Non-Energy Impacts Approaches and Values: an Examination of the Northeast, Mid-Atlantic, and Beyond

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Table of Contents

List of Tables

List of Figures

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About NEEP

NEEP was founded in 1996 as a non-profit whose mission is to serve the Northeast and Mid-Atlantic to accelerate energy efficiency as an essential part of demand-side solutions that enable a sustainable regional energy system. Our vision is that the region will fully embrace next generation energy efficiency as a core strategy to meet energy needs in a carbon-constrained world.

Disclaimer: NEEP verified the data used for this brief to the best of our ability. This paper reflects the opinion and judgments of the NEEP staff and does not necessarily reflect those of NEEP Board members, NEEP Sponsors, or project participants and funders.

Introduction

A non-energy impact (NEI) is an additional benefit (positive or negative) for participants in energy efficiency beyond the energy savings gained from installing energy efficient measures. NEIs include benefits such as reduced costs for operation and maintenance associated with efficient equipment or practices, or reduced environmental and safety costs. There are NEIs attributable to both participants and to society at large. NEIs are being considered, in addition to energy and cost savings, when making decisions about cost-effective energy efficiency investments in order to account for impacts such as avoided pollution, economic development, improved system performance, and deferring system upgrades. NEIs are also referred to as non-energy benefits (NEBs), but for the purpose of this report and to remain consistent, NEI will be the terminology used.

The literature on NEIs has transitioned from the recognition of these impacts by regulators and program administrators to recommendations on how best to incorporate these benefits into cost-effectiveness screening. This report summarizes the key findings from NEIs reviewed in literature, technical references manuals, and utility annual reports. This report does not develop specific recommendations on NEI values or treatment in cost-effectiveness testing, but does objectively report treatment of non-energy impacts in various jurisdictions, with a focus on distinguishing approaches used to develop the impacts (e.g. evidence-based versus other approaches). In addition, key elements in recent and forthcoming cost-effectiveness guidance and selected studies identified from a literature review are briefly summarized. The intent of this report is to provide an objective foundation of current practices that New Hampshire can use to formulate its own recommendations on how to proceed with NEIs.

As a quick recap of findings from the summary section, while the Total Resource Cost and Societal tests enable inclusion of non-energy impacts, there is no clear prevailing approach to including NEIs in efficiency cost-effectiveness screening. Evidence suggests that both credibility and convenience have been factors in states' decisions about what to include in NEIs, particularly for states with monetized NEIs. States that adopt monetized NEIs from other sources may apply discounts to make the values more conservative. It is difficult to compare NEI values because categories and units are not necessarily consistent, although tables in the Appendices include some comparisons that have been done and more comparisons could be done with additional digging into details. The use of adders or combined approaches in which adders and monetized NEIs are included have enabled states to be more comprehensive in terms of the types of NEIs included in cost-effectiveness analysis. Recent guidance from the National Standard Practice Manual provides important direction for states developing or revising cost-effectiveness practices because it defines core principles that avoid biased, asymmetrical application of cost-effectiveness tests and it recommends that states make their energy efficiency policy context a key element in deciding about what to include in NEIs. The guidance documents aim at a high level. There is little or no guidance literature addressing exactly what NEIs to include and how best to include them. The process of selecting NEIs based on literature will most likely involve judgments or modifications to reflect a jurisdiction's comfort with values used in other states. While evaluation reports and academic studies demonstrate the ability to value some NEIs using recognized research and analytical methods, important work remains to be done on valuation. This is especially true for applications of cost-effectiveness for distributed energy resources as well as energy efficiency; over time the methods may become increasingly sophisticated and precise, and with greater visibility additional valuation methods may become available. Regardless, learning from experience and others is a valuable strategy. Looking ahead, the region and the country would also benefit from: development of a national central collection place for methods for and values of NEIs; inclusion of NEIs values and formulas in TRMs, protocols or templates to increase transparency; and guidance on implementing cost-effectiveness frameworks.

New Hampshire Policy Context

New Hampshire policy supporting energy efficiency has long recognized that there are relevant non-energy impacts related to the objectives of energy efficiency. For example, following restructuring in the late 1990's, a working group of diverse stakeholders' recommendations included statewide energy programs, low income programs and an adder for non-energy impacts: "The Group agrees that even with the inclusion of non-electric resource benefits and costs in the proposed New Hampshire Cost effectiveness analysis, energy efficiency programs produce environmental and other benefits that are not otherwise captured in the direct avoided costs. The Group, with the exception of Northern, agrees that 15% should be added to avoided energy costs at this time as a proxy for the net benefits from energy efficiency-related savings, and believes that including this adder is consistent with New Hampshire law."[1] The adder was viewed as an appropriate mechanism at that time, with an understanding that either the value or use of that mechanism warranted reconsideration when appropriate – for example when credible market-based price proxies for emissions values became applicable or if the value of avoided emissions is incorporated into avoided cost estimates. In 2000 the Public Utility Commission (PUC) noted: "We will accept the cost effectiveness test as proposed in the Working Group's report. We do so recognizing that the thresholds of a benefit-cost ratio have changed, and that the test itself now includes spillover benefits and costs not previously included in the cost effectiveness test, as well as a 15% adder to represent environmental and other benefits of energy efficiency/conservation programs. Although the Commission has not previously authorized the use of adders, we will do so here and permit such a mechanism until some material change occurs that would warrant our reconsideration of the adder or its magnitude."[2]

Subsequently the commission removed the 15 percent adder for other non-quantified benefits (e.g., environmental and other benefits), finding that the costs associated with these adders were already internalized in the energy avoided costs associated with NOx, SO_2 and CO_2.

The 2002 Energy Plan discussion of energy efficiency policy simulation analysis noted that "operating cost-effective energy efficiency programs provides significant lasting benefits to New Hampshire's energy security, reliability, and economy, and environmental improvements for the state's residents and businesses. The economic benefits start immediately, as New Hampshire businesses ramp up to deliver efficiency programs, and last for the lifetimes of the measures. These measures also reduce the risk to residents and businesses posed by the possibility of a fuel price shock."[3]

The 2009 New Hampshire Climate Action Plan connects energy efficiency, greenhouse gas reductions and long-term economic benefits. "The most significant reductions in both emissions and costs will come from substantially increasing energy efficiency in all sectors of our economy, continuing to increase sources of renewable energy, and designing our communities to reduce our reliance on automobiles for

[1] Report to the NH PUC, at 16, 1999

[2] New Hampshire Public Utilities Commission, at Section D, Nov 1 2000.

[3] New Hampshire Energy Plan, at 9

transportation…Our response to climate change and our economic future are inextricably linked and should focus on how we produce our energy and how much energy we use.[4]

The 2014 New Hampshire Ten-Year Energy Strategy called for the PUC to open a "proceeding that directs the utilities in collaboration with other interested parties, to develop efficiency savings goals …aimed at achieving all cost effective efficiency over a reasonable time frame. The Legislature should also adopt an overarching policy directive that all State actions should be guided by the goal of capturing all cost effective energy efficiency savings." In addition the strategy encouraged distributed generation, reducing costs for low income customers, and grid modernization. It encourages borrowing of "best in class" strategies and programs from other jurisdictions to assist in achieving the state's potential. [5]

Legislative mandate established use of the Total Resource Cost Test in New Hampshire. The exclusion of the adder is continuing, as mentioned in the state energy plan.[6] However, note that the cost-effectiveness test currently takes into account some non- energy impacts (e.g., water). The PUC staff believes that after 17 years, some history should now be available to replace the adder with evidence-based proxies for some if not all of the non-energy benefits. The need for an updated cost-effectiveness is particularly evident based on the most recent energy efficiency plan for 2017, which emphasizes energy efficiency as the least cost resource for carbon reduction. The NHSaves energy efficiency programs save electricity at an average cost of approximately $0.0366 per lifetime kWh, compared to the retail price of $0.16292 and save natural gas at an average cost of $0.336 per therm, compared to the retail price of $0.813 per therm.[7] Non-energy impacts within cost-effectiveness screening may enable more energy efficiency programs, which will result in more savings.

This plan is built around new opportunities in energy efficiency made possible by the newly approved (August 2016) Energy Efficiency Resource Standard (EERS). The EERS defines energy savings targets that increase overtime. The NHPUC's Order of August 2, 2016[8] defines energy savings goals as a percentage of the NH utilities 2014 delivery sales, with transition targets of 0.60 percent for electric savings and 0.66 percent for natural gas savings in 2017. The initial three-year period of the EERS will be calendar years 2018 through 2020, where the cumulative annual savings goals are 3.1 percent of the NH Electric Utilities 2014 kWh delivery sales, and 2.25 percent of the NH Gas Utilities 2014 MMBtu delivery sales.

This quick policy review shows that energy efficiency in New Hampshire is understood to intersect with the following other state policy drivers:

- GHG mitigation
- Economic development
- Low Income support
- Development of Distributed Energy Resources
- Other Natural Resources

[4] New Hampshire Climate Action Plan, at 3
[5] The New Hampshire 10 Year Energy Strategy, at iii
[6] New Hampshire Energy Efficiency Plan, at 34-36
[7] New Hampshire Energy Efficiency Plan, at 3
[8] Order No. 25,932

Report Overview

In this report, the **Cost-Effectiveness and NEIs Section** briefly identifies the traditional cost-effectiveness tests types of NEIs and common measurement approaches. It also identifies the core elements of guidance on cost-effectiveness from NEEP as well as an overview of the National Standard Practice Manual for Assessing Cost-Effectiveness which proposes a framework for development of a jurisdictional policy-specific test, the Resource Value Test. This test can be applied to efficiency and other DERs. The **Approaches to Quantifying NEIs Section** categorizes the prevailing approaches for incorporating NEIs into cost-effectiveness screening and it provides an overview of approaches to NEIs as well as an overview of what primary and other tests are used throughout the country. In addition it profiles various states with respect to available background information such as the decision-making process or source information for NEIs. **The Summary of Findings and Conclusion** characterizes prevailing practice, pros and cons of various states' experience s and recommendations and considerations that would assist a jurisdiction as well as the region or country with decisions regarding development of NEIs. **Appendix 1: State Summarized NEI Values** and **Appendix 2: Reported NEIs in Evaluation Research** provide specific NEI values extracted from various state sources and reports, respectively. **Appendix 3: Rhode Island Cost-Effectiveness Framework, Docket 4600** provides Rhode Island's version of an application of the Resource Value Framework, in the form of a table from the Docket which is essentially a populated version of the RVF template for development of a Rhode Island policy-based cost-effectiveness assessment. **Appendix 4: NEI Categories, definitions, and specific examples** is included for background reference. **Appendix 5: Annotated Bibliography** provides abstracts of a selection of reports and studies that address or estimate NEIs. **Appendix 6: Arkansas Protocol L** is included as an example of a jurisdiction making NEI assumptions and calculation approaches transparent and accessible.

Cost-Effectiveness and NEIs

Cost-effectiveness screening practices are used to ensure that the use of ratepayer funds will result in ratepayer benefits by identifying investments in energy efficiency resources that will benefit customers, utility systems, and society at large. Incorporating NEIs into cost-effectiveness screening is now seen as a best practice for energy efficiency programs. When evaluating NEIs, both negative and positive impacts are included. Within the different types of cost-effectiveness testing, NEIs are captured to different degrees. In the Utility Cost Test (UCT), only utility NEIs are captured. In the Total Resource Cost test (TRC), participant and utility NEIs are captured. Societal NEIs are only captured in the Societal Cost Test (SCT). These three tests are a part of the California Standard Practice Manual[9].

[9] California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects, (July 2002), Available here: http://www.calmac.org/events/spm_9_20_02.pdf

Table 1. *California Standard Practice Manual Tests*

Abbr.	Name	Perspective	Description
TRC	Total Resource Cost	Utility+ Participant	Combines the costs and benefits of the program administrator & the participants
UCT	Utility Cost Test	Utility	Includes costs and benefits experienced by the program administrator
RIM	Ratepayer Impact Measure	Impact on rates	Includes all PAC costs and benefits, plus changes in revenues
PCT	Participant Cost Test	Participant	Includes costs and benefits experienced by the participants
SCT	Societal Cost Test	TRC + Society	Includes all TRC costs and benefits, plus several environmental benefits and a lower discount rate

The Societal Cost test includes the costs and benefits experienced by all members of society. This includes all of the costs incurred by any member of society: the program administrator, the customer, and anyone else. Similarly, the benefits include all of the benefits experienced by any member of society. The costs and benefits are the same as for the TRC Test, except that they also include externalities, such as environmental costs and reduced costs for government services.

The Total Resource Cost test includes the costs and benefits experienced by all utility customers, including both program participants and non-participants. The costs include all the costs incurred by the program administrator and participating customer, including the full incremental cost of the efficiency measure, regardless of whether it was incurred by the program administrator or the participating customers. The benefits include all the avoided utility costs, plus any other program benefits experienced by the customers, such as avoided water costs, reduced operations and maintenance costs, improved comfort levels, health and safety benefits, and more.

The Utility Cost test includes the energy costs and benefits that are experienced by the energy efficiency program administrator. This test is most consistent with the way that supply-side resources are evaluated by vertically integrated utilities. The costs include all expenditures by the program administrator to design, plan, administer, deliver, monitor and evaluate efficiency programs offset by any revenue from the sale of freed up energy supply. The benefits include all the avoided utility costs, including avoided energy costs, avoided capacity costs, avoided transmission and distribution costs, and any other costs incurred by the utility to provide electric services (or gas services in the case of gas energy efficiency programs).

Various sources of guidance exist to supplement the California Standard Practice Manual or to direct specific jurisdictions. The impetus for guidance comes from the fact that the California Standard Practice Manual does not connect the tests to local policies and across jurisdictions there is variation in which tests are used, how the tests are calculated, as well as the level of confidence in the values of inputs included in the tests. NEIs are one aspect where best practice continues to evolve.

Types of NEIs

NEIs may be divided into three main categories: utility, participant and societal NEIs. Participant NEIs are impacts that accrue to the utility customer, whereas societal NEIs are those that are realized by the public, not just the participants in utility programs or utility customers where the measures are installed. NEIs realized by society at large as externalities include public health impacts, reductions in greenhouse gas emissions, water impacts, and local economic development effects. There societal factors may impact the overall value of energy efficiency investments. Below is a list of NEI categories, for definitions see appendix 4.

