state's emissions reduction targets in the electric sector.

The California Public Utilities Commission (CPUC) first established the GHG Adder within its TRC test in 2017 in response to concern that the costs included in the previous TRC test did not reflect the costs needed to achieve the GHG targets of SB-32 California Global Warming Solutions Act of 2006.[27] Without immediate revisions to avoided costs, energy efficiency goals in the short term would be understated and programs "could experience a decrease in budgeting due to perceived lower cost-effectiveness only to need an exponential increase in program output" once a later policy was adopted.[28] The CPUC therefore adopted an interim GHG Adder using the state's Cap-and-Trade Allowance Price Containment Reserve (APCR) price as an estimated abatement cost of GHG reduction. APCR prices represent the highest cost of compliance with California's cap-and-trade requirements. Due to evidence insufficient to determine whether the APCR price can be equated with a marginal carbon abatement price, and an effort to link the GHG values used in investor-owned utility (IOU) Integrated Resource Plan (IRP) proceedings with DER cost-effectiveness screening, the CPUC replaced the GHG

[24] "Wisconsin's Greening Grid, Effects of Carbon Intensity Changes on the Valuation of Energy Efficiency." Prepared for Focus on Energy by Cadmus. January 14, 2021.
[25] The modest reductions in emissions savings per kWh are due to the declining use of coal in MISO.
[26] "Wisconsin's Greening Grid, Effects of Carbon Intensity Changes on the Valuation of Energy Efficiency." Prepared for Focus on Energy by Cadmus. January 14, 2021. Page 2.
[27] The California Global Warming Solutions Act of 2006 (updated in 2016) requires California's Air Resources Board to ensure statewide greenhouse gas emissions are reduced to 40% below the 1990 level by 2030.
[28] "D.17-08-022: Decision Adopting Interim Greenhouse Gas Adder." California Public Utilities Commission Rulemaking 14-10-003. August 24, 2017. See page 6.

Adder's Cap-and-Trade APCR values with the "GHG planning price" used in California's IRP proceedings to approximate the marginal cost of GHG abatement associated with reducing 42 million metric tons of carbon from the electric sector by 2030.[29, 30] The GHG Adder values increase linearly, beginning at $66.37/metric ton of CO_2e in 2018 and growing to $150/metric ton of CO_2e by 2030.[31] Neither the GHG Adder utilized in the TRC test nor the GHG planning price utilized in IRP proceedings is designed to serve as an additional GHG compliance regime; rather, they are implemented to promote greater certainty in planning and increase the chances that California will achieve its GHG reduction targets.[32] This being the case, California's GHG Adder supports the traditional perspective of the TRC test, in that it reflects the costs of achieving state policy as paid for by ratepayers rather than quantifying the impacts of greenhouse gas emissions to society at large.

The CPUC's decision to align GHG values in IRP proceedings and DER cost-effectiveness screening is part of the CPUC's broader effort to establish uniform treatment of screening across all resources, both demand- and supply-side resources. To establish a universal cost-effectiveness framework, the CPUC has directed the use of the SCT for informational purposes in testing all resources, including IRP proceedings. Using the SCT will allow the CPUC to determine "whether and the extent to which the SCT will help meet California's carbon reduction objectives."[33] After a data gathering period, the CPUC is expected to issue final guidance on the SCT elements and future use of the SCT. For now, California's SCT includes:[34]

- **Societal discount rate**: The CPUC established a societal discount rate of 3%.
- **Avoided social cost of carbon**: Whereas the GHG Adder is used when performing the TRC test, the CPUC adopted the use of the SCC when performing the SCT.[35]
- **Air quality adder**: The air quality adder represents the reduction of societal health-related costs when DERs reduce electricity generation from power plants. The CPUC adopted an interim value of $6/megawatt-hour (MWh) until a more robust model for determining air quality impacts of electricity generation can be developed.[36]

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[29] "D. 18-02-018: Decision Setting Requirements for Load Serving Entities Filing Integrated Resource Plans." California Public Utilities Commission Rulemaking 16-02-007. February 8, 2018. See Table 6. The 42 million metric tons scenario assumes full implementation of the renewable portfolio standard (at 50% level), doubling of energy efficiency (as required by SB 350), reaching CPUC's storage requirements for load serving entities, and the continued penetration of photovoltaics under the net metering tariff.
[30] "D.19-05-019: Decision Adopting Cost-Effectiveness Analysis Framework Policies for All Distributed Energy Resources." California Public Utilities Commission Rulemaking 14-10-003. May 16, 2019. See pages 58-59.
[31] Id. at Table 1.
[32] CPUC D. 18-02-018, pages 114-115.
[33] CPUC D.19-05-019, at page 3.
[34] Id. at pages 37-47.
[35] The CPUC requires that the SCT be tested using both the IWG's high-impact SCC values and the average SCC values, both using a 3% discount rate.
[36] This value represents a statewide approximation of the reduction in societal health-related costs based on the U.S. Environmental Protection Agency's CO-Benefits Risk Assessment (COBRA) model. See NEI section for more details.

Applications of the costs of greenhouse gases

California's avoided cost calculator (ACC) is used to determine the cost-effectiveness of DERs implemented by the state's investor-owned utilities (IOUs). In response to stakeholder concerns that the ACC overestimates GHG emissions avoided by DERs as California's grid continues to decarbonize, in April 2019 the CPUC updated the methodology for calculating avoided GHG emissions in the 2020 ACC.[37] The methodology change was twofold: First, it updated the hourly short-run marginal emissions from an implied market heat rate approach[38] to a production stimulation to calculate short-run marginal emissions.[39] Second, to account for the decline in annual average GHG emissions intensity of the grid, as well as the modifications needed in supply-side procurement due to changes in load, the 2020 ACC shifted its calculation of total GHG avoided costs. This methodological shift assumes that utilities' supply-side electric portfolios will be "rebalanced" in response to the DERs installed, to achieve the annual emissions intensity targets set in utilities' IRPs.[40]

California's ACC calculation of total GHG cost begins by calculating the marginal GHG impact of a DER. The ACC calculates and aggregates a DER's hourly marginal impact by multiplying hourly marginal emissions rates by the ACC's total GHG cost component (the sum of the cap-and-trade price and the GHG Adder). The calculation for determining a DER's hourly marginal GHG impact is displayed in light blue in Equation 1.

New to the ACC's 2020 methodology is that a DER's hourly marginal GHG impact is "rebalanced" to account for how utilities' electric portfolio will achieve annual emissions intensity targets. This is calculated by subtracting a DER's annual average GHG impact from the hourly marginal GHG impact. A DER's annual average GHG impact is calculated by using a DER's annual kilowatt-hour (kWh) impact, the IOU's annual average emissions intensity levels, and only the GHG Adder cost, (rather than the total cap-and-trade plus GHG Adder cost used when calculating the hourly marginal GHG emissions impact). The annual average GHG impact is displayed in dark blue in Equation 1.[41]

[37] "Decision 20-04-010: 2020 Policy Updates to the Avoided Cost Calculator." California Public Utilities Commission Rulemaking 14-10-003. April 16, 2020. See pages 43-49.
[38] The implied market heat rate approach sets heat rates based on market price forecasts for electricity and natural gas, which are then adjusted to reflect increased renewable generation to result in lower implied market heat rates during higher solar generation.
[39] "Decision 20-04-010: 2020 Policy Updates to the Avoided Cost Calculator." California Public Utilities Commission Rulemaking 14-10-003. April 16, 2020. See page 47.
[40] Id.
[41] "2020 Distributed Energy Resources Avoided Cost Calculator Documentation." Produced by E3 for the California Public Utilities Commission. See Version c1c (Final) published on June 24, 2020. See page 28.

Equation 1: California's Calculation for Determining Total Electric GHG Costs.

$$Electric\ GHG\ (\$) = [hourly\ load\ shape\ (kWh) * hourly\ marginal\ emissions\ rate(\frac{tCO2e}{kWh}) * (Cap\&Trade) + GHG\ Adder)(\frac{\$}{tCO2e})] - [Annual\ load\ (kWh) * annual\ emissions\ intensity\left(\frac{tCO2e}{kWh}\right) * GHG\ Adder\left(\frac{\$}{tCO2e}\right)]$$

The ACC's rebalancing methodology means that a program that reduces load would incur a rebalancing disbenefit (i.e., rebalancing would reduce the avoided cost benefits of the program), and, conversely, rebalancing a program that increases load would reduce the net cost increases associated with the program.

It's important to note the savings shapes of measures have a large impact on the avoided GHG impact. For example, a 3,000 MWh commercial heat pump (assumed to be mostly supplied by zero-emissions solar) and a 3,000 MWh unmanaged electric vehicle (EV) charger (assumed to add load during times of high demand supplied by natural gas combustion) will have the same rebalancing impact. However, the final emissions impact (on the electric side) of the unmanaged EV charger will be much greater than that of the commercial heat pump. This is because the cumulative hourly marginal emissions of the unmanaged EV charger (based on natural gas combustion) are significantly greater than the marginal emissions of the commercial heat pump (based on solar).

California's methodology is complex. The methodology is reliant upon detailed measure characterizations—hourly avoided cost and savings shapes. As reflected in Figure 1, the combination of hourly emissions rates, hourly savings shapes, and portfolio rebalancing cause the value of GHG in the ACC to vary dramatically across hours of the day and months of the year. California's calculation is also enabled by the interrelationship between California IRP and DRP modeling and goals, and IOU's annual emissions intensity targets that support the achievement of the state's statutory greenhouse gas reduction requirements for the electric sector.

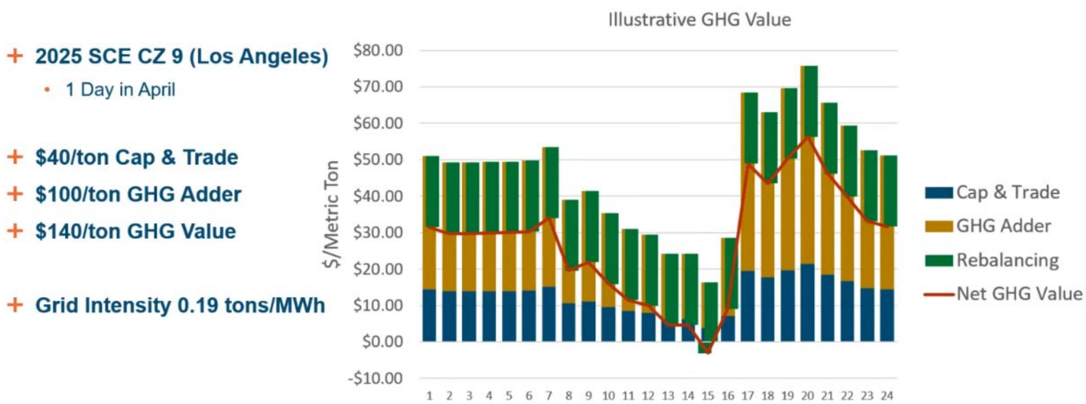

Figure 1: Example GHG value temporal variation.[42]

California's PUC approved this more complex approach in attempt to better-reflect how DERs will affect future emissions and annual grid emission intensities will decline. In complement with other hourly avoided cost values, California's new approach to GHG encourages program administrators to optimize portfolios to save energy during high-value and GHG-intensive hours.