Utility NEI categories:

- Peak load reductions
- Transmission and/or distribution savings
- Reduced payments arrearages
- Reduced carrying costs,
- Lower debt written off/ lower collection costs
- Fewer customer calls

Participant NEI categories:

- Operations and Maintenance (O&M) cost savings
- Participant heath impacts
- Comfort
- Employee productivity
- Property values
- Benefits to low-income customers

Societal NEI categories:

- Public health and welfare effects
- Air quality impacts
- Water quantity and quality impacts
- Coal ash ponds and coal combustion residuals
- Economic development and employment effects
- Employment impacts
- Economic development constraints
- Other economic considerations
    - Societal risk and energy security
    - Benefits unique to low-income energy efficiency programs

The various calculation results and studies surrounding NEIs have resulted in some inconsistency and varying certainty around NEI values. For instance, some must be locally measured, such as water, whereas some depend on the reliability of the local utility system. The table below shows the variability and patterns in NEI values. The top right box represents NEIs that have a high value associated with the impact, with little variations in calculation results. This table covers whether there is variation across programs and within program or measure types. This is important because there are NEIs that are generally consistent across programs, such as emissions, with little variation besides peak versus baseload programs.[10]

[10] Skumatz (b), at 37

Table 2. *Variation of NEI Values*

Variation	Low Value NEI	High Value NEI
Low variation, consistent across programs		Emissions (Societal) Potentially T&D, infrastructure, reliability (utility)
Low variation WITHIN program / measure types	Utility arrearage and coll'n NEIs (utility & participant)	Economic multipliers (Societal) Home value improvement (participant; if valued according to program investment) Participant benefits including: comfort / noise / light, control over bills, equipment O&M / service. Safety measures, estimated using survey responses, are fairly consistent (participant)
High variation		Emergency gas service calls; emergencies; insurance (utility and participant)
Not well studied	Tax effects Wastewater / water infrastructure (unknown size) Hardship / social welfare indicators (definition; unknown size) Neighborhood property improvements (societal, unknown size) Fish / wildlife mitigation (societal, unknown size) National security (societal, unknown size)	Health and safety; health care; IAQ effects (participant and societal) Substation / infrastructure / power quality (possibly high value; utility) Reliability (participant) Fewer moves (participant)

Source: Skumatz (b and c), 2014 updated from Skumatz, et al. 2010

Guidance on Cost-effectiveness

Cost-effectiveness tests should fully account for all costs and benefits and excluding NEIs may result in less-than economic investments in energy efficiency. This is often because costs are easy to capture, whereas benefits are not as straightforward. When conducting a cost-effectiveness analysis, when a cost is included, the benefit should also be included to maintain symmetry. A core issue with the TRC test, and the SCT if not properly calculated, is that it may be imbalanced as currently implemented because participant benefits are not always extensively included. In current practice, the test sometimes includes all customer costs for an energy efficiency project, but may ignore the customer non-energy impacts from the project. To address this imbalance, NEIs should be added to the equation so that it reads:

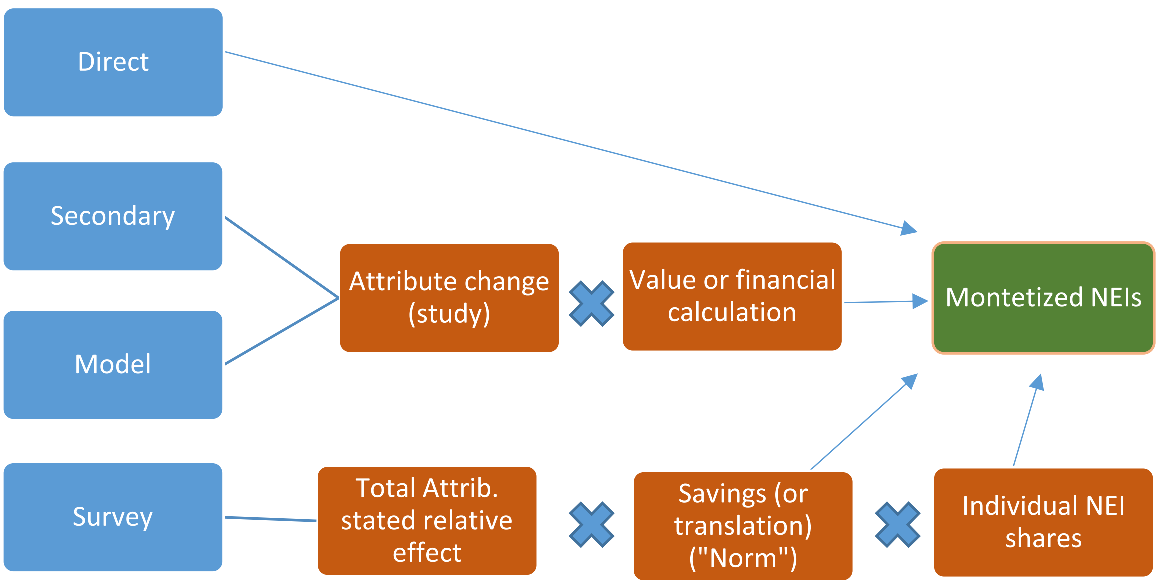
$$\text{TRC}=\frac{(Utility\ costs + Participant\ costs)}{(Utility\ benefits+Participant\ benefits)} \quad \text{SCT}=\frac{Utility+Participant+Societal\ costs}{Utility+Participant+Societal\ benefits}$$

In current practice, non-energy impacts are more frequently or only included for some sectors (notably low-income) than others (notably commercial and industrial). This may inaccurately reflect the value that energy efficiency delivers to participants or more broadly, to the jurisdiction. There are a number of methods available to account for NEIs. Five of the primary means of accounting NEIs are to (1) monetize them directly, (2) develop proxy values, (3) develop alternative screening benchmarks, (4) to rely on regulatory judgment, and (5) Multi-

Attribute Decision Analysis.[11] Adders are typically used to describe a factor applied to quantify impacts for various reasons, such as if the impact is difficult or costly to monetize, as well as when it is convenient to bundle multiple impacts into one factor.

Monetary values are often considered the most rigorous approach to estimate the value of NEIs. They often focus on observable (easily measured) attributes and results may be based on statistical analysis with associated confidence intervals. There are four main approaches to measuring NEIs. This includes direct (corporate records, utility data), secondary (financial calculations), model (jobs and emissions), and survey (including academic studies, utility or state-specific studies, and questions included as part of process and impact evaluations). These methods result in monetized NEIs.

Figure 1. *Monetizing NEIs*



Source: Modified from Skumatz, LBNL webinar on NEIs, 2016

[11] NEEP, at 20

Table 3. *Measurement Methods for Monetized NEIs*

Method	NEI Category and Beneficiary/ Perspective
Arrearage studies, directly or derived	Utility: Arrearages, bad debt, shutoffs/reconnects, notices, calls/collections, Participant: calls, connections/ disconnections, notices
Incidence change times value	Utility: emergency/ safety, T&D savings Participant water bill savings Societal: tax effects
Engineering/ third party models	Societal: economic, emissions
Surveys:	Participant: moving, maintenance, equipment lifetimes, equipment function, comfort, noise, light quality, sick days, satisfaction, ability to pay bills, property value / aesthetics in home, satisfaction
Not currently estimated, or few studies, or multiple methods being tested	Utility: substations / infrastructure, power quality / reliability Societal: Health, H&S, social welfare, infrastructure, wildlife, national security Participant: Deeper health benefits; IAQ

Source: Skumatz (c), Figure 2.2 at 23

Even with various methods applied to NEIs, some attributes may be difficult and costly to monetize. In addition, accuracy of the many NEIs estimates may be questionable and controversial and very difficult to use effectively in modeling. It may be difficult to attribute specific NEIs to specific measures, which may make it difficult to determine the cost-effectiveness of individual measures.[12] Adders are an alternative to monetized NEIs. While the derivation of adders is not as tied to direct observation, adders have advantages beyond lower cost. They can acknowledge the existence of impacts that we know are not zero in value. They can be applied conveniently across the range of programs for societal benefits such as emissions rather than requiring analysis at a measure, program, or sector level.

Regardless of how they are developed, it is important to provide a transparent, consistent structure for presenting efficiency costs and benefits. The following guiding principles will assist in examining the cost-effectiveness screening process.

1) **Energy Policy Goals:** Energy efficiency screening practices should account for the energy policy goals of each state, as articulated in legislation, commission orders, regulations, guidelines and other policy directives. These policy goals provide guidance with regard to which efficiency programs are cost-effective and in the public interest.

2) **Symmetry**: Energy efficiency screening practices should ensure that tests are applied symmetrically, where both relevant costs and relevant benefits are included in the screening analysis. For example, a state that chooses to include participant costs in its screening test should also include participant benefits, including low-income and other participant non-energy benefits.

3) **Hard-to-Quantify Benefits**: Energy efficiency screening practices should not exclude relevant benefits on the grounds that they are difficult to quantify and monetize. Several methods are available to approximate the magnitude of relevant benefits, as described below.

[12] Morgenstern, J., slide 13

4) **Transparency:** Energy efficiency program administrators should use a standard template to explicitly identify their state's energy policy goals and to document their assumptions and methodologies.

These principles provide states with a common framework for addressing decisions about cost-effectiveness screening and ensuring that these decisions are made transparently and are clearly understood by all stakeholders.[13] These principles are important because energy efficiency is the least cost option for carbon reduction and new supply for utilities. If a flawed or incorrect cost-effectiveness screening results in the exclusion of energy efficiency programs that are actually cost-effective, then utility system costs will be higher than necessary. If energy efficiency programs are excluded then additional benefits realized by the participant or society will be lost as well.

Therefore, the framework should clearly document the key screening assumptions (e.g., discount rate, measure life, savings levels), as well as the quantitative and qualitative cost and benefit findings.[14] Transparency will ensure that all stakeholders understand the inputs and assumptions used within cost-effectiveness screening and can help inform the state's cost-effectiveness screening protocols. One way to achieve transparency is to encourage the use of standard templates to present the costs, benefits, assumptions and methodologies used. The following table presents costs and benefits separately, from different perspectives (utility, participant, and public/societal interest) and identifies those impacts that are monetized versus not.

[13] For more on guidance on cost-effectiveness screening, see NEEP., *Cost-Effectiveness Screening Principles and Guidelines: For Alignment with Policy Goals, Non-Energy Impacts, Discount Rates, and Environmental Compliance Costs*

[14] The Resource Value Framework, the National Efficiency Screening Project, at 11

Table 4. *Sample Efficiency Screening Template*

Efficiency Screening Template			
1. Key Assumptions, Parameters, and Summary of Results			
Program Administrator:		**Reporting Period**:	
Program Name:		**Date of Filing:**	
Analysis Level (e.g., program, porfolio):		**Relevant State Policies:** [ADD LINK TO SUPPORTING DOCUMENT]	
Average Program Measure Life		Discount Rate	
Projected Annual Savings		Projected Lifetime Savings	
2. Monetized Utility Costs		**Monetized Utility Benefits**	
Program Administration		Avoided Energy Costs	
Incentives Paid to Participants		Avoided Capacity Costs	
Shareholder Incentive		Avoided T&D Costs	
Other Utility Costs		Wholesale Market Price Suppression	
		Avoided Environmental Compliance Costs	
		Other Utility System Benefits	
NPV Total Utility Cost		NPV Total Utility Benefits	
3. Monetized Participant Costs		**Monetized Participant Benefits**	
Participant Contribution		Participants' Savings of Other Fuels	
Particiapnt's Increased O&M Costs		Participant Non-Energy Benefits	
Other Participant Costs		Participants' Water and Sewer Savings	
		Participants' Reduced O&M Costs	
		Participants' Health Impacts	
		Participant Employee Productivity	
		Participant Comfort	
		Additional Low-Income Participant Benefits	
		Other Participant Non-Energy Benefits	
NPV Total Participant Cost		NPV Total Participant Benefits	
4. Monetized Energy Policy Costs		**Monetized Energy Policy Benefits**	
Public Costs		Public Benefits of Low Income Programs	
		Reduced Environmental Impacts (if monetized)	
		Public Fuel and Water Savings	
		Reduced Public Health Care Costs	
		Other Public Benefits	
NPV Total Participant Cost		NPV Total Public Benefits	
Total Monetized Costs and Benefits			
Net Benefits (PV$): Utility		**BCR: Utility Impacts**	
Net Benefts (PV$): Utility + Participant		**BCR: Utility + Participant Impacts**	
Net Benefts (PV$): Utility + Participant + Public		**BCR: Utility + Participant + Public Impacts**	
5. Non-Monetized Energy Policy Benefits and Costs			
Benefits or Cost	**Comments (how considered in screening)**		
Promotion of Customer Equity			
Promotion of Market Transformation			
Reduced Environmental Impacts (if not monetized)			
Increased Jobs and Economic Development			
6. Determination			
Program Benefits Exceed Costs		**Program Benefits Do Not Exceed Costs**	

Source: NEEP, at 50

National Standard Practice Manual (NSPM)

The National Efficiency Screening Project (NESP) announced the publication of the National Standard Practice Manual for Assessing Cost-Effectiveness of Energy Efficiency Resources (NSPM or manual) in May, 2017[15]. The NSPM provides neutral, objective guidance learned from experience. It also addresses the importance of applicable policy goals of jurisdiction to provide a clear and transparent framework. The manual introduces a new test: the Resource Value Test (RVT), designed to be flexible with respect to what is included in the test, so that cost-effectiveness can be assessed relative to the scope and evolution of jurisdiction-specific policy goals. It recommends use of the RVT as the primary test but notes that use of traditional secondary tests may also have value for informing decisions regarding efficiency, such as program design, investment priorities or public discussion of resource acquisition. The manual identifies core principles that are fundamental to sound tests, as well as a multi-step framework to help jurisdictions with the development of its primary test for assessing energy efficiency (and other distributed energy resource) cost-effectiveness.