Externality costs of embodied carbon

Embodied carbon emissions are the total GHG emissions that result from the extraction, processing, manufacturing, transportation, installation, and disposal of materials.[43] Embodied carbon can also be referred to as life-cycle emissions. Currently, no jurisdiction accounts for the externality costs of embodied carbon in DER cost-effectiveness screening.

However, embodied carbon–related efforts in the regulatory policy arena are taking place through market transformation activities, particularly through the establishment of codes and standards for embodied carbon in building materials.[44] In other words, currently the regulation of embodied carbon occurs through building procurement codes rather than energy codes. However, discussions have begun in California to explore incorporating embodied carbon into energy efficiency efforts, screening practices, and energy codes. California's Emerging Technologies Coordinating Council, IOU Emerging Technologies Programs, and California Technical Forum are engaged in discussions to determine whether and how embodied carbon should be incorporated into California's technical reference manual and TRC test calculations.[45]

[42] Screenshot at hour 1:04 from a recording of the *2020 ACC Workshop: Greenhouse Gas Value and Emissions webinar* hosted by Energy and Environmental Economics on May 8, 2020. The recording is publicly available at: https://ethreesf-my.sharepoint.com/personal/gabe_mantegna_ethree_com/_layouts/15/onedrive.aspx?id=%2Fpersonal%2Fgabe%5Fmantegna%5Fethree%5Fcom%2FDocuments%2FCPUC%20ACC%20Documents%2FWebinar%20Recordings.

[43] Embodied Carbon 101. Carbon Leadership Forum. Webpage. Published December 17, 2020. Available at: https://carbonleadershipforum.org/embodied-carbon-101/#:~:text=Embodied%20carbon%20refers%20to%20the,urgent%20action%20to%20address%20it.

[44] For example, California's Buy Clean California Act (AB 262) directs California's Department of General Services to establish maximum acceptable GWP limits for selected construction materials (structural steel, concrete reinforcing steel, flat glass, and mineral wood board insulation) to be used in state infrastructure and construction projects.

[45] Notes from Emerging Technologies Coordinating Council workshop: The Energy Within: ET Support for Embodied Energy in New Buildings.

Vermont has conducted embodied carbon studies for weatherization materials and common heating systems,[46, 47, 48] and will continue to monitor whether and how jurisdictions begin accounting for embodied carbon costs.

Valuation of greenhouse gas externalities beyond carbon

Fugitive emissions, or the unintentional release of methane or other high global warming potential (GWP) gases from supply chain systems or DER measures, is a growing topic of discussion within cost-effectiveness practices. Starting in 2020, California's ACC added a new avoided cost category of high-GWP gases, which value the GHG impacts of DERs on methane and refrigerant leakage.[49] Included in California's high-GWP gases avoided cost category are 1) an upstream methane adder to all measures and programs that impact electricity or natural gas usage; 2) a behind-the-meter methane adder that is applied only to measures and programs that eliminate natural gas appliances from a building; and 3) a refrigerant adder to all measures and programs that impact refrigerant leakage—new measures that result in the installation of refrigerants, measures that replace high-GWP refrigerants with lower-GWP refrigerants, and measures that replace an older refrigerant measure with a different refrigerant charge, leakage rate, or refrigerant.[50] California is the first, and so far only, state to include the impacts of high-GWP gas from fugitive emissions in avoided cost screening.

NON-ENERGY IMPACTS

Non-energy impacts (NEIs) are the impacts produced by energy efficiency beyond energy and demand savings. NEIs can accrue to the utility system, efficiency program participants, and society at large. NEIs can be difficult to quantify and are applied differently across jurisdictions.

The most common NEIs included in cost-effectiveness screening are the NEIs that are easiest to quantify—savings from unregulated fuels (i.e., fuels other than electricity or natural gas), savings from reduced water use and wastewater contribution, and impacts to operation and maintenance costs. As reflected in Appendix A, sixteen jurisdictions account for at least one harder-to-quantify NEI in primary cost-effectiveness testing, such as impacts to participant comfort, health and safety, productivity, and property; utility impacts such as reduced

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[46] Nedzinski, Megan, Jacob Deva Racusin, Chris Gordon, Brian Just, Matt Sharpe, and Mike Fink, "Embodied Carbon in Vermont Residential Retrofits," Efficiency Vermont R&D Program Report, 2020. https://www.efficiencyvermont.com/news-blog/whitepapers/embodied-carbon-in-vermont-residential-retrofits.

[47] Just, Brian, "The High Greenhouse Gas Price Tag on Residential Building Materials," Efficiency Vermont R&D Program Report, 2020. https://www.efficiencyvermont.com/news-blog/whitepapers/the-high-greenhouse-as-price-tag-on-residential-building-materials

[48] Jordan, Daniel, "Lifecycle GHG Impacts of C&I Heat Pump Applications in Vermont," Efficiency Vermont R&D Program Report, 2020. https://www.efficiencyvermont.com/news-blog/whitepapers/lifecycle-ghg-impacts-of-c-i-heat-pump-applications-in-vermont

[49] "Decision 20-04-010: 2020 Policy Updates to the Avoided Cost Calculator." California Public Utilities Commission Rulemaking 14-10-003. April 16, 2020. See pages 62-65.

[50] "2020 Distributed Energy Resources Avoided Cost Calculator Documentation." Produced by Energy and Environmental Economics for the California Public Utilities Commission. See Version c1c (Final) published on June 24, 2020. See pages 71-77.

arrearages and debt collection costs; and societal impacts to public health, air and water quality, economic development, and energy security.

Percent adders

A common approach for accounting for harder-to-quantify NEIs, utilized by twelve states as summarized in Table 2, is to apply a percent adder that is intended to represent utility, participant, and/or societal non-energy benefits (NEBs) generally.[51] NEB percent adders range from 5% to 25%. Low-income (LI) adders, adders that specifically represent benefits accruing to low-income customers, range from 10% to 30%. Conservation adders, adders that represent the benefits, notably reduced risk and uncertainty, of conservation over supply-side resources, range from 5% to 10%. Because these percent adders typically magnify energy or other resource benefits, the magnitude or effect of the NEIs is associated with achieved energy savings.

Table 2. State NEI percent adders

State	NEB Adder	LI Adder	Conservation Adders and Risk Adjustments
Colorado	20%	30%	
District of Columbia	5%		5%
Idaho			10%
Iowa	10%		
Nevada	10% C&I 15% Res	25%	
New Hampshire	10% C&I 25% Res		
New Jersey	5%	10%	
Oregon	10%		
Utah	10%		
Vermont*	15%	15%	5%**
Washington	10%		10%
Wyoming	10%		

* Vermont also applies an additional 10% economic development adder when screening Energy Savings Account (ESA) projects.

** Vermont applies a risk discount on costs (rather than a risk adder to benefits) equivalent to 10% for the Thermal Energy and Process Fuels (TEPF) portfolio and 5% for the electric portfolio.

Monetized Adders

Eight states – California, Delaware, Illinois, Maryland, Massachusetts, New Hampshire, Rhode Island, and Wisconsin, utilize monetized adders to account for NEIs, in addition to, or in place of, percent adders as summarized in Table 3. Whereas percent adders account for all utility, participant, and/or societal NEBs depending on the cost-effectiveness test applied, monetized adders account for a specified set of NEIs, whose monetized dollar values are sourced from

[51] While generally this paper uses the term NEI due to its comprehensiveness (NEIs include both positive and negative non-energy impacts), this paper also uses NEB when appropriate to more-closely reflect states' adopted terminology.

studies that estimate the value of various NEIs for a specific region or state. Whereas percent adders magnify a measure's energy or resource savings, monetized adders are applied at the measure or program level regardless of actual resource savings accrued. This in turn causes the magnitude of NEIs from monetized adders to be more strongly associated with the number of measures installed or projects completed than with the energy savings of such measures and projects.

- **Per-measure basis**: Massachusetts and Rhode Island apply monetized NEIs on a per-measure (or per-unit) basis. Measures may receive benefits for a variety of market-rate or low-income participant NEIs, or both.
- **Per-program basis**: Delaware, Maryland, New Hampshire[52], and Wisconsin apply monetized adders to market-rate and/or low-income comprehensive weatherization programs to represent various participant NEBs. Whether the monetized adder is applied annually or just once depends on the NEI.
- **Portfolio basis**: Wisconsin applies a monetized adder to total portfolio TRC benefits when performing its expanded TRC test and SCT. The adder represents net economic benefits attributable to Wisconsin's Focus on Energy program activity, defined as employment (number of full-time and part-time jobs), economic benefit (net contribution to Wisconsin's gross state product), and disposable personal income (the change in money available to Wisconsin consumers for purchasing goods and services, saving money, and paying taxes). Net economic benefits are recalculated every two years; CY2019 net economic benefits increased TRC benefits by $526 million.

Table 3. Monetized NEI adders

Level	State	NEI Type	Value	Application
Measure or Unit	Massachusetts —**Modified TRC**	Monetized residential, LI, and C&I sector NEIs (including health benefits, durability, noise reduction)	NA	Values such as comfort, home durability, health benefits, noise reduction are applied annually per unit. Property value benefits are applied once per unit.
		LI sector NEIs (including reduced arrearages, bad debt write-offs, customer calls and connections)	NA	Benefits are applied annually per unit.
	Rhode Island—**RI Test** (similar to TRC)	Monetized Residential and LI NEIs (including thermal comfort, noise reduction, home durability, and health benefits)	NA	Values such as comfort, home durability, health benefits, reduced noise reduction are applied annually by measure category. Property value benefits are applied once by measure category.