The manual will improve the way utility customer-funded energy efficiency programs are evaluated by providing best practices for incorporating NEIs in cost-effectiveness testing. This manual improves upon the California Standard Practice Manual (CaSPM) since the CaSPM may limit jurisdictions to these tests, which may not reflect the mix of perspectives reflected in relevant policies and lacks guidance on accounting for policies and goals. The NSPM provides regulatory perspectives and recommends accounting for hard-to-quantify impacts with symmetry across all costs and benefits.

The core principles overlap somewhat with principles from the NEEP Guidance:

1) **Efficiency as a Resource.** EE should be compared with both supply-side and demand-side alternative energy resources in a consistent and comprehensive manner.
2) **Energy Policy Goals.** Each jurisdiction's primary cost-effectiveness test should account for its applicable policy goals.
3) **Hard-to-Quantify Impacts.** Efficiency assessment practices should account for all relevant, important impacts, even those that are difficult to quantify and monetize.
4) **Symmetry.** Efficiency assessment practices should be symmetrical, for example by including both costs and benefits for each relevant type of impact.
5) **Forward Looking.** Analysis of impacts of efficiency investments should be forward-looking, capturing the difference between costs and benefits that would occur over the life of the measures with those that would occur absent the efficiency investments. (Sunk costs and benefits are not relevant).
6) **Transparency.** Efficiency assessment practices should be completely transparent and should fully document all relevant inputs, assumptions, methodologies and results.

The framework for developing the Resource Value Test follows the principles; it puts forth steps shown below for developing a cost-effectiveness test.

[15] Available here: https://nationalefficiencyscreening.org/national-standard-practice-manual/

Table 5. *Steps to Develop Resource Value Test*

Steps	Framework: Process to Develop Test
1	Identify and articulate the jurisdiction's applicable policy goals.
2	Include all the utility system costs and benefits.
3	Decide which non-utility impacts to include in the test, based on applicable policy goals.
4	Ensure that the test is symmetrical in considering both costs and benefits.
5	Ensure the analysis is forward-looking and incremental.
6	Develop methodologies to account for all relevant impacts, including hard to quantify impacts.
7	Ensure transparency in presenting the inputs and results of the cost-effectiveness test.

In the document, justification for each step is discussed and defended. To assist in providing a comprehensive, consistent and easily accessible structure for presenting a jurisdiction's findings from cost-effectiveness analysis, the document includes the following sample standard template in which to document both monetized and non-monetized findings of an assessment as well as references for all key assumptions and methodologies used. The template can be used to report cost-effectiveness at the program, sector or portfolio level. (The manual recommends including EE program costs at the level at which they are truly variable). The template is included below to help illustrate the scope of costs and benefits to consider and to note that net present value-based benefit-cost ratios should be used for decision-making. The manual includes discussion of considerations on some of the other decision-elements associated with cost-effectiveness testing.

Table 6. *NSPM Example Template*

Efficiency Cost-Effectiveness Reporting Template			
Program/Sector/Portfolio Name:		Date:	
A. Monetized Utility System Costs		B. **Monetized Utility System Benefits**	
Measure Costs (utility portion)		Avoided Energy Costs	
Other Financial or Technical Support Costs		Avoided Generating Capacity Costs	
Program Administration Costs		Avoided T&D Capacity Costs	
Evaluation, Measurement, & Verification		Avoided T&D Line Losses	
Shareholder Incentive Costs		Energy Price Suppression Effects	
		Avoided Costs of Complying with RPS	
		Avoided Environmental Compliance Costs	
		Avoided Bad Debt, Arrearages, Disconnections	
		Reduced Risk	
Sub-Total Utility System Costs		**Sub-Total Utility System Benefits**	
C. Monetized Non-Utility Costs		**D. Monetized Non-Utility Benefits**	
Other fuel costs	*These impacts would be included to the extent that they are part of the Resource Value (primary) test.*	Other fuel benefits	*These impacts would be included to the extent that they are part of the Resource Value (primary) test.*
Water and other resource costs		Water and other resource benefits	
Participant costs		Participant benefits	
Low-income customer costs		Low-income customer benefits	
Environmental costs		Environmental benefits	
Public health costs		Public health benefits	
Economic development and job costs		Economic development and job benefits	
Energy security costs		Energy security benefits	
Sub-Total Non-Utility Costs		**Sub-Total Non-Utility Benefits**	
E. Total Monetized Costs and Benefits			
Total Costs (PV$)		**Total Benefits (PV$)**	
Benefit- Cost Ratio		**Net Benefits (PV$)**	
F. Other Non-Monetized Considerations			
Customer Equity Impacts	*Quantitative data, qualitative info and discussion of how considered*		
Market Transformation Impacts	*Quantitative data, qualitative info and discussion of how considered*		
Program and Market Continuity	*Quantitative data, qualitative info and discussion of how considered*		
Pilot, RD&D Impacts	*Quantitative data, qualitative info and discussion of how considered*		
Other Non-Monetized Impacts	Quantitative data, qualitative info and discussion of how considered		
Determination:	**Do Efficiency Resource Benefits Exceed Costs? [Yes / No]**		

Considerations in Applying Cost-Effectiveness Tests

Free-Riders and Spillover. Participant rebates or incentives are only a cost if the cost-effectiveness test excludes participant impacts. Spillover incurs costs only if the test includes participant impacts.

Discount Rates. The discount rate should reflect the regulatory perspective, which should reflect the time preference of customers as a whole and be guided by the same perspective used to define the cost-effectiveness test. The Manual outlines a series of questions for regulators to answers to guide determination of the discount rate. An abbreviated version of guidance is included here.

Table 7. *Regulatory Questions*

Regulatory Question	If Yes	If No
Does the Weighted Average Cost of Capital (WACC) represent the regulatory time preference (focus on utility investment)?	Can use the WACC	Can use a rate lower than utility WACC
Does the average customer discount rate represent the regulatory time preference (focus on broad range of utility customer interests)?	Can use the average customer discount rate	Can use a rate lower than average customer discount rate
Is a societal time preference appropriate for the jurisdiction's applicable policy goals?	Can use societal discount rate	Can use a rate higher than societal

Analysis Period End Effects. The analysis period should be long enough to cover lifecycle costs and benefits; a second best alternative is to amortize costs and compare portions of costs over a sorter analysis period.

Analysis of Early Replacement. The analysis should reflect that up-front investment cost is partially offset by the value of deferring the next replacement. The analysis may need to also account for a shifting efficiency baseline and may result in different savings levels in different future years.

Inclusion of Participant Impacts. One of the key reasons for including participant impacts in the primary cost-effectiveness test is to account for impacts on all utility customers regardless of who experiences the impacts. This allows for a broader accounting of impacts than what is included as utility system costs alone. However, it is important to recognize that some are energy related while others are not. The Manual recognizes that there are challenges with estimating participant costs and benefits, along with other nuanced discussion of considerations associated with the treatment of participant impacts.

The framework also addresses cost-effectiveness for other Distributed Energy Resources (DERs). While the manual focuses on cost-effectiveness assessment of energy efficiency resources, it can be used for any type of DER. However, the applicable policy goals and the magnitude of some of the costs and benefits may be different. Other types of DERs might also have different magnitudes for the same type of cost or benefit. The manual provides an illustration of both utility and non-utility costs and benefits and the degree of association (as indicated by shading in the dots) with DERs. Further DER experience is needed to more comprehensively address the applicability of costs/benefits to the range of DERS.

Table 8. Utility System Costs and Benefits of DERs

		Energy Efficiency	Demand Response	Distributed Generation	Distributed Storage
Costs					
Utility System	Measure costs (utility portion)	●	◑	○	○
	Other financial incentives	●	●	◑	◑
	Other program and administrative costs	●	◑	◑	◑
	Evaluation, measurement, and verification	●	●	●	●
	Performance incentives	◑	◑	◑	◑
	Interconnection costs	○	○	●	●
	Distribution system upgrades	○	○	●	●
Benefits					
Utility System	Avoided energy costs	●	◑	●	◑
	Avoided generation capacity costs	●	●	●	●
	Avoided reserves or other ancillary services	●	●	●	●
	Avoided T&D system investment	●	●	●	●
	Avoided T&D line losses	●	●	●	●
	Wholesale market price suppression	●	●	●	●
	Avoided RPS or EPS compliance costs	●	◑	●	◑
	Avoided environmental compliance costs	●	◑	●	◑
	Avoided credit and collection costs	◑	◑	◑	◑
	Reduced risk	●	●	◑	◑

Table 9. *Non-Utility System Costs and Benefits of DERs*

		Energy Efficiency	Demand Response	Distributed Generation	Distributed Storage
Costs					
Non-Utility	Measure costs (participant portion)	●	●	●	●
	Interconnection fees	○	○	◕	◕
	Annual O&M	○	○	●	●
	Participant increased resource consumption	◑	◑	◑	◑
	Non-financial (transaction) costs	◔	●	○	○
Benefits					
Non-Utility	Reduced low-income energy burden	◑	◑	◑	◑
	Public health benefits	●	◑	●	◑
	Energy security	●	◑	●	◑
	Jobs and economic development benefits	●	●	●	●
	Environmental benefits	●	◑	●	◑
	Participant health, comfort, and safety	◑	○	○	○
	Participant resource savings (fuel, water)	◑	○	○	○

Approaches to quantifying NEIs: National Overview and Selected State-Specific Information

The variety of approaches to incorporating NEIs in cost-effectiveness testing and program evaluation can be categorized as follows[16]:

- "Incorporating a simple, conservative "adder" to the impacts. Most suggest they are trying to incorporate factors related to omitted environmental or emissions effects;
- Incorporating "readily measurable" NEIs into the screening. Several states are adopting this flexible approach, with the readily measurable impacts varying among programs (for example, including easier-to-measure water bill savings from clothes washer programs, and omitting "softer" NEIs such as comfort, measured from surveys);
- Taking an "all in" approach trying to measure all NEIs, or the leading from among several dozen NEIs;
- A hybrid approach: using an adder and measuring either readily measurable impacts, or as many impacts as possible beyond what is included in the adder.
- NEIs can be incorporated by measure, program, or across the board."

The table below shows which states include adders, followed by a state by state look at whether an adder or readily measured method is deployed for NEIs, or in some cases a hybrid with both incorporated.

Table 10. *States with NEI Adders*

State	Adder	Description	Description source
California	$30/ton	PUC requires program administrators to account for utility-perspective and participant-perspective NEBs when assessing the low-income efficiency programs (SERA, 2010, p. 34). The participant-perspective NEBs include: water and sewer savings; fewer shutoffs; fewer calls to the utility; fewer reconnects; property value benefits; fewer fires; reduced moving costs; fewer illnesses and lost days from work or school; net benefits for comfort and noise; and net benefits for additional hardship	CPUC Report, 2012; RAP/Synapse, 2012.
Colorado	10% electric adder, 25% low-income program adder, 5% gas	The percentage is applied to the sum of the other quantifiable benefits and is used when calculating TRC Test values for specific DSM programs and the overall portfolio. The Colorado PUC also allows for the option of including specific non-energy benefits, on a program-by-program basis, when such benefits are clearly occurring and can be easily calculated. Furthermore, in applying the TRC Test to low income DSM programs, the benefits included in the calculation are increased by 20 percent to reflect the higher level of non-energy benefits that are likely to accrue from	CPUC Report, 2012; RAP/Synapse, 2012.

[16] Malmgren, I. & Skumatz, L., *Lessons from the Field: Practical Applications for Incorporating Non-Energy Benefits into Cost-Effectiveness Screening,* ACEEE 2014 Summer Study, (2014), Pg. 4, Available at: http://aceee.org/files/proceedings/2014/data/papers/8-357.pdf

		DSM services to low-income customers (CO PUC, 2008, p. 26-27, 43).	
Illinois	Ameren 10% electric, 7.5% gas; DCEO 10% adder; ComEd NA; Emissions adder $0.0139/kWh	Water savings is quantified in the IL-TRM. Measures include: Clothes Washer; showerhead; aerator; thermostatic restrictor valve; dishwasher; ozone laundry; and HE pre-rinse spray valve measures. IL-TRM also quantifies operations and maintenance savings where differences exist between baseline and efficient measures.	ICC Staff
Iowa	10% adder for electric; 7.5% adder for gas	Iowa legislature, 1999.	Johnson Consulting Group
Maryland	A 1.115 cent per kWh adder has been applied to the ex-ante societal cost test in developing EmPOWER plans	Aside from this adder, there has been no attempt to include environmental externality costs into the EmPOWER ex ante or ex post cost effectiveness analyses.	Itron, 2014
New Mexico	15% adder; low income weatherization includes a multiplier of 1.25 for benefits.	Allows avoided carbon emissions to be included in the TRC (environmental) for low-income. Lifetime energy savings from programs targeted exclusively to low-income customers are valued at 1.25 times the actual KWh savings.	CPUC Report, 2012
New York	$15 adder for carbon	Order Establishing Energy Efficiency Portfolio Standard and Approving Programs, the Commission found that implementation of energy efficiency programs will have a more favorable impact on air quality so the TRC was amended to include the CO_2 adder in 2008	RAP/Synapse, 2012
Oregon	Carbon ($15/ton) 10% adder	The PUC of Oregon has a long-standing policy that utilities (now the Energy Trust of Oregon) should calculate non-energy benefits if they are significant and there is a reasonable and practical method for calculating them (OR PUC, 1994, p. 15; SERA, 2010, p. 34-35).	CPUC Report, 2012; RAP/Synapse, 2012
Utah	Environmental "adder" of 10% of benefits for low income cost-effectiveness if regulators allow	Environmental adder for low-income	Johnson Consulting Group
Vermont	15% non-energy adder, 10% cost reduction for risk and flexibility	The Vermont Public Service Board requires that several Other Program Impacts (OPIs) be accounted for in EE screening: 1) the risk benefits of EE resources should be accounted for by applying a 10% discount to the EE	RAP/Synapse, 2012

	advantages + 15% low income	costs; 2) the non-energy benefits of EE resources should be accounted for by applying a 15% adder to the energy benefits (Vermont PSB, 2012); 3) water, O&M, and other fuel savings should be accounted for with quantified and monetized estimates of those benefits, and applied to those programs in which these savings are expected to occur; 4) the non-energy benefits of low-income programs should be accounted for by applying a 15% adder to the energy benefits associated with those programs..	
Washington	10% adder	Puget Sound Energy: Puget Sound Energy categorizes NEBs as quantifiable and non-quantifiable. Where possible and easily quantifiable, Puget Sound Energy may include dollar values for non-energy benefits in its TRC Test, including values for water usage savings or maintenance savings. Non-quantifiable NEBs may include legislative or regulatory mandates, support for regional market transformation programs, low-income health and safety, low income energy efficiency, or experimental and pilot programs. Where there is a significant amount of non-quantifiable NEBs, then Puget Sound Energy is able to accept EE programs with a benefit-cost ratio of less than 1.0, as long as the ratio exceeds 0.667 (PSE, 2012; SERA, 2010, p. 35). SERA 2010 report notes: "*NEBs were, but are no longer, used for internal and regulatory cost-effectiveness test. No NEBs are required to be reported for regulatory purposes, but lower B/C ratios are allowed for low-income weatherization programs because NEBs are assumed to be associated with those programs*."	Johnson Consulting Group, RAP/Synapse, 2012; SERA Report, 2010
Washington D.C.	10% adder, 10% risk, 10% environ + NEIs in goals and measured benchmarking	A risk adder is applied to energy efficiency benefits, as a proxy for the risk benefits. Accounts for improved health and reduced environmental degradation	District Dept. of the Environment
Wisconsin	Carbon $30/ton	CO_2 is part of economic externalities and is included in their benefit cost called "simple benefit cost test," which combines elements of the TRC and Societal Cost Tests' approach. Mercury, which is currently considered a non-economic externality, is included in a test called "expanded benefit cost test." This test incorporates non-energy benefits as well as macroeconomic benefits	RAP/Synapse, 2012