[52] New Hampshire's PUC recently rejected the stakeholder-proposed NHSave's 2021–2023 statewide energy efficiency plan (see NHPUC Docket No. DE 20-092); the impact to New Hampshire's cost-effectiveness testing practices remains unclear

Level	State	NEI Type	Value	Application
		Low-income sector NEIs (including reduced arrearages, bad debt write-offs, customer calls and connections)	NA	Benefits are applied annually by measure category.
Project or Participant	Delaware—**TRC**	LI improved comfort and health, reduced noise	$264	Benefits are applied to weatherization assistance program projects annually.
	Maryland—**TRC, SCT,** PCT	Comfort	$34 for market-rate Home Performance with ENERGY STAR (HPwES), $27 for LI	Values are multiplied by the number of comprehensive air sealing participants for each year of measure life, then modified for free ridership and inflation.
	New Hampshire—**Primary Granite State Test** and Secondary Granite State Test[53]	Improved comfort, reduced noise, and improved health	$406	Values are applied annually to each low-income weatherization project in NH's Home Energy Assistance program.
	Wisconsin—SCT	Improved property value	$7,000	Applied once to net present value benefits for each participant in comprehensive HPwES program
		Reduced arrearages	$19.40	Applied to each LI participant in HPwES program
Portfolio	Wisconsin—Expanded TRC and SCT	Economic benefits of efficiency (increased jobs, gross state product, and disposable personal income).	Calculated every two years	Added to net benefits. For example, in CY2019, net economic benefits attributable to Focus on Energy program activity increased total TRC benefits by $526 million.

Bold indicates a test is the state's primary test.

Multipliers

Rather than *adding* a monetized value to a measure, program, or portfolio's benefits, multipliers *multiply* some element of a measure, program, or portfolio by a monetized value. Seven states employ multipliers to account for NEIs in cost-effectiveness screening as listed in Table 4.

- **Energy savings basis**: Multipliers applied on an energy savings basis quantify health benefits from reduced emissions or reduced utility costs for low-income utility rates and/or reduced customer arrearages. California, Illinois, Maryland, and Wisconsin apply a $/kWh multiplier to represent the health benefits from reduced emissions using the EPA's Avoided Emissions and Generation Tool (AVERT) and CO-Benefits Risk Assessment Health Impacts Screening and Mapping Tool (COBRA) to calculate $/kWh health benefits. Maryland, Massachusetts, and Rhode Island apply a $/kWh multiplier to electric savings from low-income measures to account for reduced utility costs for low-income

[53] New Hampshire's PUC recently rejected the stakeholder-proposed NHSave's 2021–2023 statewide energy efficiency plan (see NHPUC Docket No. DE 20-092); the impact to New Hampshire's cost-effectiveness testing practices remains unclear.

rate discounts or the benefits from reduced customer arrearages. Rhode Island uses a $/MMBtu multiplier (only on oil savings) to account for improved national security.

- **Spending basis**: In addition to quantifying NEIs on a measure-specific basis, Rhode Island applies program-specific economic development multipliers (gross domestic product per dollar of program spending) to all efficiency programs to account for economic growth and job creation benefits.
- **Bill savings basis**: Connecticut uses a multiplier to account for all its NEIs; the multiplier is applied to all bill savings from low-income programs to account for improved comfort, reduced noise, reduced maintenance, increased home value and appearance, and improved home safety lighting quality.

Table 4. NEI multipliers

Level	State	NEI Type	Value	Application
Energy savings	California—SCT	Health benefits from reduced emissions	$6/MWh	Applied to electric savings
	Maryland—**TRC, SCT**	Health benefits from reduced emissions	$0.002/kWh	Multiplied by all kWh saved for life of each measure, then multiplied by net-to-gross ratio for each measure
		Reduced customer arrearages	2% of kWh savings	Applied to all kWh saved over life of measures installed in LI program, then adjusted for free ridership
	Illinois—**Modified TRC**	Health benefits from reduced emissions	Values vary by program	Values are applied to cumulative persisting annual savings (CPAS) of each program. For new programs, summation of annual portfolio-level benefit per kWh is applied to new program's CPAS
	Wisconsin—SCT	Health benefits from reduced emissions	$0.0396/kWh	Value applied to the first five years of life-cycle program savings
	Massachusetts—**Modified TRC**	Reduced utility costs for LI rate discounts	Varies	Applied annually per kW of estimated energy savings per installed LI measure
	Rhode Island—**RI Test** (similar to TRC)	Reduced utility costs for LI rate discounts	Varies	Applied annually per kW of estimated energy savings per installed LI measure
		National security	$1.83	Value is multiplied by MMBtu oil savings annually (for measures with oil savings)
Spending	Rhode Island—**RI Test** (similar to TRC)	Economic development (economic growth and job creation benefits)	Program specific	Applies program-specific economic development multipliers (gross domestic product/$ program spending) to all efficiency programs
Bill savings	Connecticut—**UCT**	Improved comfort, reduced noise, reduced maintenance, increased home value and improved appearance, and improved home safety lighting quality	$0.70	Value multiplied by bill savings from LI programs.

Bold indicates a test is the state's primary test.

Research shows states vary in their approach to incorporating NEIs into screening practices.

Application of Screening Tests to Non-traditional Demand Management Programs

FLEXIBLE LOAD MANAGEMENT

Many states allow utilities to implement load management programs as stand-alone programs or in combination with energy efficiency programs. Generally, states apply the same cost-effectiveness tests to load management, active demand management, and demand response demand-side management programs.[54] An exception to this is California, where demand response programs undergo a separate cost-effectiveness protocol.[55] This section captures whether and how the application of costs and benefits within the same cost-effectiveness test may differ between traditional energy efficiency and load management programs.

Load management programs address grid system conditions and issues. For example, programs may be aimed at increasing load to reduce renewable energy curtailment, whereas more traditional load management programs focus solely on load reductions during peak capacity periods. Understanding and characterizing the problems that a load management program seeks to address is the first step in evaluating cost-effectiveness.[56]

The NSPM for DERs shows that the costs and benefits of load management resources are similar to those of passive energy efficiency.[57] There are impacts that could be benefits or costs depending on the timing of deployment and the nature of the load shift, such as, societal GHG emissions and subsequent environmental impacts and societal public health impacts, participant NEIs, participant reliability and resilience, and utility energy generation costs (a benefit if load management either reduces total electricity generation or avoids energy generation during hours of higher marginal cost). The NSPM describes load management programs as rarely saving unregulated fuels; it is unclear whether this is true in Vermont.

Treatment of costs

The costs of load management programs are treated similarly to energy efficiency program costs. There may be differences in the relationship between measure life and program costs when screening traditional efficiency compared with load management, and these variations can be accounted for through changes to measure characteristics in a TRM.

A cost unique to load management is the net loss, if any, in productivity due to modified electricity consumption. For example, losses in participant comfort or reduced productivity at a manufacturing facility. When screening applicable demand response programs, California assumes 75% of a program's financial incentive as a proxy for a) the value of participant lost

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[54] "Use of Cost-Effectiveness Tests for Evaluation of Distributed Energy Resources: A Literature Review." Regulatory Assistance Project. December 2016. See page 13 of Attachment A.
[55] California 2016 Demand Response Cost Effectiveness Protocols." July 2016.
[56] *National Standard Practice Manual, For Benefit-Cost Analysis of Distributed Energy Resources*. National Energy Screening Project. August 2020. See page 7-7.
[57] Id at Table S-6. Potential Benefits and Costs: Electric Utility System, at page xi.

service or productivity and b) any transaction costs.[58] Transaction costs are calculated from the opportunity cost associated with education, equipment installation, and application of the load management program.

Treatment of benefits

Energy (and emissions) savings

Modifications to load management measures or programs' energy savings are made to savings characterizations in a TRM. In a Massachusetts whitepaper describing the study and modification of cost-effectiveness screening for LI and C&I battery storage, energy savings were subtracted from energy demand during summer and winter peak and added to demand during summer and winter off-peak; the sum added up to zero across the four time periods.[59] The whitepaper discussed the need for selecting hours of energy savings by energy price.[60] Because the hours of energy savings also directly affect a load management measure or a program's emissions savings, if emissions savings are determined on an hourly rather than seasonal peak/off-peak basis, hours of energy savings could also be based on hours of highest emissions rate if the program design allows.

Avoided capacity costs

Avoided capacity costs are an important benefit associated with load management, but can be difficult to determine.[61] There is no standard approach to modifying avoided capacity costs for load management programs.

Massachusetts's TRC test awards measures with avoided capacity benefits based on avoided costs of summer generation capacity, winter generation capacity, electric capacity demand reduction induced price effects, transmission, distribution, and reliability. The winter generation capacity value is assumed to be $0/kW for all measures.[62] The Massachusetts battery storage whitepaper, however, modified the assumed winter generation capacity value to mirror AESC's uncleared capacity value to reflect the benefits of avoided winter generation capacity accrued by winter active demand management activities.[63]

California's demand response cost-effectiveness protocols modify avoided generation capacity cost values to reflect the individual characteristics of demand response programs. For a program without usage or availability constraints, the program is awarded the full avoided capacity cost of a new combustion turbine in screening.[64] For demand response programs that

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58 "California 2016 Demand Response Cost Effectiveness Protocols." July 2016. See page 48.
59 "Massachusetts Battery Storage Measures: Benefits and Costs." Applied Economics Clinic, July 31, 2018. See page 9.
60 Ibid. at page 11.
61 "A Framework for Evaluating Cost-Effectiveness of Demand Response." Tim Woolf et al. February 2013. See page 35.
62 "Massachusetts Battery Storage Measures: Benefits and Costs." Applied Economics Clinic, July 31, 2018. See page 13.
63 Id.
64 California 2016 Demand Response Cost Effectiveness Protocols." July 2016. See page 30. Note: as California nears larger electric GHG reduction targets, it is possible the assumed avoided generation capacity value could change from a combustion turbine to grid-scale batteries sited with solar.

have usage or availability constraints or benefits, the full avoided capacity cost is adjusted downward or upward, respectively, by adjustment factors. The adjustment factors allow capacity savings to reflect the operational realities of individual demand response programs, such as the length of notification time needed and the ability or a program or resource to be dispatched locally.[65]

Transmission and distribution cost savings

Avoided transmission and distribution (T&D) costs of load management are second in magnitude to capacity savings.[66] As with capacity benefits, no standard approach exists for quantifying load management's avoided T&D costs.

As with avoided capacity costs, California modifies avoided T&D costs for each demand response program, based on "right time", "right place", "right certainty," and "right availability" principles.[67] With a default assumption that a given program does not avoid T&D upgrades, program administrators are able to increase avoided T&D cost values by demonstrating how a given demand response program supports one or more of the above principles.

In Colorado, avoided distribution costs of passive energy efficiency and demand response are treated more equally. In addition to accounting for unspecified, or system-wide, avoided distribution capacity costs, Xcel Energy in Colorado claims incremental avoided distribution capacity costs from its geo-targeting projects.[68] The incremental value is equal to the avoided distribution capacity cost of the targeted system upgrades less the system-wide avoided distribution cost.[69] Both passive and active efficiency measures receive the same incremental benefit, but the measures included in geo-targeting projects are strategically selected based on load profile.[70]

Non-energy impacts

No standard practice exists for quantifying and including NEIs in load management programs. NEIs applied in load management screening could include the same impacts as those used when screening efficiency measures, such is the case in Colorado and Nevada where the same NEB percent adders are applied to demand response programs, and could also include FLM-specific NEIs, such as increased customer control over bills. The authors of the Massachusetts battery storage whitepaper completed a literature review of the NEBs associated with battery

[65] Id. See pages 32-35 for full description of capacity adjustment factors.
[66] "A Framework for Evaluating Cost-Effectiveness of Demand Response." Tim Woolf et al. February 2013. See page 43.
[67] California 2016 Demand Response Cost Effectiveness Protocols." July 2016. See pages 36-38.
[68] Confidential Direct Testimony and Attachments of Donna A. Beaman on Behalf of Public Service Company of Colorado. Filed on July 3, 2017. Colorado Public Utilities Commission Proceeding No. 17A-0462EG. See pages 25-33.
[69] For example, a high-efficiency air conditioner installed is estimated to result in $50 in system-wide avoided distribution capacity over the lifetime of the measure. However, if the measure is installed in a distribution-constrained area, the avoided distribution capacity of the unit results in $300 lifetime savings. The enhanced, or incremental benefit, is $250. Xcel caps the enhanced spending on geo-targeting projects at the summation of the incremental avoided distribution capacity costs to ensure cost-effectiveness.
[70] 2021/2022 Demand-Side Management Plan, Electric and Natural Gas. Public Service Company of Colorado. Colorado Public Utilities Commission Proceeding No. 20A-0287EG. March 16, 2021. See pages 238-243.

storage and determined the only NEB appropriate for including in the state's TRC test was a one-time increase to property value for adding a storage system.[71]

New benefit streams

More research is needed to see whether and how new benefit streams are appropriate to include in cost-effectiveness screening of load management programs. Benefits of enhanced market competitiveness, reduced price volatility, and innovation in retail markets may exist, but they are not well defined, quantified, or accepted in cost-effectiveness screening.[72]

ELECTRIFICATION

The NSPM considers the participant and societal costs and benefits of electrification measures, if implemented strategically, to be similar to those of electric efficiency measures.[73] Societal benefits closely tied to electrification, which could potentially be accounted for in a screening test, are increased resilience, particularly if the electrification device is paired with a load management program, and improved energy security, economy, and employment due to electrification's displacement of petroleum products.[74] Depending on the temporal deployment of electrification resources, avoided GHG emissions and subsequent public health benefits could also increase. Making the transition to hourly profiles more accurately reflects electrification measures' energy and GHG emissions impacts.

Although more research is needed, NEIs associated with electrification measures generally overlap with those of electric efficiency—increased building value, reduced operations and maintenance costs, improved thermal comfort, noise reduction, improved health from reduced indoor air pollution, increased psychological benefit from empowerment and/or energy independence, and increased satisfaction and pride from helping to reduce environmental impacts.[75]

Topic deep-dive: Transportation electrification

States do not appear to be screening electric transportation efficiency or transportation electrification programs through the traditional cost-effectiveness screening tests for ratepayer-funded electric energy efficiency programs.[76] This is assumed to be due to a difference in

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[71] "Massachusetts Battery Storage Measures: Benefits and Costs." Applied Economics Clinic, July 31, 2018. See page 17.

[72] "A Framework for Evaluating Cost-Effectiveness of Demand Response." Tim Woolf et al. February 2013. See pages 53-54.

[73] *National Standard Practice Manual for Benefit-Cost Analysis of Distributed Energy Resources*. National Energy Screening Project. August 2020. See Table S-7. Potential Benefits and Costs of DERs: DER Host Customer and Table S-8. Potential Benefits and Costs of DERs: Societal, on pages xi-xii.

[74] Id. at page 10-3.

[75] Ibid at 10-11.

[76] Utilities, such as Xcel Energy in Colorado, that offer EV charging management offerings under demand response programming may screen these load management programs through their demand side management cost-effectiveness test(s). For example, see 2021/2022 Demand-Side Management Plan, Electric and Natural Gas. Public Service Company of Colorado. Colorado Public Utilities Commission Proceeding No. 20A-0287EG. March 16, 2021. See page 246.

funding sources—in general, the funding streams for clean transportation programs are not electric efficiency ratepayer dollars but state revenues allocated through legislation or third-party funding attained through grants or external partnerships. Alternative cost-effectiveness tests, however, have been developed for allocating funding among clean transportation programs. These cost-effectiveness tests place less emphasis on programmatic administrative costs and more emphasis on the societal benefits of a transportation electrification measure.

The California Energy Commission's School Bus Replacement Program

SB 110 allocates up to $75 million[77] to public school districts for school bus replacement grants through the California Energy Commission's (CEC's) School Bus Replacement Program. In addition to the grant funding to purchase electric school buses, the CEC offers incentives for EV charging infrastructure and workforce development and training resources.[78] SB 110 gives priority to districts operating the oldest school buses, districts containing disadvantaged communities, and districts that have a majority of students eligible for free or reduced-price meals; the CEC established a cost-effectiveness to evaluate each district's bid.[79] The CEC's test, summarized in Table 5, places a strong emphasis on societal benefits—public health benefits, economic benefits, and reduction of carbon emissions, but excludes the potential benefits of job creation, scrappage of the replaced buses (as required by legislation), safety benefits, and vehicle-to-grid abilities from the test methodology.[80] Notably absent from the test are the administrative costs of the school bus replacement program. The energy justice policy priorities of the program are also not directly included in the cost-effectiveness test and are instead considered simultaneously to cost-effectiveness results.

Table 5. CEC School Bus Replacement Program Cost-Effectiveness Test

Benefits	Costs
Lifetime savings from reduced fuel costs	Bus and infrastructure (e.g., electric vehicle supply equipment)[81]
Lifetime savings from reduced maintenance	Operational costs
Health benefits[82] from reduced particulate emissions	
Economic benefits[83] from purchase of buses and electric infrastructure construction and manufacturing	

[77] California SB 110 Clean Energy Job Act. Signed into law July 10, 2017.
[78] Grant Funding Opportunity – School Bus Replacement for California Public School Districts, County Offices of Education, and Joint Power Authorities. State of California Energy Commission. GFO-17-607. October 2018. See page 4.
[79] GFO-17-607: Cost Effectiveness Model Battery Electric School Buses. Posted on California Energy Commission School Bus Replacement Program website. Accessed June 2021.
[80] Id. at page 1.
[81] Each bus is assumed to have a 20-year measure life and uses a 2% discount rate.
[82] Health benefits are calculated using the diesel emissions quantifier (DEQ). DEQ estimates the "reduction of premature mortality, chronic bronchitis, asthma attacks, non-fatal heart attacks, and other health problems" resulting in a reduction of $PM_{2.5}$.
[83] Economic benefits are calculated using the Regional Input-Output Modeling System created by the Bureau of Economic Analysis, which determines changes of economic outputs statewide due to changes of final demand caused by new purchases of school buses and electric infrastructure construction and manufacturing.

Benefits	Costs
Reduction of carbon emissions[84]	

In comparison with the NSPM's screening tests commonly used by electric efficiency programs, the CEC's test is similar to the PCT plus some societal benefits. The PCT includes all direct and non-energy costs incurred by the participant to install, operate, and maintain a measure and bill savings and NEIs experienced by the participant. Because this test does not attempt to determine the value of school buses as a utility system resource, and instead emphasizes participant operational costs and savings, this test diverges from the "least cost resource" utility lens that is embedded in traditional cost-effectiveness test for energy efficiency. This sort of test would be helpful to run, however, for advertising and education purposes to better inform participants of bill savings, GHG savings, and selected societal benefits that result from installing a transportation electrification measure.

California Air Resource Board Air Quality Improvement Program

The California Air Resource Board's (CARB) Air Quality Improvement Program (AQIP) is an incentive program that focuses on reducing mobile source criteria pollutant, diesel particulate, and GHG emissions.[85] Pursuant to the requirements of AB 8, staff established a benefit-cost score and total benefit index to prioritize funding allocations among clean transportation programs such as the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project, Clean Cars 4 All which incentivizes the scrappage of old high-emitting vehicles and replacement with cleaner vehicles, and the Clean Off-Road Equipment Voucher Incentive Project.[86]

Calculating the AQIP's benefit-cost score and total benefit index is a multi-step process. First, the cost-effectiveness ($/ton) of each project is calculated by multiplying the incentive amount per vehicle or equipment by a capital recovery factor (CRF),[87] and dividing the sum by the annual per-vehicle or equipment weighted emissions reductions. *Emissions reductions* in this situation refer only to NO_x, reactive organic gas (ROG), and particulate matter emissions. The cost-effectiveness values ($/ton) are then converted to benefit-cost values (lb/$) and assigned a benefit-cost score based on a scale of 1 to 5, with 1 being the greatest emissions benefit per dollars spent.[88] Next, projects are scored between 0 and 5 for support of and/or alignment with additional preference criteria:

[84] Emissions reductions benefits are calculated using the price of CO_2 from California's cap-and-trade program ($15.10/metric ton as of March 29, 2018).
[85] Low Carbon Transportation Investments and AQIP Funding Plans. California Air Resources Board. Accessed June 2021.
[86] See Appendix B: Emission Reductions Quantification Methodology of Fiscal Year 2020-2021 Funding Plan for Clean Transportation Incentives. California Air Resources Board. Posted January 14, 2021.
[87] The CRF uses an interest rate and project life to determine the rate at which earnings could reasonably be expected to accrue if the same funds were invested over that length of time. The AQIP's cost-effectiveness test utilizes a 1% discount rate and corresponding CRF based on the assumed usage life of vehicles or equipment supported by a given project.
[88] The 1-5 "bins" are determined by taking the high and low resulting benefits and scaling them to develop an equal distribution of scores.

- Potential reduction of critical or toxic air pollutants
- Contribution to regional air quality improvement
- Ability to promote use of clean fuels and technologies
- Ability to achieve GHG emissions reductions
- Ability to support market transformation
- Ability to leverage private capital investments

The final total benefit index score is then calculated by preferentially weighting the benefit-cost score, at 75% of the total score, with additional preference scores, at 25% of the total score. This allows cost-effectiveness of emissions reduction to remain the primary metric for assigning funding preferences, and allows for the consideration of complementary, or even competing, policy priorities.

Although the AQIP cost-effectiveness test differs in scope from traditional cost-effectiveness tests for efficiency, the test quantitatively incorporates the state's broader policy context and goals. If there is desire to develop a test that placed efficiency and electrification programs' benefit within Vermont's policy context, for cost-effectiveness, planning, or advertising purposes, AQIP's approach is an informative example to consider.