Source: Modified and updated from 2015 NEBs research by Illinois , 2015 http://bit.ly/2r9d8Vy

Figure 2. *Map of Adder Tests& Program Screening Across the U.S.*

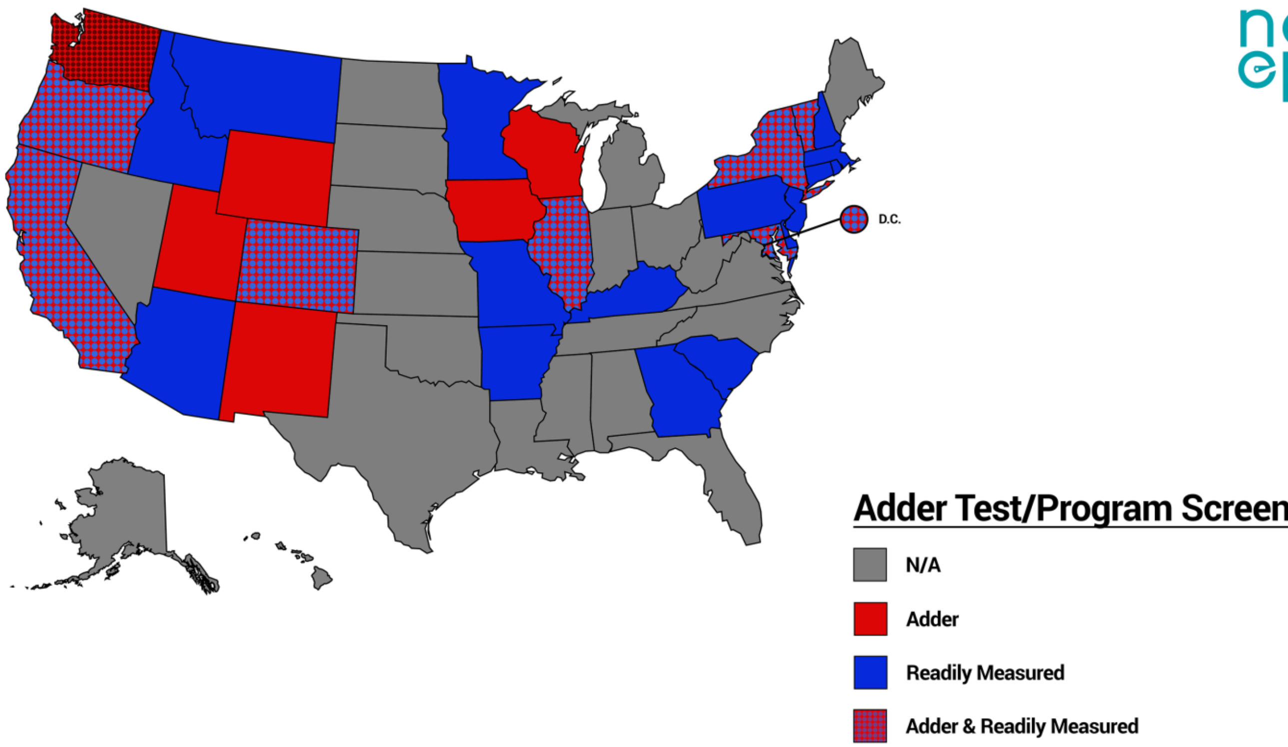


Table 11. *National Overview of NEIs in Cost-Effectiveness Screening*

State	Adder test/program screen	Readily Measured test/program screen
Alabama	NA	NA
Alaska	NA	NA
Arizona	NA	The Arizona Corporation Commission does not require NEIs to be included in cost-effectiveness evaluations, but will allow utilities to report air emissions reductions if presented to them
Arkansas	NA	Quantify other fuels, water, and deferred equipment costs in the total resource cost test
California	GHG ($30/ton)	Formal inclusion of participant-side NEIs was approved in low-income tests; currently reinvestigating that issue.
Colorado	10% adder, 25% adder for low-income programs	Measurable with market value; see Table 13
Connecticut	NA	Low income
Delaware	NA	Quantifiable NEIs; see Table 14
Florida	NA	NA
Georgia	NA	NEIs do not need to be reported for regulatory evaluations
Hawaii	NA	NA
Idaho	NA	Under review to add in NEBs and adders
Illinois	Ameren 10% electric, 7.5% gas; DCEO 10% adder; ComEd NA; Emissions adder	Easily measured water, plus easy others
Indiana	NA	NA
Iowa	10% adder for electric; 7.5% adder for gas	NA
Kansas	NA	NA
Kentucky	NA	California Public Purpose Test (PPT) broad range of NEBs
Louisiana	NA	NA
Maine	NA	NA
Maryland	A 1.115 cent per kWh adder has been applied to the ex-ante societal cost test in developing EmPOWER plans	Societal cost test used in combination with the total resource cost test to include participant and societal NEIs from job impacts to environment[17]
Massachusetts	NA	NEIs must be "reliable and with real economic value"; utility, prop, health and safety, comfort; low income; equipment,

[17] MD, Order No. 87082, at 13

		utility, all costs of complying with foreseeable environmental regulations; see Table 16
Michigan	NA	NA
Minnesota	NA	Portfolio, total program, and customer project level screening
Mississippi	NA	NA
Missouri	NA	Portfolio and total program level screening
Montana	NA	NEIs do not need to be reported for regulatory evaluations.
Nebraska	NA	NA
Nevada	NA	NA
New Hampshire	NA	Adder recently removed
New Jersey	NA	Consider emission reductions as ancillary benefits
New Mexico	15% adder; low income weatherization includes a multiplier of 1.25 for benefits.	
New York	$15/ton adder for carbon	Comfort, safety, air quality, productivity, etc. are included in regulatory cost-effectiveness evaluations for low income.
North Carolina	NA	NA
North Dakota	NA	NA
Ohio	NA	NA
Oklahoma	NA	NA
Oregon	Carbon ($15/ton) 10% adder	Hybrid adder/readily available for C&I; carbon value on societal test, PV deferred plant extension, water / sewer savings, and laundry soap
Pacific Northwest; (from BPA, Energy Trust, and NEEA)	NA	BPA will only fund cost-effective measures with a BC ratio of 1 or greater. Energy Trust / NEEA report that they include the “readily measured” NEIs in the cost-effectiveness reporting.
Pennsylvania	NA	Low income only
Rhode Island		low income; quantify utility, societal; health and safety, equipment, prop, comfort)
South Carolina	NA	NEIs do not need to be reported for regulatory evaluations.
South Dakota	NA	NA
Tennessee	NA	NA
Texas	NA	NA
Virginia	NA	NA

Utah	Environmental "adder" of 10% of benefits for low income cost-effectiveness if regulators allow	NA
Vermont	15% non-energy adder, 10% cost reduction for risk and flexibility advantages + 15% low income	NEIs such as reduced air emissions, property value increases, tax benefits, health improvements and employment impacts are incorporated into formal cost-benefit analysis for the low-income program, which is required by the state legislature.
Virginia	NA	NA
Washington	10% adder	NA
Washington – Puget Sound Energy	NA	NEIs are not used for internal and regulatory cost-effectiveness test. Lower B/C ratios are allowed for low-income weatherization programs because NEBs are assumed to be associated with those programs.
Washington D.C.	10% adder, 10% risk, 10% environ + NEIs in goals and measured benchmarking	equipment, comfort, health and safety, prop, societal
West Virginia	NA	NA
Wisconsin	Carbon $30/ton	NA
Wyoming	Environmental "adder" of 10% of benefits for low income cost-effectiveness if regulators allow	NA

Sources: Updated and Summarized from Johnson Consulting Group, 2014; Malmgren & Skumatz. 2014; Nickerman et al. 2014

Comfort impacts are harder to quantify and monetize compared to air emissions because they cannot be measured directly. Therefore, there are noteworthy uncertainties that exist around their estimated or self-reported dollar values[18]. Four states in the Northeast (MA, RI, DC and VT) include comfort in its cost-effectiveness tests.[19] New York and California include health, safety, and comfort impacts in cost-effectiveness screening for low income programs only. Massachusetts and New York have estimated comfort impacts as a part of studies and the Rhode Island TRM uses the Massachusetts estimates in its cost-effectiveness screening. Other states (IA, CO, OR, WA, VT, DC, ID, UT, WY) include generic NEI adders where comfort impacts may be implicitly or explicitly included.[20]

As a result of the vast number of variations of cost-effectiveness frameworks, as seen above, different policy choices can have a dramatic impact on the amount and the types of energy efficiency efforts that are pursued in each state. For instance, if a test is very inclusive NEIs, such as water, health, air quality, and comfort, among others, the net benefits of a given portfolio will likely be much higher than a portfolio that does not include these. Program administrator that employ an inclusive framework are able to pursue additional energy

[18] Itron, 2014, at 42
[19] Itron, 2014; Tim Woolf, et al., 2013, at 9
[20] Itron, 2014; Skumatz, 2014

efficiency savings for projects that would not be cost-effective under a more stringent test. The table below shows the types of tests used in each state.

Table 12. *Summary of Cost-Effectiveness Tests Used by States (*denotes inclusion of readily measured NEIs)*

State	Test[21]	Legislative Mandate or Regulatory Order	State	Test	Legislative Mandate or Regulatory Order
Alabama	The Commission permits rate recovery for energy efficiency programs that are cost-effective for all retail customers.		Nebraska	**TRC**, UCT, RIM	Not formally required
Alaska	No formally approved ratepayer-funded energy efficiency programs		Nevada	**TRC**, UCT, PTC, SCT, RIM, ATRC	Regulatory order
Arizona	**SCT**	Regulatory order	New Hampshire	TRC	Legislative mandates
Arkansas*	**TRC**, UCT, PCT, RIM	Regulatory order	New Jersey	TRC, UCT, PCT, SCT, RIM	Not formally required
California	**TRC**, UTC, PCT, SCT	Regulatory order	New Mexico	**UCT**	Legislative requirement
Colorado*	**TRC**, RIM	Regulatory order	New York	**TRC**, switching to SCT	Regulatory order
Connecticut	TRC, **UCT**	Legislative Mandates	North Carolina	**TRC**, UCT, PCT, RIM	Regulatory order
Delaware*	**TRC**	Legislative Mandates	North Dakota	None	None
Florida	TRC, PCT, RIM	Regulatory and legislative mandates	Ohio	**TRC**, UCT	Regulatory order
Georgia	TRC, UCT, PCT, RIM, SCT	Commission order	Oklahoma	**TRC**, UCT, PCT, SCT, RIM	Regulatory order and Commission rules
Hawaii	**TRC**	Legislative mandates	Oregon*	**TRC**, UCT	Regulatory order
Idaho	TRC, UCT, PCT, RIM	Regulatory order	Pennsylvania*	**TRC**	Regulatory order and legislative mandates
Illinois*	**TRC, w/ societal components**	Regulatory and legislative mandates	Rhode Island*	**TRC**[22]	Formal requirements
Indiana	**TRC**, UCT, PCT, RIM	Regulatory order	South Carolina	TRC, UCT, RIM	Regulatory order and

[21] Bold indicates the primary test for that state, some states do not identify a primary test
[22] Rhode Island is developing its own cost-effectiveness framework called the Rhode Island Test

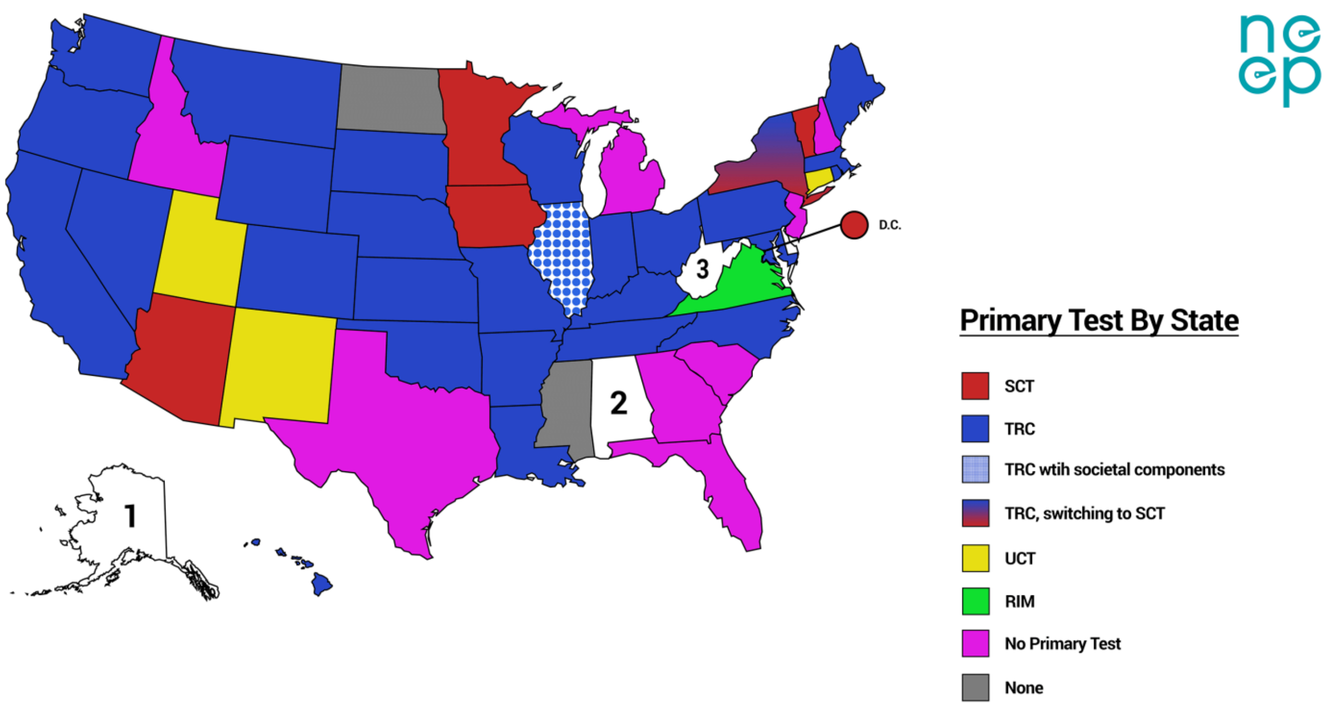
					legislative mandates
Iowa	**SCT**, UCT, PCT, RIM	Regulatory and Legislative	South Dakota	**TRC**, RIM	Regulatory order and legislative mandates
Kansas	**TRC**, UCT, PCT, RIM	Regulatory order	Tennessee	**TRC**, UCT, RIM	None specific
Kentucky*	**TRC**, UCT, PCT, RIM	Regulatory order	Texas	UCT	Regulatory order and legislative mandates
Louisiana	**TRC**, UCT, PCT, RIM	Regulatory order	Utah	TRC, **UCT**, PCT, RIM	Regulatory order
Maine	**TRC**	By statute	Vermont*	**SCT**, PCT, UCT	Regulatory order and legislative mandate
Maryland*	**TRC**, UCT, PCT, RIM, SCT	Regulatory order and legislative mandates	Virginia	TRC, UCT, PCT, **RIM**	Legislative mandates
Massachusetts*	**TRC**	Regulatory order and legislative mandates	Washington	**TRC**, UTC	Regulatory order
Michigan	USRCT	Legislative mandates	Washington D.C.	**SCT**	Legislation
Minnesota	**SCT**, UCT, PCT, RIM	Legislative mandates	West Virginia	Appalachian Power is required to have a 3rd party program evaluator.	
Mississippi	None	None	Wisconsin	**TRC**[23], UTC, RIM	Regulatory order and legislative mandates
Missouri*	**TRC**, PCT, SCT, RIM	Code of state regulation	Wyoming	**TRC**, UCT, PCT,SCT, RIM	Regulatory orders in utility dockets
Montana	**TRC**, SCT, UCT, PCT	Regulatory order			

Source: ACEEE EM&V, 2017

[23] TRC, which counts reduced emissions as benefits along with utility avoided costs, to be its primary test for decision making.

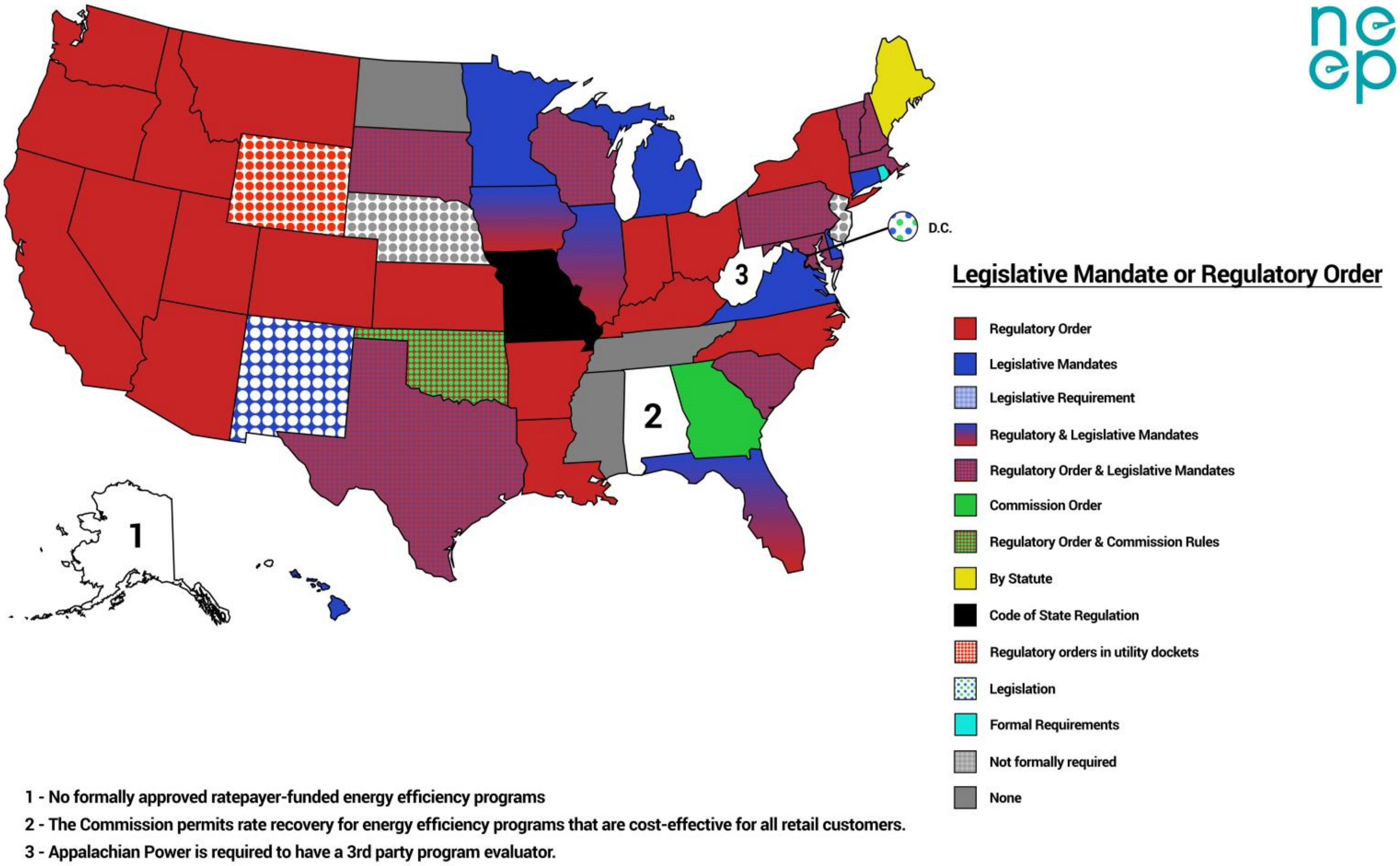
There is little consistency in the types of test used across states. Many use a variety, and states that use more than one test typically use the TRC as a primary test method. Where states use the same test, they are often applied differently. States such as West Virginia, Mississippi, Alaska, and Alabama do not use any test to screen for cost-effectiveness. This can be seen visually in the maps below, one showing the cost-effectiveness test(s) used, and another showing how it is mandated.

Figure 3. *Map of Cost-Effectiveness Tests Across the U.S.*



1 - No formally approved ratepayer-funded energy efficiency programs
2 - The Commission permits rate recovery for energy efficiency programs that are cost-effective for all retail customers.
3 - Appalachian Power is required to have a 3rd party program evaluator.

Figure 4. *Map of Cost-Effectiveness Testing Requirements across the U.S*



Arkansas

In 2016, the commission ordered and directed three categories of NEIs to be consistently and transparently accounted for in the TRC test as it applied to programs, measures, and portfolios.[24] The TRM provides protocols for quantifying the NEIs. The categories are as follows:

- Benefits of electricity, natural gas, and liquid propane energy savings (i.e., other fuels);
- Benefits of public water and wastewater savings; and
- Benefits of avoided and deferred equipment replacement costs as conditioned herein. This NEI is to be included in the annual TRM update filing.

Protocol L of the Arkansas TRM provides direction and guidance regarding the inclusion of NEIs in the EM&V process. The protocol provides calculations that shall be used to determine the value for each NEI included in the TRC test. The protocol also provides values for water and wastewater savings, which can also be seen below.

The other fuel NEI is calculated using the following equation:

Impact= Energy savings X Avoided other fuel costs

The avoided cost resulting from the water savings is calculated as follows:

Impact= Water savings X Avoided water costs

The deferred replacement cost is calculated as follows:

Deferred Baseline Replacement Cost = NPV(RDR,ML,RLCCt)

$$NPV = \text{Net Present Value function } \sum_{t=1}^{ML} \frac{RLCC_t}{(1+RDR)^t}$$

Where:

- RDR = Real Discount Rate = (NDR-ER)/(ER+1) where:
- NDR = nominal discount rate
- ER = baseline installed cost annual escalation rate
- ML = Program Measure Life (EUL)
- RLCCt = Real Levelized Carrying Charge in year t (annualized baseline installed cost at RDR)

[24] Arkansas Public Service Commission, Arkansas Technical Reference Manual, Protocol L, Version 6.0, Approved in Docket 10-100-R, (August 2016), at 87-91

Table 13. *Arkansas Water Values*

Arkansas	Water Rates (per 1,000 gallons)		Sewage Rates (per 1,000 gallons)		Total Combined Water Rates (per 1,000 gallons)	
Customer class	First 1,000 gallons	Additional gallons	First 1,000 gallons	Additional gallons	First 1,000 gallons	Additional gallons
Residential	$4.13	$2.86	$3.82	$2.72	$7.95	$5.58
Commercial	$2.93	$2.79	$4.29	$4.29	$7.22	$7.08
Average cost $/gallon	$3.53	$2.83	$4.06	$3.50	$7.59	$6.33

Source: Arkansas TRM, based on primary research conducted by the IEM of six Arkansas water districts

California

California is home to the Standard Practice Manual that many states across the country have adopted for its own cost-effectiveness testing. In addition, California has the Energy Savings Assistance (ESA) program cost-effectiveness test that includes participant and utility NEIs, calculated using the LIPPT model. The low-income public purpose test (LIPPT)[25] model was developed in 2001 and provides NEIs incorporated into a revised test specific to low income programs. California uses participant and utility NEIs in low income program tests. When performing a cost-effectiveness screening of energy efficiency programs, an "energy-only" cost-effectiveness test is conducted, with NEIs excluded. The avoided cost of greenhouse gases is included with a $30/ton of GHG adder. When evaluating demand response, societal NEIs are included in the TRC, and the quantifications of NEIs is optional, but utilities are required to provide a qualitative analysis.[26] The California methodology was updated for the 2013 program year to reflect an after tax weighted average cost of capital (7.66 percent).[27]

Colorado

Colorado employs a 10 percent adder, and a 25 percent adder for low-income programs. In addition, Colorado considers NEIs that are readily measurable with market values. Key drivers in the state included: 1) intervenors that were successful in introducing a requirement for an NEI study for the low income programs; 2) research in 2008 and 2011 that examined NEIs in the context of cost-effectiveness screening. This included referring to work from other jurisdictions and conducing primary research in the state, and 3) a large group of intervenors in the dockets supported decisions to count NEIs as an electric and gas adder in the cost-effectiveness screening.[28] The 2008 study and deliberations led to proxy values introduced in 2009/2010 (10 percent electric, 20 percent for low income, and 5 percent for gas). A later proceeding and study led to adoption of values of 25 percent for the low income programs. To judge cost-effectiveness of its natural gas programs, the Colorado PUC uses the SCT, and uses a 25 percent non-energy benefits adder[29]. Colorado continues to consider updates to its cost-effectiveness testing.