Exceptions to Cost-Effectiveness Testing

A significant number of jurisdictions remove cost-effectiveness requirements, either because of the practical expectation that low-income programs cannot meet cost-effectiveness screening requirements, or to balance cost-effectiveness with a state's other policy priorities. These states, rather than expending time, effort, and resources quantifying and incorporating the benefit streams of efficiency, load management, and/or electrification measures or programs, take an alternative approach exempting certain programs from cost-effectiveness given their significant, but unquantifiable, contribution to NEIs, market transformation, or state policies.

At minimum, five jurisdictions remove cost-effectiveness requirements for low-income-focused programs.[89] Illinois, Pennsylvania, and Minnesota do not require low-income programs to be cost-effective. Low-income weatherization projects in Washington, and low-income and tree-planting programs in Iowa, are not required to be cost-effective and are excluded from cost-effectiveness screening.

Maryland, New Jersey, and Oregon allow the implementation of non-cost-effective programs for additional reasons. Maryland's PUC may approve programs that are not cost-effective "to ensure a broader array of energy-saving opportunities amongst rate classes, income levels, etc., or because the program may promote innovative technologies and market-transformative practices leading to broader energy savings."[90] New Jersey allows efficiency programs to have a

[89] There are likely other jurisdictions that remove cost-effectiveness requirements for LI programs but were unidentified by this project.
[90] The EmPOWER Maryland Energy Efficiency Act Report of 2021. Filed with the Public Service Commission of Maryland on April 2021. See page 20.

benefit-cost ratio less than 1 if the program is "in the public interest" such as benefitting low-income customers or promoting emerging technologies.[91] Oregon regulation allows a utility to offer a non-cost-effective measure or program if:[92]

- The measure produces significant non-quantifiable NEBs
- Inclusion of a measure will increase market acceptance and is expected to lead to reduced cost of the measure
- The measure is included for consistency with other demand side management programs in the region
- Inclusion of the measure helps increase participation in a cost-effective program
- The pack of measures cannot be changed frequently, and the measure will be cost-effective during the period the program is offered
- The measure or package of measures is included in a pilot or research project
- The measure is required by law or is consistent with Oregon Public Utilities Commission policy and/or direction

California has taken the approach of exempting efficiency programs from cost-effectiveness farther than any other state. In May 2021, California's Public Utilities Commission approved the segmentation of the state's IOU energy efficiency program portfolios into programs whose primary purposes are resource acquisition, market support, and equity.[93] The cost-effectiveness threshold is applied only to the resource acquisition portfolio; market support and equity portfolios are exempt from cost-effectiveness requirements. This exemption was enabled by the CPUC's decision that it was "free to exercise its judgement and fund energy efficiency and conservation investments that go beyond the budget 'floor' required by the cost-effectiveness standard in §381(b)(1) if they provide value to ratepayers, even if the costs may sometimes exceed the measurable benefits."[94] Having determined that the CPUC may legally consider portfolios in which cost-effectiveness is among the considerations but not the sole consideration, the CPUC then exempted the market transformation and equity portfolios from cost-effectiveness given the portfolios still provide benefits to ratepayers and are important for supporting state policy goals.

In the same decision, the CPUC adopted a new metric called total system benefit (TSB).[95] TSB is an expression, in dollars, of the avoided costs of life-cycle energy, ancillary services, generation capacity, transmission and distribution capacity, and GHG benefits of energy efficiency activities

[91] 2018 New Jersey Revised Statutes Title 48 – Public Utilities Chapter 3 – Section 87.9. (NJ REV Stat (S) 48:3-87.9(2018).
[92] Cost-Effectiveness Board Learning Paper. Prepared by Fred Gordon in April 2019. See pages 7-8.
[93] "Decision 21-05-031 – Assessment of Energy Efficiency Potential and Goals and Modifications of Portfolio Approval and Oversight Process." California Public Utilities Commission. Rulemaking 13-11-005. May 20, 2021. See pages 10-17.
[94] Id. at 20.
[95] Decision 21-05-031 – Assessment of Energy Efficiency Potential and Goals and Modifications of Portfolio Approval and Oversight Process." California Public Utilities Commission. Rulemaking 13-11-005. May 20, 2021. See pages 9-10.

on an annual basis.[96,97] Starting with its 2022-2023 energy efficiency goals, the CPUC is issuing both traditional MW, MWh, and therm, and TSB goals for IOU efficiency program administrators. Starting in 2024, performance administrators will be required to submit new portfolio applications and plans designed to meet TSB goals, with TSB goals being the primary metric.[98] The resource acquisition portfolio segment (rather than market transformation or equity portfolio segments) will make up the bulk of savings to achieve TSB goals. The TSB metric is an innovative and comprehensive new approach for encouraging program administrators to optimize portfolios to achieve benefits during high-value hours. Previously, energy savings in any day or hour counted equally toward goals.

Recommendations

Researching innovative cost-effectiveness practices and fine-tuning existing protocols will remain important for optimizing distributed energy resources for the benefit of customers, utilities, and society. Based on current cost-effectiveness screening practices across the United States, Efficiency Vermont provides the following recommendations to support discussions and decisions regarding energy efficiency utility cost-effectiveness testing in Vermont:

- Engage stakeholders regarding the feasibility of hourly avoided costs and savings to value resources and inform future investments.
    - It is difficult to justify the time and money required to adopt hourly costs and savings if the goals and performance compensation of Efficiency Vermont are not also modified to incentivize investment in technologies that are targeted to certain hours of the day. While exploring the adoption of hourly costs and savings Vermont could consider complementary metrics, such as the TSB as employed in California, to fully realize the opportunities that hourly costs and savings present.
- Continue to monitor the emissions impact of efficiency as electric grids continue to decarbonize and quantify the value of efficiency to decarbonization of the entire system, such as the reduced need for distribution infrastructure associated with electrification.[99]
- Continue to monitor whether and how jurisdictions begin accounting for embodied carbon costs.
- Continue to monitor how other states value NEIs in cost-effectiveness testing. Economic benefits and air quality benefits of efficiency, both of which are highly aligned with

[96] Total System Benefit Technical Guidance, Version 1.2. Published by California Public Utilities Commission Staff on October 25, 2021. See pages 7-8. "The benefits portion of the TSB calculation includes the sum of all measure avoided costs reduced by the measures' net to gross ratio. The TSB calculation does not include non-avoided cost benefits, such as customer rebates, bill savings, or non-energy benefits unless specified by PUC decision … the three types of supply cost increases that are subtracted in the TSB metric are interactive effects, load increases resulting from fuel substitution, and costs related to increased high GWP gas emissions."
[97] Id. at 7. The ACC's avoided cost of refrigerant leakage is not applied per kWh saved and therefore avoided costs are calculated separately in a Refrigerant Calculator and then added to TSB calculation.
[98] "Decision 21-09-037 – Decision Adopting Energy Efficiency Goals for 2022-2032." California Public Utilities Commission. Rulemaking 13-11-005. See Section 3.2.3 2022-2032 Energy Efficiency Goals on pages 18-21.
[99] This recommendation is sourced from Wisconsin's Greening Grid, Effects of Carbon Intensity Changes on the Valuation of Energy Efficiency." Prepared for Focus on Energy by Cadmus. January 14, 2021. See page 2.

Vermont’s policy goals, are NEIs that Efficiency Vermont can continue to monitor given the substantial size of these two benefits, and their alignment with the state’s policy goals. Efficiency Vermont could analyze whether the EEUs’ current screening test (and approach to quantifying NEIs) fully accounts for economic and air quality benefits, or if current practices are instead undervaluing such societal benefits.

- Incorporate support for policy goals into cost-effectiveness testing, in a more direct and quantifiable way, providing Efficiency Vermont and its regulators greater information on the benefits and impacts of Efficiency Vermont’s services. Tests that incorporate policy goals could be used to supplement primary cost-effectiveness testing.

Appendix A - Cost-effectiveness Practices Summary

Table A- 1: Summary of cost-effectiveness practices related to avoided environmental externality costs, hard-to-quantify NEBs, low-income NEBs, and reduced risks/uncertainty.

Jurisdiction	Primary Tests	Secondary Tests	Environmental Externality Costs	Readily Quantifiable NEIs Other Fuel	Water	O&M	Hard-to-Quantify NEIs	Low-Income
California	Modified TRC	SCT, UCT, PCT	TRC, PCT, RIM: GHG Adder of the marginal abatement cost of achieving electric sector GHG target (\$/MT of CO_2e); SCT: SCC adder (\$/MT of CO_2e)[100]	X	X	X	Load serving entities (LSEs) are required to provide qualitative analysis of non-energy and non-monetary impacts when performing DR cost-effectiveness analyses. LSEs are required to include quantitative values for these impacts if and when possible. DER NEIs include social benefits (job creation and environment) in TRC test; utility	California's IOUs use a separate cost-effectiveness test when screening low-income programs called the Low Income Public Purpose Test (LIPPT). The LIPPT includes utility, societal, and participant benefits. Annualized benefits are added per participant across various horizons/years.[102,103]

[100] Decision 19-05-019 - Decision Adopting Cost-Effectiveness Analysis Framework Policies for all Distributed Energy Resources. Rulemaking 14-10-003. Issued May 19, 2019. *See* pages 25-29.
[102] Utility NEIs include reduced carrying costs on arrearages, less bad debt written off, fewer shutoffs, fewer reconnects, fewer notices, fewer customer calls, reduction in gas emergency calls, and reduced subsidy. Societal benefits include health and safety benefits and water and wastewater savings. Participant benefits include program incentives, participant water and wastewater bill savings, participant value from fewer shutoffs, participant value from fewer calls to the utility (i.e., time savings), fewer reconnects, property value benefits from program-provided home repairs, fewer fire losses, fewer health-related expenses from health and safety improvements, participant savings from fewer moves, fewer lost sick days from work, improved comfort and noise, reduced other hardship benefits such as greater control over bill and energy use.
[103] The Low-income Public Purpose Test (LIPPT), Updated for Version 2.0. Prepared by TecMarket Works, Skumatz Economic Research, and Megdal and Associates on May 25, 2001.

Jurisdiction	Primary Tests	Secondary Tests	Environmental Externality Costs	Readily Quantifiable NEIs Other **Fuel**	Water	O&M	Hard-to-Quantify NEIs	Low-Income
							(changes in complaints, billing costs, customer perception of LSE) in TRC, PAC, and RIM; participant (e.g. participant "feeling green") in participant test; and market impacts (market power mitigation or market transformation benefits) in TRC, PAC, and RIM tests.[101]	
Colorado	Modified TRC	RIM, PCT, UCT	Performs a sensitivity analysis of Modified TRC test that includes reduced emissions benefits valued at SCC (from IWG)[104]	X	X	X	20% adder applied to all measures and products (including DR).[105]	30% adder (incremental to 20% NEB adder) applied to LI measures and products.[106]

[101] California 2016 Demand Response Cost Effectiveness Protocols. July 2016. *See* section 3.J.
[104] 2021/2022 Demand-Side Management Plan Electric and Natural Gas. Filed by Public Service Company of Colorado in Colorado Public Utilities Commission Proceeding 20A-0287EG on March 16, 2021. *See* Appendix E.
[105] Decision Approving with Modifications Non-unanimous Comprehensive Settlement; and Establishing Electric Energy Savings and Demand Reduction Goals for 2019 through 2023, with Associated Financial Incentives. Decision No. C18-0417 in Colorado Public Utilities Commission Proceeding No. 17A-0462EG on June 6, 2018. *See* paragraph 45 at page 12.
[106] Id.

Jurisdiction	Primary Tests	Secondary Tests	Environmental Externality Costs	Readily Quantifiable NEIs Other Fuel	Water	O&M	Hard-to-Quantify NEIs	Low-Income
Connecticut	UCT (or Modified UCT for electric programs that save fossil fuels) TRC used as primary test for LI weatherization program.	TRC	Non-embedded cost of GHG and No_x emissions included in TRC.[107]	X (only in Modified UCT and TRC)	X (only in TRC)	X (only in TRC)		For LI weatherization, annual customer bill savings are multiplied by an NEI factor ($0.70 for every $1.00 saved). NEIs in the multiplier are comfort, outside noise, appliance noise, maintenance, home value, home appearance, home safety, and lighting quality.[108]
Delaware	TRC		Estimated avoided cost of reduced CO_2, So_2, and NO_x emissions are included in TRC test.[109] Avoided cost of reduced emissions are sourced from Delmarva Power and	X	X	X		Applies annual $236 adder per weatherization assistance program project to account for thermal comfort, noise, and health NEBs.[111]

[107] 2021 Plan Update to the 2019-2021 Conservation & Load Management Plan. Submitted by Eversource Energy, United Illuminating, Connecticut Natural Gas Corporation, and Southern Connecticut Gas on November 1, 2020. See pages 39-44.
[108] Connecticut's 2021 Program Savings Document, 18th Edition. Filed on March 1, 2021. See Appendix Six: Non-energy Impacts at pages 329-330.
[109] 2019 Evaluation Report. Delaware Department of Natural Resources and Environmental Control. Prepared for Delaware Department of Natural Resources and Environmental Control on December 9, 2020 by EcoMetric Consulting LLC and NMR Group Inc. *See* pages 24-28.
[111] 2019 Evaluation Report. Delaware Department of Natural Resources and Environmental Control. Prepared for Delaware Department of Natural Resources and Environmental Control on December 9, 2020, by EcoMetric Consulting LLC and NMR Group Inc. *See* pages 30-31.

Jurisdiction	Primary Tests	Secondary Tests	Environmental Externality Costs	Readily Quantifiable NEIs			Hard-to-Quantify NEIs	Low-Income
				Other **Fuel**	Water	O&M		
			Light's 2016 IRP.[110]					
District of Columbia	SCT		Externality cost included; use non-embedded GHG costs of global marginal abatement cost from 2018 AESC report.[112]	X	X	X	5% NEB adder. [113] 5% Risk adder. [114]	
Idaho	UCT	TRC, PCT			X	X	10% adder may be applied to all efficiency measures and programs in TRC test to account for reduced risk/uncertainty.[115] Utilities are allowed to include quantified NEI by program when possible.	Utilities are allowed to include quantification of payment-related NEIs when possible (reduced arrearages, health and safety).[116]
Illinois	TRC (includes avoided GHG costs and societal discount rate)	UCT	SCC set at $16.50/MWh (based on IWG 2016 update using 3%	X	X	X	TRC estimates health benefits from reduced emissions (using	LI programs do not need to be cost-effective.

[110] 2016 Integrated Resource Plan. Delmarva Power & Light Company. Issued November 30, 2016. *See* page 15 of Section 8.
[112] Performance Benchmark Assessment of FY2019 DC Sustainable Energy Utility Programs. Submitted to District of Columbia Department of Energy and Environment on June 1, 2020. See pages 36-37.
[113] Id.
[114] Id.
[115] Demand-Side Management 2019 Annual Report, Supplement 1: Cost-Effectiveness. Idaho Power on March 15, 2020. See page 5.
[116] Order No. 32788 in Idaho Public Utilities Commission Case No. GNR-E-12-01 on April 12, 2013. See pages 5-8.

Jurisdiction	Primary Tests	Secondary Tests	Environmental Externality Costs	Readily Quantifiable NEIs			Hard-to-Quantify NEIs	Low-Income
				Other **Fuel**	Water	O&M		
			discount rate). Beginning in 2023, the price increases by $1/MWh annually.[117]				EPA's AVERT COBRA tool).[118]	
Iowa	SCT	PCT, RIM, UCT	See 10% adder description.[119]		X	X	10% adder applied in SCT; unclear if the adder accounts for NEBs, environmental externalities, or both.[120]	LI and tree-planting programs are not required to be cost-effective and are not considered in determining cost-effectiveness of efficiency plans as a whole.[121]
Maryland	SCT, TRC	PCT, RIM, UCT	Applies SCC (net cost of Regional Greenhouse Gas Initiative) to emissions rate. Use latest SCC value from IWG.			X[122]	Quantify Business as Usual value equivalents for comfort, C&I O&M, and reduced customer arrearages in SCT and TRC tests.[123,124]	Cost-effectiveness screening of LI portfolio is required to serve as a point of comparison with other jurisdictions and past programmatic performance rather than as a basis for cost-effectiveness.[125]

[117] ComEd Energy Efficiency Plan 6. Filed March 1, 2021 in Illinois Commerce Commission Docket 21-0155. See Appendix A.
[118] ComEd Societal Non-Energy Impacts Research Report. Prepared by Guidehouse. Published on March 10, 2021. See pages 11-12.
[119] IPL 2020 Appendix D Benefit Cost Excel Calculations. Prepared by Cadmus and filed with the Iowa Utilities Board on April 30, 2021 in EEP-2018-003. See User Inputs tab.
[120] IPL 2020 Appendix D Benefit Cost Excel Calculations. Prepared by Cadmus and filed with the Iowa Utilities Board on April 30, 2021 in EEP-2018-003. See User Inputs tab
[121] Final Order. Iowa Utilities Board Docket No. EEP-2018-0004. Issued March 26, 2019. See pages 5-6.
[122] O&M benefits only calculated and applied to C&I portfolio when screening with the SCT, TRC, and PCT. Benefits vary by measure, and are applied on a per-measure basis.
[123] Order No. 87082. Public Service Commission of Maryland Case Nos. 9153-9159157 and Case No. 9362. Issued July 16, 2015. See pages 4-17.
[124] Development and Application of Select Non-Energy Benefits for the EmPOWER Maryland Energy Efficiency Programs. Prepared by Itron Inc. on August 5, 2014.
[125] The EmPOWER Maryland Energy Efficiency Act Report of 2021. Filed with the Public Service Commission of Maryland on April 2021. See page 20

Jurisdiction	Primary Tests	Secondary Tests	Environmental Externality Costs	Readily Quantifiable NEIs			Hard-to-Quantify NEIs	Low-Income
				Other Fuel	Water	O&M		
Massachusetts	TRC		Applies SCC value from the 2021 Avoided Energy Supply Components (AESC) report to all measures except fossil fuel heating and cooling measures[126,127]	X	X	X	Program Administrators monetize NEBs with "reliable and real economic value" on a per-measure basis. Monetized NEIs—including thermal comfort, noise reduction, home durability, and health benefits.[128]	Program Administrators monetize LI NEBs with "reliable and real economic value" on a per-measure basis. Monetized NEBs for LI measures—including thermal comfort, noise reduction, home/property durability, reduced tenant complaints, health benefits, improved safety, and utility savings.[129,130]
Minnesota	SCT	PCT, RIM, UCT, TRC	Uses a range of costs for CO_2, all based on IWG SCC values. Commission also approves cost values for criteria pollutants (SO_2, $PM_{2.5}$,NO_x)[131]			X		Historically, LI programs have not been held to the same cost-effectiveness requirements as non-low income programs; for example, not needing to

[126] An Act Creating a Next-generation Roadmap for Massachusetts Climate Policy (Senate Bill 9). Signed into law by Governor Baker on March 26, 2021.
[127] 2022-2024 Massachusetts Joint Statewide Electric and Gas Three-year Energy Efficiency Plan. Massachusetts Department of Public Utilities dockets 21-120 and 21-129. Filed November 1, 2021 as Exhibit 1. See page 15 of 48 of Appendix A.
[128] Id. at pages 16-17 of Appendix A.
[129] Id.
[130] Program Administrators of Massachusetts Non-Energy Impact Framework Study Report. Produced by Tetra Tech, DNV GL and NMR on January 23, 2018. See Appendix B.
[131] Order Updating Environmental Cost Values. Minnesota Public Utilities Commission Docket No. E-999/CI-14-643. Issued January 3, 2018. See pages 30-34.

Jurisdiction	Primary Tests	Secondary Tests	Environmental Externality Costs	Readily Quantifiable NEIs Other Fuel	Water	O&M	Hard-to-Quantify NEIs	Low-Income
								have a benefit-cost ratio greater than 1 for the SCT.
Nevada	TRC	Non-energy Benefits TRC (NTRC), SCT, UCT, PCT, RIM, SCT	10% conservation adder for environmental externalities included in SCT.[132]	X	X		NTRC test and SCT includes a 10% adder for C&I programs, 15% residential non-LI.[133]	NTRC and SCT includes a 25% adder for residential LI.[134]
New Hampshire	Primary Granite State Test	Secondary Granite State Test, UCT	Secondary test includes environmental externality value based on non-embedded GHG cost. Value derived from AESC 2018.[135]	X	X		The Secondary Granite State Test includes percent adders for participant NEBs for the residential (non-LI) and C&I sectors. Value of adders has yet to be approved, though 25% residential and 10% C&I are proposed.[136]	Both primary and secondary tests include an annual $406 per-project adder for LI weatherization projects reflecting LI participant NEBs (comfort, decreased noise, and health-related NEIs).[137]

[132] 2019 Combined Annual Electric Demand Side Management Update Report. Nevada Power Company d/b/a NV Energy and Sierra Pacific Power Company d/b/a NV energy. Public Utilities Commission of Nevada Docket No. 19-07. July 1, 2019. See page 124 of 358.
[133] Id. at pages 123 of 358.
[134] Id.
[135] New Hampshire Technical Reference Manual for Estimating Savings from Energy Efficiency Measures, 2021 Program Year. Revised copy filed December 15, 2020, by the New Hampshire Utilities in NHPUC Docket No. DE-20-092. See pages 10-11.
[136] Settlement Agreement for the 2021-2023 New Hampshire Statewide Energy Efficiency Plan. Filed in NHPUC Docket No. DE 20-092 on December 3, 2020. See pages 6-7.
[137] New Hampshire Technical Reference Manual for Estimating Savings from Energy Efficiency Measures, 2021 Program Year. Revised copy filed December 15, 2020, by the New Hampshire Utilities in NHPUC Docket No. DE-20-092. See pages 10-11.