[25] Available here
[26] California PUC, at 7
[27] Nickerman & Aslin, at 6
[28] Skumatz (a), at 9
[29] More available at: http://programs.dsireusa.org/system/program/detail/4489

In 2014, Skumatz Economic Research Associates, Inc. (SERA) produced a report on NEIs and NEBs and their role in cost-effectiveness testing in Colorado. The table below represents the recommended NEI value adders for the Colorado Weatherization (Wx) Program[30]

Table 14. *Colorado Recommended Values for NEIs*

Category	Discussion	Value- Somewhat Conservative	Value- Very Conservative
Include utility arrearage/ financial impacts	Full arrears: $20 for most; $30 for low income; if carrying costs instead, $2.50-$4 (or about 2 percent). Consider adding low income subsidy avoidance at 16 percent if appropriate	2 percent if carrying charges; larger if full arrears; $2.50-$4; Add 16 percent / $13 if low income subsidies	2 percent / $2.50-$4 for carrying costs ($20-30 for full arrears) (higher for low income applications);
Include societal emission impacts	Multiplier from literature 7 percent; simple CO calculations 22 percent adder ($0.025/kWh or $25/hh at $20/MTCO2e) for CO	22 percent ($0.025/kWh, $25/hh) CO calc; general literature: 7 percent; $60	22 percent ($0.025/kWh, $25/hh) CO calc; general literature: 7 percent; $60
Consider societal economic impacts	Multiplier from literature 31 percent / $60; prefer simple calculations from economic multipliers from a weatherization study $690,000 per $1 million in program; or add factor multiplying 0.69 times per-household cost (conservative excludes admin cost)	Multiplier of 0.69 on program expenditures less administrative costs	Multiplier of 0.69 times program expenditures less administrative costs
Include participant comfort/noise impacts	Values from literature: 10 percent for comfort/ $30; 26 percent / $69 including noise and similar impacts	26 percent/ $69	10 percent/ $30
Include Health/ safety impacts	Values from literature: 12.6 percent/ $16.50	13 percent/ $16.50	13 percent/ $16.50
Consider Home improvement impacts	The literature value for these impacts is about 18.8 percent/ $36. Excluding aesthetics (and focusing on home value), the multiplier is 10 percent/ $18	19 percent/ $36	10 percent/ $18 excluding aesthetics

[30] Skumatz (b), at 17-18

Consider Water bill savings	Values from literature: 20 percent/ $15; range depends on program measures and local water rates	20 percent/ $15	20 percent/ $15
Total (recommended and to consider)	Percentage items are used by adding the percentage to the energy savings in the B/C test. The value in dollar terms would be incorporated by adding $x per household (per year) in net benefits attributable from the program	Base (Emissions): 22 percent adder (or 2.5 ¢/kWh or $25/hh for CO) (7 percent from literature) Plus Wx-specific adder 80 percent (or $124) plus economic multiplier 0.69 time program expenditures per hh (or $60 econ from lit) Plus low income adder: 16 percent ($13) if low income subsidies in place	Base (Emissions): 22 percent adder (or 2.5 ¢/kWh or $25/hh for CO) (7 percent from literature) Plus Wx-specific adder: 55 percent ($82) plus economic multiplier 0.69 time program expenditures per hh (or $60 econ from liter) Plus low income adder: 16 percent ($13) if low income subsidies in place
Total excluding "to be considered"		Base (Emissions): 22 percent adder (or 2.5 ¢/kWh for CO) (7 percent from literature) Plus Wx-specific adder: 41 percent adder (or $73)	Base (Emissions): 22 percent adder (or 2.5 ¢/kWh for CO) (7 percent from literature) Plus Wx-adder: 35 percent ($49)

Source: Skumatz (b), 2014

The short term recommendations presented in the table above do not incorporate the full values for estimated NEIs. A conservative approached was taken, which incorporates less than half or a fifth of the total typical values from categories that are typically estimated. SERA presented mid and long term recommendations that build upon this table. Such recommendations[31] are as follows;

- Incorporate NEI questions into process and impact surveys for major programs at least every other evaluation cycle;
- Conduct a Colorado-based economic multiplier study to then adapt the multipliers and affected industries to the program modeled in the study. Weatherization programs will have higher multipliers than single-measure programs;
- Conduct a refined emissions study, using the most recent relevant factors based on Colorado's generation mix and accepted/ stakeholder-approved values for tonnage values. The modeled results can be updated with updated factors, dollar values for tons, and generation mix;
- Consider adding arrearage studies periodically to other program evaluations to update figures; and
- Use values from the multipliers table for other key values, but consider periodically updating values based on literature.

[31] Skumatz (b), at 18

These recommendations highlight the evolving nature of NEIs and the need to continuously update factors and values to remain consistent and reliable in cost-effectiveness testing.

Delaware

Delaware uses the TRC test (with DRIPE[32] and NEIs) as the primary test. The test captures full effective useful life of measures, discounting at a social rate. This include NEIs, either quantifiable and/or an adder.[33] Rules for benefit-cost tests and evaluation requirements are outlined in the Delaware Evaluation Framework[34] Values were decided based on literature review of values from studies and results from other jurisdictions for a limited set of types of impacts.

Table 15. *Delaware NEI Values by Category*

Category or Type of NEI	Value (2016$)	Source	Notes
Weatherization			
LI Weatherization	$164 per home (NPV)	ORNL (2002)	Participant health and safety benefits, based on literature review
	OR		
	$182 per home (annual)	Three[3] (2016)	Participant health & safety benefits, no avoided death value; ultimately based on national WAP evaluation
LI Weatherization reduced arrearages	2% of participant bill savings	Itron (2014); MD PSC (2015)	Low end of published estimates for relevant programs
Non-LI HPwES/shell measures/ etc.	$35.35 per home (annual)	Itron (2014); MD PSC (2015)	Low case, derived from data in 2011 MA study; included in MD PSC order
Air Emissions			
Air emissions externalities	$0.002 per kWh (annual)	Itron (2014); MD PSC (2015)	Low case; includes health impacts, does not include compliance costs for NO_x or SO_2
	OR		
	$0.009 per kWh (annual)	PJM (2015); DPL IRP (2014)	Based on low end of avoided costs for NOx and SO2 from DPL IRPs (2012/2014) & reported PJM emissions rates for 2014/5, emissions de-rated by 75%, & inflated to 2016$
Other Benefits			
Water Savings	$5 per 1,000 gallons	Conservative value based on	Water savings indicated in the TRM should be valued at this rate; water

[32] DRIPE= Demand Reduction Induced Price Effects- Calculating DRIPE quantifies the price benefits of efficiency measures and demand response

[33] Delaware Technical Reference Manual, Delaware Regulations, (July 2016)

[34] Available at : http://www.dnrec.delaware.gov/energy/information/otherinfo/Pages/Division%20Regulations/EMV-Regulations.aspx

		AWWA (2016) & U of DE (2014)	savings can also be estimated using IPMVP Method C
O&M savings	As specified in the TRM	DE TRM	

Source: Delaware Energy Efficiency Advisory Council December 2016 meeting

Maryland

Maryland uses the TRC and SCT tests with a hybrid approach to NEIs including **readily measured, in addition to an environmental adder**. In July of 2015, the Public Service Commission issued an order that stated because the TRC test includes all participant costs, they concur that quantified NEIs accruing to program participants must be included in the TRC. In addition to quantified participant NEIs, quantified societal NEIs that represent indirect program effects and accrue to society at large also must be reflected in the SCT.[35]

The evaluation of ratepayer-funded energy efficiency programs in Maryland relies on both legislative mandates (Empower Statute Public Utilities 7-211) and regulatory orders (Orders in case numbers 9153-9157, Order 82869, and Order 87082). The orders follows the legislation. In 2014, Itron conducted an analysis on particular NEIs to develop estimates of selected NEIs that may be included in the ex-ante and/or post cost-effectiveness analyses for the EmPOWER programs. This included air emissions, comfort, commercial operations and maintenance (O&M), and utility bill arrearages

When considering air emissions a 1.115 cent/kWh environmental adder was included in the Societal Cost Test (SCT) of the ex-ante analysis used for the 2009-11 and 2012-14 EmPOWER program plans for four of the five of the EmPOWER utilities (Potomac Edison did not include it). Aside from this adder, there has been no attempt to include environmental externality costs into the EmPOWER ex ante or ex post cost effectiveness analyses. Itron recommended that future ex ante and ex post cost effectiveness analyses for all EmPOWER programs include a 1.1 cents ($ 2014) per kWh adder.[36] In 2014, SERA produced a report specifically for Maryland that also recommended Maryland include societal emission impacts, using a 12 percent adder (or 1.7 cents/kWh, $22/MD household, or a 7.1 percent multiplier from an array of studies.[37]

The recommended values for comfort include the Massachusetts comfort benefits of $136 and $110 for every Home Performance with ENERGY STAR (HPwES) and limited income participant for which air sealing and/or insulation measures are installed as a result of the EmPOWER program (i.e., after adjusting for free ridership and spillover)[38]. Itron suggested these values be applied annually for 15 years.

SERA recommended an arrearage reduction benefit of two percent of retail bill savings, or roughly $2.50 - $4.00 per participant[39]. This estimate is based on the results of SERA's 2010 California study, which was a compilation of non-energy impacts studies across the country. The report recommends that if the utility provides low income subsidies, an adder associated with those savings may be considered. The table below summarizes the SERA recommended NEI adders for Maryland in the short term.

[35] MD, Order No. 87082, Pg. 14
[36] Itron, 2014, pg. 41
[37] Skumatz (c), at 16
[38] Itron. at 47
[39] Skumatz (c), at 16

Table 16. *Maryland Recommended NEI Values*

Category	Discussion	Value- Somewhat Conservative	Value- Very Conservative
Include utility arrearage/ financial impacts	Full arrears: $20 for most; $30 for low income; if carrying costs instead, $2.50-$4 (or about 2 percent). Consider adding low income subsidy avoidance at 16 percent if appropriate	2 percent if carrying charges; larger if full arrears; $2.50-$4; Add 16% / $13 if low income subsidies	2 percent / $2.50-$4 for carrying costs ($20-30 for full arrears) (higher for low income applications);
Include societal emission impacts	Calculations for MD 12 percent adder (or 1.7 ¢ /kWh, $22/MD household (hh))34 ; Multiplier from literature 7 percent / $60;	12 percent adder (or 1.7¢ /kWh, $22/MD hh) (7 percent from literature)	12 percent adder (or 1.7¢ /kWh, $22/MD hh) (7 percent from literature)
Consider societal economic impacts	Multiplier from literature 31 percent / $60; prefer simple calculations from economic multipliers from a weatherization study $690,000 per $1 million in program; or add factor multiplying 0.69 times per-household cost (conservative excludes admin cost)	Multiplier of 0.69 on program expenditures less administrative costs	Multiplier of 0.69 times program expenditures less administrative costs
Include participant comfort/noise impacts	Values from literature: 10 percent for comfort/ $30; 26 percent / $69 including noise and similar impacts	26 percent/ $69	10 percent/ $30
Include Health/ safety impacts	Values from literature: 12.6 percent/ $16.50	13 percent/ $16.50	13 percent/ $16.50
Consider Home improvement impacts	The literature value for these impacts is about 18.8 percent/ $36. Excluding aesthetics (and focusing on home value), the multiplier is 10 percent/ $18	19 percent/ $36	10 percent/ $18 excluding aesthetics
Consider Water bill savings	Values from literature: 20 percent/ $15; range depends on program measures and local water rates	20 percent/ $15	20 percent/ $15
Total (recommended	Percentage items are used by adding the percentage to the energy savings in the B/C test.	<u>Base (Emissions):</u> 12 percent adder (or 1.7	<u>Base (Emissions):</u> 12 percent adder (or 1.7 ¢/kWh or $22/hh for

and to consider)	The value in dollar terms would be incorporated by adding $x per household (per year) in net benefits attributable from the program	ȼ/kWh or $22/hh for MD) (7 percent from literature) Plus Wx-specific adder 80 percent (or $124) plus economic multiplier 0.69 time program expenditures per hh (or $60 econ from lit) Plus low income adder: 16 percent ($13) if low income subsidies in place	MD) (7 percent from literature) Plus Wx-specific adder: 55 percent ($82) plus economic multiplier 0.69 time program expenditures per hh (or $60 econ from liter) Plus low income adder: 16 percent ($13) if low income subsidies in place
Total excluding "to be considered"		Base (Emissions): 12 percent adder (or 1.7 ȼ/kWh for MD) (7 percent from literature) Plus Wx-specific adder: 41 percent adder (or $73)	Base (Emissions): 12 percent adder (or 1.7 ȼ/kWh for MD) (7 percent from literature) Plus Wx-adder: 35 percent ($49)

Source: Skumatz (c), Figure 1.3, at 17

The short term recommendations presented in the table above do not incorporate the full values for estimated NEIs. A conservative approached was taken, which incorporates less than half or a fifth of the total typical values from categories that are typically estimated. SERA presented mid and long term recommendations that build upon this table. Such recommendations[40] are as follows;

- Incorporate NEI questions into process and impact surveys for major programs at least every other evaluation cycle;
- Conduct a Maryland-based economic multiplier study to then adapt the multipliers and affected industries to the program modeled in the study;
- Conduct a refined emissions study, using the most recent relevant factors based on Maryland's generation mix and accepted/ stakeholder-approved values for tonnage values. The modeled can be updated with updated factors, dollar values for tons, and generation mix .

As NEIs are further incorporated into cost-effectiveness testing, the robustness of NEI estimates will improve, which will lead to better tests and consistency across jurisdictions. This will assist in properly allocating funds to energy efficiency programs.

Massachusetts

The Total Resource Cost (TRC) test is used in Massachusetts to evaluate cost-effectiveness of ratepayer energy efficiency programs. In 1998, the systems benefit charge was adopted. Shortly after in 1999, NEIs were first included in energy efficiency cost-benefit analysis, where the Department of Public Utilities (DPU) rejected an adder for NEIs and instead required quantification of measure-specific NEIs where possible[41]. With this practice in place, the Green Communities Act of 2008 was implemented, which requires electric and gas utilities to

[40] Skumatz (c), at 18
[41] Brant, J., at 5

pursue all cost-effectives energy efficiency. To do so, the TRC calculation requires all costs of complying with foreseeable environmental regulations.

Massachusetts uses a **readily measured test/program** where NEBs must be "reliable and with real economic value"; utility, prop, health and safety comfort; low income; equipment, utility, all costs of complying with foreseeable environmental regulations.[42] DPU guidelines explicitly include non-electric benefits including: resource benefits (oil, wood, and water savings) and non-resource benefits (i.e. customer O&M, reduced environmental and safety costs, and all benefits for low-income customers. Program administrators further expanded and improved their inclusion of NEIs for the 2013-2015 planning cycle to achieve all cost effective energy efficiency. Participant perspective NEIs for residential and low-income programs derived from a combination of surveys, engineering estimates, and literature review, primarily from the 2011 NMR Group and Tetra Tech study. C&I programs participant perspective NEIs are derived from surveys. The table below shows examples of NEI values used in energy efficiency program planning.

Table 17. *Massachusetts NEI Values*

Participant Perspective NEI	Value or Range of Values
Low Income	
Economic Development	$0.04 per KWh saved
Equipment	
Light Quality	$3.50 per LED or CFL fixture; $3.00 per LED or CFL bulb
Equipment Maintenance	$9.42 to $124 per participant depending on the customer sector, heating or cooling system, and program
Window AC Replacement	$45 per measure
Comfort	
Thermal Comfort	$3.92 to $125 per participant depending on the customer sector, heating or cooling system, and program
Noise Reduction	$1.42 to $40 per participant depending on the customer sector, heating or cooling system, and program
Health & Safety	
Health Benefits	$0.13 to $19 per participant depending on the customer sector, heating or cooling system, and program
Improved Safety	$45.05 per measure
Property Value	
Home Durability	$1.54 to $149 per participant depending on the customer sector, heating or cooling system, and program
Property Value Increase	$62.65 to $1,998 per participant depending on the customer sector, heating or cooling system, and program

Source: Brant, J., slide 8

[42] Malmgren, I., Skumatz, L.