Jurisdiction	Primary Tests	Secondary Tests	Environmental Externality Costs	Readily Quantifiable NEIs Other **Fuel**	Water	O&M	Hard-to-Quantify NEIs	Low-Income
New Jersey	New Jersey Test (similar to TRC)	TRC, SCT, PACT, PCT, RIM	Calculates avoided damage cost of CO_2, uses SCC published by IWG with 3% discount rate.[138]	X	Included in NEB adder.		5% non-energy benefit adder applied to all non-LI programs to account for difficult-to-quantify benefits (public health, water and sewer benefits, economic development).[139]	10% adder applied to all LI programs to account for benefits (including health and safety).[140]
New York	SCT	RIM, UCT	Damage cost of carbon, based on either Clean Energy Standard Tier 1 Renewable Energy Credit price, or federal SCC net RGGI clearing price.[141]	X	Assessed qualitatively in SCT. Also include qualitative assessment of land impact in SCT.	X	Benefits directly related to utility or grid operations that cannot be monetized can be included qualitatively. [142]	
Oregon	TRC	UCT	Utilities are required to consider the potential future cost of carbon		X		10% adder to benefits of energy efficiency to account for risk, uncertainty, and	

[138] Order Adopting the First New Jersey Cost Test. Issued August 24, 2020, in New Jersey Board of Public Utilities Docket No. Q020060389. See Table 1: Summary of New Jersey Cost Test Inputs and Values.
[139] Id.
[140] Id.
[141] Benefit-Cost Analysis Handbook, Version 3.0 of Niagara Mohawk Power Corporation d/b/a National Grid. Updated June 30, 2020, in New York Public Utility Commission Case 14-M-0101. See pages 41-45.
[142] Id at page 46.

Jurisdiction	Primary Tests	Secondary Tests	Environmental Externality Costs	Readily Quantifiable NEIs Other **Fuel**	Water	O&M	Hard-to-Quantify NEIs	Low-Income
			regulation to the utility in forecasts of gas and electric costs. These "carbon compliance costs" are included in the avoided costs used in the UCT and the TRC test.[143]				known but difficult-to-quantify benefits.[144,145]	
Pennsylvania	TRC			X[146]	X[147]	X		No cost-effectiveness requirement for LI programs or measures.[148]
Rhode Island	Rhode Island Test (similar to TRC)		Includes non-embedded GHG cost. Moving from global to NE marginal abatement cost	X	X	X	Include monetized participant NEBs on a measure-specific basis (includes national security, thermal comfort, noise	PAs include LI NEBs on a measure-specific basis.[151]

[143] Cost-Effectiveness Board Learning Paper. Energy Trust of Oregon in April 2018. See page 11.
[144] Id at 14.
[145] 4.06.000-P Cost-Effectiveness Policy and General Methodology for Energy Trust of Oregon. Energy Trust of Oregon. Last updated December 12, 2014. See page 3.
[146] Heating penalties (therms per kWh of lighting savings) applied to homes and businesses with fuel oil and propane heat and natural gas heating systems due to the installation of LED lighting reducing the amount of waste heat produced by lighting end-use.
[147] Use $0.01 per gallon (in 2021 dollars) as the marginal cost of water used for TRC testing escalated annually over the forecast horizon, with a loss factor of 24.5% (1.32 multiplier) to be applied to all savings calculated at the end-use level.
[148] 2021 TRC Test Final Order. Issued by Pennsylvania Public Utility Commission on December 19, 2019, in Docket No. M-2019-3006868. See page 25.
[151] Id. at page 9.

Jurisdiction	Primary Tests	Secondary Tests	Environmental Externality Costs	Readily Quantifiable NEIs Other **Fuel**	Water	O&M	Hard-to-Quantify NEIs	Low-Income
			from AESC report.[149]				reduction, home durability, health benefits). Include program-specific multipliers for economic development impacts of all efficiency measures (GDP/$ program spending)[150]	
Utah	UCT	PacifiCorp TRC, TRC, PCT, RIM, UCT	Included in 10% conservation adder.				10% conservation adder included in PacifiCorp TRC test to account for non-quantified environmental and non-energy benefits of conservation resources over supply-side alternatives.[152]	.
Vermont	SCT	UCT	Includes non-embedded GHG cost. Use global Marginal Abatement	X	X	X	15% adder to broadly account for NEBs in SCT; 5% adjuster to costs for reduced	15% LI adder in SCT.[156]

[149] 2021 Rhode Island Test Description. Attachment 4 of 2021 Energy Efficiency Program Plan. Filed by the Narragansett Electric Company d/b/a National Grid in Docket No. 5076 on October 15, 2020. See pages 10-11 of Attachment 4.
[150] Id at pages 9-19 of Attachment 4.
[152] Utah Energy Efficiency and Peak Reduction Annual Report. Issued by Rocky Mountain Power on June 18, 2019. See page 6.
[156] Id.

Jurisdiction	Primary Tests	Secondary Tests	Environmental Externality Costs	Readily Quantifiable NEIs Other Fuel	Water	O&M	Hard-to-Quantify NEIs	Low-Income
			Cost from AESC report.[153]				risk/uncertainty in SCT;[154] 10% economic development adder applied only to ESA electric and fuel impacts.[155]	
Washington	Modified TRC	UCT, PCT, RIM	Environmental benefits considered to be included in 10% conservation adder.	X	X	X	10% conservation benefit adder,[157] 10% risk adder.[158]	Cost effectiveness of LI weatherization projects not assessed.[159]
Wisconsin	Modified TRC	Expanded TRC, UCT, RIM, SCT	Market-based values of avoided CO_2, NO_x, and SO_2 included in modified TRC,		X (in SCT)	X (in SCT)	Expanded TRC includes benefits of Modified TRC plus net economic benefits. SCT includes benefits of Expanded TRC plus NEBs (health benefits from	In SCT, a per-participant adder applied to LI Home Performance with ENERGY STAR program to represent reduced costs to utility and customers

[153] Order on the EEU Screening Values for Use Starting in 2021. Vermont Public Utility Commission. Case No. 19-0397-PET. Issued July 6, 2020. See page 14-17.
[154] Id. at 33-34.
[155] Order Re Valuation, Measurement, and Verification of the SMEEP and ESA Pilot Program. Vermont Public Utility Commission. Case No. 19-0302-PET. Issued December 20, 2019. See pages 5-7.
[157] Washington Utilities and Transportation Commission required utilities to demonstrate progress toward identifying, researching, and developing a plan to properly value non-energy impacts that have not previously been quantified. The non-energy impacts considered must include the "costs and risks of long-term and short-term public health benefits, environmental benefits, energy security, and other applicable non-energy impacts." These impacts must be included in utilities' 2022–2023 Biennial Conservation Plans. See pages 4-5 of Attachment A of Order 01 Accepting 2020-2029 Ten-Year Achievable Conservation Potential and 2020-2021 Biennial Conservation Target, Subject to Conditions. Docket EU-190912. December 18, 2019.
[158] Id at page 4.
[159] Washington Administrative Code. Title 480, Chapter 480-109, Section 100 (WAC 480-109-100(10)).

Jurisdiction	Primary Tests	Secondary Tests	Environmental Externality Costs	Readily Quantifiable NEIs			Hard-to-Quantify NEIs	Low-Income
				Other **Fuel**	Water	O&M		
			expanded TRC, and SCT.[160,161]				reduced emissions and increased property values).[162]	from reduced arrearages.[163]
Wyoming	TRC	PacifiCorp TRC, TRC, UCT, PCT, RIM	Included in 10% conservation adder.				10% conservation adder included in PacifiCorp TRC test to account for non-quantified environmental and non-energy benefits of conservation resources over supply-side alternatives.[164]	

[160] Order establishing a value of avoided carbon dioxide emissions for purposes of assessing the cost-effectiveness of the statewide Focus on Energy efficiency and renewable resource program. Issued December 23, 2015, by Public Service Commission of Wisconsin in 5-FE-100.
[161] Focus on Energy Calendar Year 2020 Evaluation Report, Volume III Appendices. Prepared by Cadmus for Public Service Commission of Wisconsin on May 21, 2021. See Appendix H: Cost-Effectiveness and Emissions Methodology and Analysis, pages H-2 to H-17.
[162] Id. at pages H-2 to H-5.
[163] Id. at pages H-12 to H-13.
[164] 2017 Wyoming Annual Demand-Side Management Report. Rocky Mountain Power. Issued June 25, 2018. See page 6

Appendix B - Resources

GENERAL RESOURCES

Cost-Effectiveness Tests: Overview of State Approaches to Account for Health and Environmental Benefits of Energy Efficiency. American Council for an Energy-Efficient Economy (ACEEE). December 13, 2018.

Database of Screening Practices. National Energy Screening Project. Accessed July 2021.

National Standard Practice Manual, For Benefit-Cost Analysis of Distributed Energy Resources. National Energy Screening Project. August 2020.

Non-Energy Impacts Approaches and Values: an Examination of the Northeast, Mid-Atlantic, and Beyond. Northeast Energy Efficiency Partnerships. June 2017.