New York

New York is currently in the process of switching to the societal cost test. NEIs are not formally considered in the Department of Public Service (DPS) calculations of cost-effectiveness, with the exception of a **$15 carbon credit adder** related to long run avoided cost.[43] Net avoided CO_2 accounts for avoided emissions due to a reduction in system load levels or an increase from onsite generation. While detailed discussion of the calculation for this value is available from a National Grid filing, here we briefly show that the equation used to determine net avoided CO_2 is: $Benefit_y = CO_2Cost\Delta LBMP_y - CO_2Cost\Delta OnsiteEmissions$, [44] where the first variable represents the cost of CO_2 due to the change in wholesale energy purchase and the second relates cost to a change in emissions. New York has conducted substantial NEI research in order to quantify and validate programs. This research has not been directly incorporated into the cost-effectiveness analysis in New York, but it has helped support decisions in other states such as Colorado and Vermont to incorporate NEI adders[45]. NYSERDA has incorporated NEIs into its program evaluation work, and modeled economic and job impacts from energy efficiency programs. In addition, National Grid has acknowledged that a suggested method for determining the impact of other NEIs is not included in the benefit-cost analysis handbook[46], NEIs may be assessed qualitatively or estimated quantitatively if it can be.[47] The Public Service Commission may find it in their interest to address NEI in addition to the carbon adder. There is an asymmetry in the way they are included in the BCA, some of the costs are included, whereas some of the NEIs are not.

Rhode Island

Rhode Island uses a **readily measured test/program screen** for low income; quantify utility, societal; health and safety, equipment, prop, and comfort. NEIs are considered an integral part to the Rhode Island TRM. NEIs attributable to electric and gas energy efficiency programs are considered its cost-effectiveness methodologies. Policy considerations in the new cost-effectiveness framework. The source for NEI values for the 2016 TRM come from the NMR Group and Tetra Tech study on Massachusetts residential and low income NEIs conducted in 2011. Rhode Island has traditionally used the TRC test to evaluate cost-effectiveness where NEIs were accounted for that applied to specific technologies or programs.[48]

In March 2016, the Rhode Island opened docket 4600[49] to develop a report that will guide the PUC's review of National Grid's rate structure. The PUC needed a better understanding of the costs and benefits associated with the activities on the system. The report suggests the cost and benefits, including NEIs that may be applied to programs, and to what level they should be quantified. This cost-effectiveness framework also considers policy implications and whether the costs and benefits are aligned with state policy.[50] This is a new resource value framework in cost-effectiveness testing that is also seen in the National Standard Practice Manual. With this report, the PUC may open a more formal grid modernization docket that will use the report to evaluate National

[43] Skumatz (a), at 9
[44] For further explanation on this equation see National Grid, at 48
[45] Malmgren and Skumatz
[46] Available at: http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7BF0CC59D0-4E2F-4440-8E14-1DC07566BB94%7D
[47] National Grid, Case 16-M-0412, at 52
[48] VEIC, at 6
[49] More available at: http://www.ripuc.org/eventsactions/docket/4600page.html
[50] Raab, J., at 7

Grid's rate structure. To a certain extent this report will also be used in the upcoming fall of 2017 rate case for National Grid. For the cost-effectiveness framework, see Appendix 3.

Vermont

Vermont uses the Societal Cost test with a **15 percent adder + 15 percent low income adder, with a three percent discount rate**. Vermont was an early adopter in incorporating the concept of NEIs into its cost-effectiveness screening. Starting in 1990, Vermont implemented a societal cost-effectiveness test with a five percent adder for environmental externalities and a 10 percent adder for reduced ricks from energy efficiency relative to generation.[51] This was done in Public Service Board Docket 5270 (1990) where the societal test was established as the primary test for efficiency investments made by utilities with ratepayer funds.

Later reevaluated in 2009, a 15 percent NEI adder for thermal and electric efficiency screening was implemented along with a 15 percent adder for low income energy efficiency. Vermont PSB order of February 2012 adopted 15 percent NEI adder to the energy benefits in cost-effectiveness screening in Vermont to account for the hard-to-quantify benefits that factor into participant decision-making. The 15 percent value will be revisited in biennial avoided-cost proceedings to ensure it remain adequate to cover NEIs.[52] The same order adopted a 15 percent low income benefits adder. Vermont also deploys a readily measured test and programs screen for maintenance, equipment replacement, low income comfort, and utility and societal NEIs. Water and operations and maintenance savings are directly quantified where appropriate. The Board acknowledges that the adders are an approximate, conservative estimate of the value of low-income benefits, but notes that such a value is better than assuming zero, which is clearly not correct (VT PSB, 2012, p. 30). Finally, the environmental externalities associated with GHG emissions should be accounted for by assuming a CO_2 allowance price of $80/ton (VT PSB, 2011).

Vermont was successful in implementing adders for NEIs because the state conducted extensive research into readily available literature to identify quantitative values for a range of key benefits associated with low income programs. In addition, research was conducted to update the cost-effectiveness screening to incorporate NEIs in Colorado and New York around the same time and this further encouraged the state to implement the 15 percent adder.

Washington D.C.

Washington D.C employs a hybrid approach with a **10 percent adder, 10 percent risk adder**, and a **10 percent environmental adder**, plus NEIs measured in goals and measured benchmarking. Washington D.C. enacted legislation in 2008, the Clean and Affordable Energy Act of 2008[53], which established the Sustainable Energy Utility and relies on the social cost test (SCT) to screen for cost-effectiveness. The Act requires that the screening include the following NEIs in a readily measurable 10 percent adder: comfort, noise reduction, health and safety, ease of selling / leading home or building, improved occupant productivity, reduced work absences due to reduced illness, ability to stay in home / avoided moves, and macroeconomic benefits.[54] These benefit-cost tests are required for overall portfolio screening. Washington D.C. also added a 10 percent risk adder, and a 10 percent adder for the reduction of environmental externalities.

[51] Malmgren & Skumatz, at 9-11
[52] Brown, E., at 7
[53] Clean and *Affordable* Energy Act of 2008, An Act in the Council of the District of Columbia, (2008)
[54] Malmgren & Skumatz, at 11-13, 2014

These adders are on top of traditional types of NEIs included in their primary goals and benchmarks for programs. The six performance benchmarks used to measure success are listed below.

1. Reduce per-capita energy consumption
2. Increase renewable energy generating capacity
3. Reduce growth of peak capacity demand
4. Improve energy efficiency of low income housing
5. Reduce the growth of energy demand of the District's largest energy users
6. Increase the number of green collar jobs

Goal number six is significant because measuring the job impacts of energy efficiency is a societal NEI and this model incorporates job impacts as one of the key measures of success for energy efficiency programs[55]. This model sets Washington D.C. a part as a leader in the Northeast and Mid-Atlantic in incorporating NEIs in its cost-effectiveness screening.

[55] Malmgren & Skumatz, at 13

Summary of Findings and Conclusion

Based on the information accumulated for this study, this summary considers: How do we characterize common practice regionally? Nationally? For what programs and types of impacts are NEIs commonly provided? How and when are evidence-based versus other approaches used to estimate NEIs? What are some of the pros and cons of states' current practices?

In the Northeast and nationally, the TRC is most widely used as a primary test and the societal test is the second most popular primary test. Most states use additional secondary tests. While the TRC and Societal tests enable inclusion of non-energy impacts, there is no clear prevailing approach to including non-energy impacts in efficiency cost-effectiveness screening. This lack of consensus impedes policymakers' abilities to compare results across states or regions.

States that include NEIs either rely on adders, evidence-based quantifiable impacts or a combination of both strategies. When adders are used, they are most often used as proxies for low-income NEIs and as proxies for emissions reductions. Quantified impacts tend to focus on observable attributes such as other fuels, water, and operations and maintenance. Massachusetts and Rhode Island are notable states in the Northeast for monetizing weatherization, comfort, and health and safety impacts for residential impacts beyond low income, as well as for survey-based studies estimating commercial and industrial sector impacts. States may not include NEIs across all sectors, however this can result in a biased representation of the value of energy efficiency to program participants as well as underrepresenting the value of energy efficiency in addressing the jurisdiction's associated goals. Within the region and across the nation, there is no correlation between how cost-effectiveness is directed (legislative mandate versus regulatory order) and whether or how NEIs are included.

Seven states identify low income NEIs as a separate category. Eight states include carbon reduction as an NEI; four monetize the impacts, while others include them in adders. The quantified carbon value used varies between $15/ton (OR, NY) and $30/ton (WI, CA). Many states include NEIs for some sectors but not all.

Evidence suggests that both credibility and convenience are factors in states' decisions about what to include in NEIs, particularly for states with monetized NEIs. Several states (AR, CO, IL, OR, MD) are explicit that criteria for inclusion of some or all NEIs are that they are "easily measured." MA requires NEIs be "reliable and with real economic value." States that adopt monetized NEIs from other sources may apply discounts to make the values more conservative; MD is one example. It is difficult to compare NEI values from the literature because categories are not necessarily consistent. For example, it is not clear whether the DE low income NEIs associated with weatherization could include comfort, health and safety and possibly other values. The DE low income weatherization NEI assumptions ($164 NPV/home or $183/home) are relatively low relative to recent values shown in Table 20.

While the literature identifies the analytical methods for developing monetized NEIs, to investigate exactly how specific NEI values are calculated or whether some of the values reported are NPV requires digging more deeply into the body of source evaluation studies than could fit into this scope. Given this, it is helpful when states include some if not all NEIs in their Technical Reference Manuals (IL, for example). Arkansas is noteworthy for making NEI information accessible (equations and values in the TRM) and transparent (a protocol that addresses quantification approaches) – see Appendix 6 of this report. However, the types of NEIs Arkansas includes are quite limited. In some instance it is difficult to determine which tables address low income and which address residential non-low income or overall.

Adders have enabled several states to be more comprehensive in terms of the types of NEIs included in cost-effectiveness analysis. Risk (VT, DC), health and regional market transformation (WA) are the types of NEIs where adders are especially used as proxies for these hard-to-quantify impacts. General adders can be applied to all NEIs, although if there are particular impacts of higher importance, such as low income or environmental, an adder for that particular impact can be developed on top of a general adder.

Including all relevant NEIs in cost-effectiveness screening is not common practice. For many states or programs, if cost-effectiveness can be demonstrated without the inclusion of NEIs then there has been little incentive to take on the challenge of developing NEI estimates, either monetized or as "adders." Underutilization of NEIs can be partly explained by low confidence in the credibility of the estimates, despite widespread acknowledgement that NEIs are likely to be non-zero values.

Literature and empirical research on commercial sector NEIs is more limited than for residential sector impacts. Even with that caveat, the volume and range of NEI values available in the literature appears overwhelming; we found no literature providing best practice guidance to help with decisions such as how granular should the impacts be, or what criteria (beyond statistical validity) or alignment with programs should be used when borrowing results from other jurisdictions. Most likely, there is an element of best judgment by stakeholders involved in whether to select a mid-range or conservative choice from among the options.

NEIs can be negative as well as positive. Use of some control devices may require training and commissioning (more skilled labor time up front) in order to operate correctly and achieve savings for example. Challenges arise if NEIs are applied in cases where a measure or program generates both negative and positive NEIs, because it is then necessary to consider the net impact. Another example is weatherization of a home in a high radon zone which could have some negative or positive health effects or both[56].

Decisions about what NEIs to include depend on what cost-effectiveness test is being used; what counts as a benefit in a TRC test may be a transfer payment in the societal test. The Resource Value Framework recommends that a jurisdiction's policy should be the guide rather than strict adherence to a test structure. Considering policies and goals will better help align the test with the types of programs deployed in each state, although it may steer away from standardization, it helps guide each state on developing the test framework based on energy efficiency programs.

While various helpful documents provide guidance on cost-effectiveness analysis at a high level, there is little or no guidance addressing exactly what NEIs to include and how best to include them –whether as evidence-based monetized values, as adders, as a hybrid, or by modifying the requirements of the test so that a threshold of benefit-cost greater or equal to one is not required (another option discussed in the National Standard Practice Manual). Important work remains to be done on valuation; over time the methods may become increasingly sophisticated and precise, and with greater visibility additional valuation methods will become available.[57]

Regardless, learning from experience and from others is a valuable strategy. As the Commission and parties gain experience with the use of cost and benefit categories and drivers, standard practices may develop and become more sophisticated over time. And, the definition of specific cost and benefit categories and drivers may be refined or modified either by the Commission, by practice in the field, by experience within the state or in other states in the region or nation.

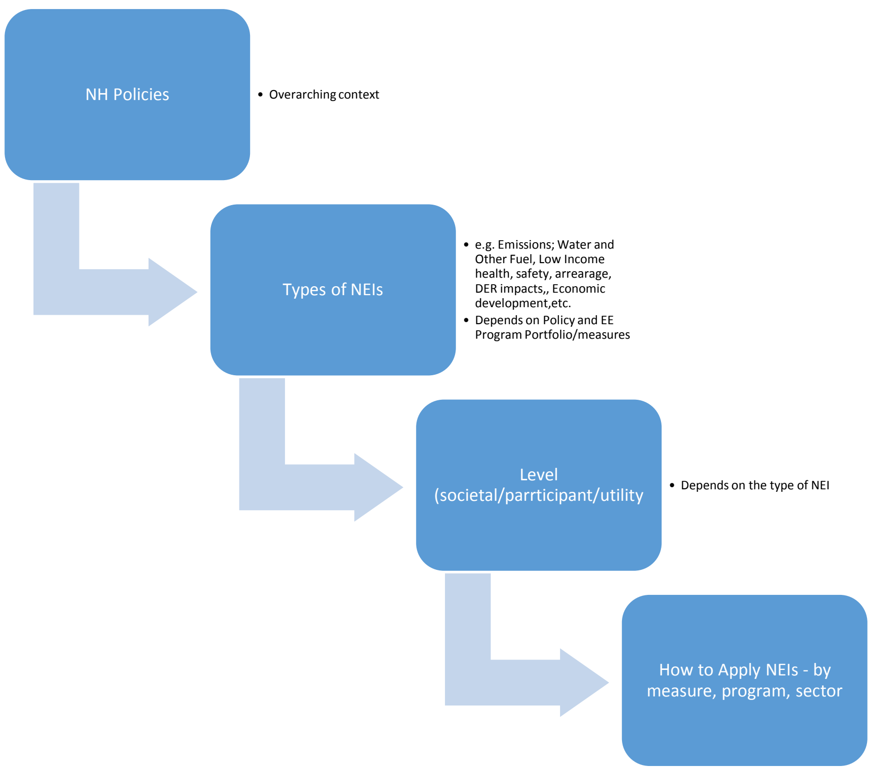
[56] Freed and Felder, at 44

[57] Raab, J.