STATE RESOURCES

California

- "D.17-08-022: Decision Adopting Interim Greenhouse Gas Adder." California Public Utilities Commission Rulemaking 14-10-003. August 24, 2017.
- Decision 19-05-019 - Decision Adopting Cost-Effectiveness Analysis Framework Policies for all Distributed Energy Resources. California Public Utilities Commission Rulemaking 14-10-003. Issued May 19, 2019.
- Decision 20-04-010 – 2020 Policy Updates to the Avoided Cost Calculator. California Public Utilities Commission Rulemaking 14-10-003. Issued April 16, 2020.
- Decision 21-05-031 – Assessment of Energy Efficiency Potential and Goals and Modification of Portfolio Approval and Oversight Process. California Public Utilities Commission Rulemaking 13-11-005. May 20, 2021.
- Decision 21-09-037 – Decision Adopting Energy Efficiency Goals for 2022-2032. California Public Utilities Commission Rulemaking 13-11-005. Issued September 23, 2021.
- 2020 Distributed Energy Resources Avoided Cost Calculator Documentation." Produced by E3 for the California Public Utilities Commission. See Version c1c (Final) published on June 24, 2020

Colorado

- 2021/2022 Demand-Side Management Plan Electric and Natural Gas. Filed by Public Service Company of Colorado in Colorado Public Utilities Commission Proceeding 20A-0287EG on March 16, 2021. *See* pages 297-319.
- Decision Approving with Modifications Non-Unanimous Comprehensive Settlement; and Establishing Electric Energy Savings and Demand Reduction Goals for 2019 through 2023, with Associated Financial Incentives. Decision No. C18-0417 in Colorado Public

Utilities Commission Proceeding No. 17A-0462EG on June 6, 2018. See paragraph 45 at page 12.

Connecticut

- 2021 Plan Update to the 2019-2021 Conservation & Load Management Plan. Submitted by Eversource Energy, United Illuminating, Connecticut Natural Gas Corporation, and Southern Connecticut Gas on November 1, 2020. See pages 39-44.
- Connecticut's 2021 Program Savings Document, 18th Edition. Filed on March 1, 2021. See Appendix Six: Non-Energy Impacts at pages 329-330.

Delaware

- Program Years 2016-2018 Evaluation Report. Delaware Department of Natural Resources and Environmental Control. *See* page 31.
- 2019 Evaluation Report. Delaware Department of Natural Resources and Environmental Control. Prepared for Delaware Department of Natural Resources and Environmental Control on December 9, 2020, by EcoMetric Consulting LLC and NMR Group Inc. *See* pages 24-28.
- 2016 Integrated Resource Plan. Delmarva Power & Light Company. Issued November 30, 2016. *See* page 15 of Section 8.

District of Columbia

- Performance Benchmark Assessment of FY2019 DC Sustainable Energy Utility Programs. Submitted to District of Columbia Department of Energy and Environment on June 1, 2020. See pages 36-37.
- Idaho
- Demand-Side Management 2019 Annual Report, Supplement 1: Cost-Effectiveness. Idaho Power on March 15, 2020. See pages 1-5.
- Order No. 32788 in Idaho Public Utilities Commission Case No. GNR-E-12-01 on April 12, 2013. See pages 4-8.

Illinois

- Order re Approval of the Energy Efficiency and Demand-Response Plan. Issued by the State of Illinois Commerce Commission on February 6, 2008, in Docket 07-0539. See pages 10-11.
- ComEd Societal Non-Energy Impacts Research Report. Prepared by Guidehouse. Published on March 10, 2021.
- Evaluation of ComEd's CY2020 Total Resource Cost Test. Prepared for ComEd by Guidehouse on June 29, 2021.
- ComEd Energy Efficiency Plan 6. Filed March 1, 2021, in Illinois Commerce Commission Docket 21-0155. See Appendix A.
- Illinois Future Energy Jobs Bill, SB2814.

Iowa

- IPL 2020 Appendix D Benefit Cost Excel Calculations. Prepared by Cadmus and filed with the Iowa Utilities Board on April 30, 2021 in EEP-2018-003. See User Inputs tab.
- Final Order. Iowa Utilities Board Docket No. EEP-2018-0004. Issued March 26, 2019. See pages 5-6.

Maryland

- MD Pub Util Code § 7-211(2019). https://law.justia.com/codes/maryland/2019/public-utilities/division-i/title-7/subtitle-2/sect-7-211/
- Order No. 87082. Public Service Commission of Maryland Case Nos. 9153-9159157 and Case No. 9362. Issued July 16, 2015. See pages 4-17.
- Development and Application of Select Non-Energy Benefits for the EmPOWER Maryland Energy Efficiency Programs. Prepared by Itron Inc. on August 5, 2014.
- The EmPOWER Maryland Energy Efficiency Act Report of 2021. Filed with the Public Service Commission of Maryland on April 2021. See page 20.

Massachusetts

- Order Approving Revised Energy Efficiency Guidelines. Issued by Massachusetts Department of Public Utilities in docket 20-150-A on May 3, 2021. See final Energy Efficiency Guidelines.
- An Act Creating a Next-generation Roadmap for Massachusetts Climate Policy (Senate Bill 9). Signed into law by Governor Baker on March 26, 2021.
- 2022-2024 Massachusetts Joint Statewide Electric and Gas Three-year Energy Efficiency Plan. Massachusetts Department of Public Utilities dockets 21-120 and 21-129. Filed November 1, 2021 as Exhibit 1. See page 15 of 48 of Appendix A.
- Program Administrators of Massachusetts Non-Energy Impact Framework Study Report. Produced by Tetra Tech, DNV GL and NMR on January 23, 2018. See Appendix B.

Minnesota

- Decision – CIP Gas and Electric Utilities 2021-2023 Cost-Effectiveness Review. Minnesota Department of Commerce Docket Nos. G999/CIP-18-782, E999/CIP-18-783. Issued February 11, 2020.
- Order Updating Environmental Cost Values. Minnesota Public Utilities Commission Docket No. E-999/CI-14-643. Issued January 3, 2018.
- Updating the Energy Efficiency Cost-Effectiveness Framework in Minnesota. Presentation by Synapse Energy Economics on September 10, 2018.

Nevada

- 2019 Combined Annual Electric Demand Side Management Update Report. Nevada Power Company d/b/a NV Energy and Sierra Pacific Power Company d/b/a NV energy. Public Utilities Commission of Nevada Docket No. 19-07. July 1, 2019.

New Hampshire

- New Hampshire Technical Reference Manual for Estimating Savings from Energy Efficiency Measures, 2021 Program Year. Revised copy filed December 15, 2020, by the New Hampshire Utilities in NHPUC Docket No. DE-20-092. See pages 10-11.

- Home Energy Assistance Program Evaluation Report 2016-2017 – FINAL. Prepared by Opinion Dynamics for the New Hampshire Utilities on July 29, 2020. See page 5.

- Settlement Agreement for the 2021-2023 New Hampshire Statewide Energy Efficiency Plan. Filed in NHPUC Docket No. DE 20-092 on December 3, 2020. See pages 6-7.

New Jersey

- 2018 New Jersey Revised Statutes Title 48 – Public Utilities Chapter 3 – Section 87.9. (NJ REV Stat (S) 48:3-87.9(2018).)
- Order Adopting the First New Jersey Cost Test. Issued August 24, 2020, in New Jersey Board of Public Utilities Docket No. Q020060389.

New York

- Benefit-Cost Analysis Handbook, Version 3.0 of Niagara Mohawk Power Corporation d/b/a National Grid. Updated June 30, 2020, in New York Public Utility Commission Case 14-M-0101.
- Establishing a Value of Carbon, Guidelines for Use by State Agencies. Published by the New York State Department of Environmental Conservation. Updated October 2021.

Oregon

- Cost-Effectiveness Board Learning Paper. Energy Trust of Oregon in April 2018.
- 4.06.000-P Cost-Effectiveness Policy and General Methodology for Energy Trust of Oregon. Energy Trust of Oregon. Last updated December 12, 2014.

Pennsylvania

- 2021 TRC Test Final Order. Issued by Pennsylvania Public Utility Commission on December 19, 2019, in Docket No. M-2019-3006868.

Rhode Island

- 2021 Rhode Island Test Description. Attachment 4 of 2021 Energy Efficiency Program Plan. Filed by the Narragansett Electric Company d/b/a National Grid in Docket No. 5076 on October 15, 2020.
- 2021 Energy Efficiency Program Plan Technical Reference Manual. Filed by the Narragansett Electric Company d/b/a National Grid in Docket 5076 on October 23, 2020. See Appendix B-1.

Utah

- Utah Energy Efficiency and Peak Reduction Annual Report. Issued by Rocky Mountain Power on June 18, 2019. See page 6.

- Order. Public Service Commission of Utah Docket No. 09-035-27. Issued October 7, 2009.

Vermont

- Order on the EEU Screening Values for Use Starting in 2021. Vermont Public Utility Commission. Case No. 19-0397-PET. Issued July 6, 2020.
- Order Re Valuation, Measurement, and Verification of the SMEEP and ESA Pilot Program. Vermont Public Utility Commission. Case No. 19-0302-PET. Issued December 20, 2019. See pages 5-7.

Washington

- Cost-Effectiveness Board Learning Paper. Energy Trust of Oregon. April 2018.
- Puget Sound Energy 2021 Annual Conservation Plan. Filed by Puget Sound Energy on November 13, 2020 in Washington Utilities and Transportation Commission Docket UE-190905.
- Washington Administrative Code. Title 480, Chapter 480-109, Section 100 (WAC 480-109-100(10)).
- 2021 Conservation Plan – Washington. Pacific Power. November 13, 2020. See pages 77-79.
- Order 01 Accepting 2020-2029 Ten-Year Achievable Conservation Potential and 2020-2021 Biennial Conservation Target, Subject to Conditions. Docket EU-190912. December 18, 2019. See page 4 of Attachment A.

Wisconsin

- Focus on Energy Calendar Year 2020 Evaluation Report, Volume III Appendices. Prepared by Cadmus for Public Service Commission of Wisconsin on May 21, 2021. See Appendix H: Cost-Effectiveness and Emissions Methodology and Analysis.
- Focus on Energy 2015-2018 Quadrennium Economic Impact Analysis. Prepared by Cadmus for Public Service Commission of Wisconsin on July 3, 2020. See Appendix D: Revised CY2019 Cost-Effectiveness Results.
- Final Decision for the statewide energy efficiency and renewable resource program's quadrennial planning period of 2019-2022 setting goals, priorities, and measurable targets for Focus on Energy. Issued June 6, 2018, by Public Service Commission of Wisconsin in 5-FE-101.
- Order establishing a value of avoided carbon dioxide emissions for purposes of assessing the cost-effectiveness of the statewide Focus on Energy efficiency and renewable resource program. Issued December 23, 2015, by Public Service Commission of Wisconsin in 5-FE-100.
- Memo re: Quadrennial Planning Process II: Carbon Valuation for use in Focus on Energy Cost-effectiveness Tests. Prepared by Evaluation Work Group for Public Service Commission of Wisconsin. Filed in 5-FE-100 on November 11, 2015.

Wyoming

- 2017 Wyoming Annual Demand-Side Management Report. Rocky Mountain Power. Issued June 25, 2018. See page 6.
- 2019 Wyoming Annual Demand-Side Management Report. Rocky Mountain Power. Issued July 1, 2020.