When deciding what NEIs to include in a benefit-cost framework, it may be necessary to decide and justify the choice of evidence-based versus adder on a case by case basis for each type of impact. Considerations include:

- Uncertainty and the appropriate adjustments for less than comprehensive data;
- The timeframe for assessing component attributes and effects, or the cost and benefit impacts perspective that should be used for each (e.g., impacts on participants, non-participants, the utility, and society at large); and
- The ability to integrate the decisions in a unified manner to avoid either double-counting or omission of an important attribute.

***Figure 5**. Considerations in the Selection of NEIs*



While the existence of NEIs is not new, one of the barriers to incorporating these features into decision-making is that they are not systematically assessed or documented. Increased efforts by all stakeholders to collect case-by-case information on multiple benefits in industry will raise awareness of their potential value and support improved methodologies for quantifying them. Some Danish energy researchers posit that visualization of NEIs increases the probability that company decision-makers will implement energy efficiency projects[58]. To that end,

[58] Gudbjerg et al (2014).

they are developing a web-based tool and database focused on the industrial sector that includes the following elements:

- Method for assessing NEIs of energy efficiency projects;
- NEI database that shows users to search by project type;
- Case studies with details; and
- Questionnaire for identification and assessment of NEIs.

This effort classifies NEIs into four main categories: influencing productivity, sales and company image, internal company environment, and external environment/society. It uses an index which rates the "size" of the NEI relative to the energy savings. The size of the NEI may be calculated based on documentation and measurement, or based on subjective ratings by the customer, or by some combination. The goal of this system is to stimulate interest and participation in future energy efficiency, not as part of a cost-effectiveness proceeding. The NEI further assesses relative size of NEI values relative to energy efficiency savings. The goal of this effort is to capture highest priority NEIs experienced by customers rather than comprehensive inventory of all NEIs. Although this system was developed with the goals of justifying and marketing energy efficiency programs in Europe, it could be adapted to also include information on quantification of NEIs. As our research has shown, there is limited consistency and transparency in defining, documenting, and approaches to quantifying NEIs in the US.

In summary, there is an overwhelming body of literature with NEIs from energy efficiency programs and yet there is still much room for additional work. As more states begin to integrate NEIs into cost-effectiveness screening, states will begin to learn from each other on what has and has not worked from a greater pool of experience. The process of selecting NEIs based on literature will most likely involve judgments or modifications to reflect a jurisdiction's comfort with values or approaches used in other states. Looking ahead, the region and the country would benefit from

- Development of a central collection place for methods and values of NEIs;
- Inclusion of NEIs values and formulas in TRMs, protocols, or in templates such as provided in the Resource Value Framework to increase transparency and ease of access to information; and
- Guidance on how to implement cost-effectiveness frameworks once a policy-oriented conceptual framework has been developed for a jurisdiction.

Faced with the immediate need to decide on NEIs New Hampshire can benefit learning from other states; Table 21 of Appendix 1, a comparison of the ranges of NEIs Maryland, Rhode Island and Massachusetts by types and sectors, provides a good starting place to understand what high level NEI values by sector and range of value are available. Updating this table with information included or referred to in this study should represent most of the literature in the field. Looking ahead, development of a cost-effectiveness framework starting from the Rhode Island template in Table 8 of Appendix 1 and taking key policy goals into account would also help guide development of unbiased, comprehensive, forward-looking energy efficiency cost-effectiveness assessment.

References

American Water Work Association (AWWA), *2015 Water and Wastewater Rate Survey,* Prepared by Raftelis Financial Consultants, Inc., (2016), Available at: http://www.awwa.org/portals/0/files/resources/water%20utility%20management/water%20and%20wastewater%20rates/overview%20of%202015%20excel%20documents.pdf

Arkansas Public Service Commission*, Arkansas Technical Reference Manual, Protocol L*, Version 6.0, Approved in Docket 10-100-R, (August 2016), pgs. 87-91, Available at: http://www.apscservices.info/EEInfo/TRM6.pdf

Brant, J., Including Non-Energy Benefits in Evaluating Massachusetts' EE Programs, Massachusetts Department of Public Utilities, (2013), Available at: https://www.iea.org/media/workshops/2013/energyproviders/Session3_2_Brant_IEA_Final.pdf

Brown, E., *The Societal Cost Test and Non-Energy Impacts: the Approach Used in Vermont*, VEIC, (February 2017), Available at: https://www.puc.nh.gov/EESE%20Board/Meetings/2017/021717EERSWorkshop2/5%20VEIC%20SCT%20and%20NEB%20Approach%202-17-17.pdf

Brown, J., et al., *Assessing the Multiple Benefits of Clean Energy: a Resource for States*, U.S. Environmental Protection Agency & contributing consultants, (2011), Available at: https://www.epa.gov/sites/production/files/2015-08/documents/accessing_the_benefits_of_clean_energy.pdf

California PUC, Energy Division Staff Research on Societal Cost Test, (September 2016), Available at: http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy/Energy_Programs/Demand_Side_Management/2016-09-21%20Societal%20Cost%20Test%20Workshop%20Agenda%20and%20Energy%20Division%20Bckgrd.pdf

Clean and Affordable Energy Act of 2008, An Act in the Council of the District of Columbia, (2008), Available at: http://dcclims1.dccouncil.us/images/00001/20080819161530.pdf

Clendenning, G., et al., *Measuring Perspective Non-Energy Impacts (NEIs). (2012), ACEEE Summer Study, Available at:* http://aceee.org/files/proceedings/2012/data/papers/0193-000046.pdf

Colorado Public Utilities Commission (Colorado PUC). *Order Granting Application in Part." In the Matter of the Application of Publix Service Company of Colorado for Authority to Implement an Enhanced Demand Side Management Program and to Revise its Demand-Side Management Cost Adjustment Mechanism to Include Current Cost Recover and Incentives*, (2008), Denver, CO, Available at: http://www.swenergy.org/Data/Sites/1/media/documents/news/news/file/2008-06-Xcel_DSM_Policy.pdf

Delaware Technical Reference Manual, Delaware Regulations, (July 2016), Available at: http://regulations.delaware.gov/register/august2016/proposed/DE%20TRM%20complete%202016.pdf

DNV KEMA, Massachusetts Program Administrators, Final Report- Commercial and Industrial Non-Energy Impacts Study, Tetra Tech, (June 2012), Available at: http://ma-eeac.org/wordpress/wp-content/uploads/Massachusetts-Program-Administrators_Commercial-Industrial-Non-Energy-Impacts-Study.pdf

DPL, *Delmarva Power and Light 2014 Integrated Resource Plan,* (1 December 2014), Available at: https://www.delmarva.com/uploadedFiles/wwwdelmarvacom/DE%20IRP%20PUBLIC%20VERSION%20%20120114.pdf

E4The Future, *Occupant Health Benefits of Residential Energy Efficiency*, E4The Future Inc., Tohn Environmental Strategies, NCHH, and Three[s], (November 2016), Available at: https://e4thefuture.org/wp-content/uploads/2016/11/Occupant-Health-Benefits-Residential-EE.pdf

Freed, M. and Felder, F.A., Non-energy benefits: Workhorse or unicorn of energy efficieincy programs? In The Electricity Journal, (January 2017), Available at: www.sciencedirect.com/science/journal/10406190.

Hawkins, B., et al

Itron, *Development and Application of Select Non-Energy Benefits for the EmPOWER Maryland Energy Efficiency Programs, (*5 August 2014), Available at: http://webapp.psc.state.md.us/intranet/Casenum/NewIndex3_VOpenFile.cfm?filepath=C:%5CCasenum%5C9100-9199%5C9153%5CItem_597%5C%5C9153-57-NonEnergyBenefitsReport-Itron-022415.pdf

Johnson Consulting Group, *An Examination of Non-Energy Benefits: Definitions, Approaches and Values Used in Other Jurisdictions*, Prepared for the Arkansas Public Service Commission, (June 2014)

Malmgren, I. & Skumatz, L., *Lessons from the Field: Practical Applications for Incorporating Non-Energy Benefits into Cost-Effectiveness Screening,* ACEEE 2014 Summer Study, (2014), Pg. 4, Available at: http://aceee.org/files/proceedings/2014/data/papers/8-357.pdf

MD PSC, From the Maryland Public Service Commission Order No. 87082, ML-171275, (July 2015), Available at: http://www.psc.state.md.us/wp-content/uploads/Order-No.-87082-Case-Nos.-9153-9157-9362-EmPOWER-MD-Energy-Efficiency-Goal-Allocating-and-Cost-Effectiveness.pdf

Morgenstern, J., California's Experience in Incorporating Non-Energy Benefits into Cost-Effectiveness Tests, California Public Utilities Commissions, (October 2013), Available at: https://www.iea.org/media/workshops/2013/energyproviders/Session3_4_Morgenstern_IEAOct16presentation.pdf

National Grid, Case 16-M-0412- In the Matter of the Benefit-Cost Analysis Handbook & Case 14-M-0101-Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision, New York State Public Service Commission, (August 2016), Available at:

National Grid*, Rhode Island Technical Reference Manual: For Estimating Saving from Energy Efficiency Measures*, 2017 Program Year, Docket 4654, Available at: http://www.ripuc.org/eventsactions/docket/4654-NGrid-2017TRM(10-24-16).pdf

New Hampshire Energy Plan, (November 2002), Available at: https://www.nh.gov/oep/resource-library/documents/nh-energy-plan-2002.pdf)

New Hampshire Climate Action Plan, (March 2009), Available at: https://www.des.nh.gov/organization/divisions/air/tsb/tps/climate/action_plan/documents/nhcap_final.pdf

New Hampshire PUC, Order No. 25,983, *Energy Efficiency Resource Standard Order Approving Settlement Agreement*, (August 2016), Available at: https://www.puc.nh.gov/Regulatory/Orders/2016orders/25932e.pdf

New Hampshire Statewide Energy Efficiency Plan, Docket DE 14-216, Jointly Submitted by New Hampshire's Electric and Natural Gas Utilities, (September 2016), Available at: https://www.puc.nh.gov/Regulatory/Docketbk/2014/14-216/LETTERS-MEMOS-TARIFFS/14-216_2016-09-26_NH_UTILITIES_2017_NH_STATEWIDE_EE_PLAN.PDF

New Hampshire 10 Year Energy Strategy, (2014), Available at: https://www.nh.gov/oep/energy/programs/documents/energy-strategy.pdf

Nickerman, L., & Aslin, R., *Cost-Effectiveness Adjustments: How Effective Have States Been At Recreating the PAC?*, (2014), Available at: http://aceee.org/files/proceedings/2014/data/papers/8-1084.pdf

NMR Group, Inc., *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation*, Prepared for Massachusetts Program Administrators, NMR and Tetra Tech, (August 2011), Available at: http://www.rieermc.ri.gov/documents/evaluationstudies/2011/Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation(76).pdf

ORNL, *Non-energy Benefits from the Weatherization Assistance Program: A Summary of Findings from the Recent Literature,* Oak Ridge National Laboratory. ORNL/CON-484. April (2002), Available at: http://weatherization.ornl.gov/pdfs/ORNL_CON-484.pdf

Peters, J. et al. *Non-Energy Benefits Accruing to Massachusetts Electric Company From the Appliance Management Program*. Research into Action, Inc., (1999).

PJM, *2012-2015 CO2, SO2 and NOX Emission Rates*, (18 March 2016), Available at: http://www.pjm.com/~/media/library/reports-notices/special-reports/20160318-2015-emissions-report.ashx

Raab, J., et al. (a), *Docket 4600: Stakeholder Working Group Process Report to the Rhode Island Public Utilities Commission*, Raab Associates, Paul Centolella & Associates, and Tabor Caramanis Rudkevich, (April 2017), Available at: http://www.raabassociates.org/Articles/RI%204600%20Final%20WG%20Report%204-5-17.pdf

Raab, J., et al. (b), Re: IR 15-296, Investigation into Grid Modernization, Raab Associates and Synapse Energy Economics, Inc., (March 2017), available at: https://www.puc.nh.gov/Electric/IR15-296/NH%20Grid%20Mod%20Final%20Report%203-20-2017.pdf

RAP/ Synapse , Woolf, T., et al., (b) Energy Efficiency Cost-Effectiveness Screening: How to Properly Account for "Other Program Impacts' and Environmental Compliance Costs, RAP/ Synapse, (November 2012), Available at: http://www.synapse-energy.com/sites/default/files/SynapseReport.2012-11.RAP_.EE-Cost-Effectiveness-Screening.12-014.pdf

Skumatz, L., (a) *Non-Energy Benefits/ NEBs- Winning at Cost-Effectiveness Dominos: State Progress and TRMs*, Skumatz Economic Research Associates, (2016), Available at: http://aceee.org/files/proceedings/2016/data/papers/6_1147.pdf

Skumatz, L., (b) *Non-Energy Benefits/ Non-Energy Impacts and their Role and Values in Cost-Effectiveness Tests: Colorado*, Skumatz Economic Research Associates, Inc. (SERA), Prepared for Energy Outreach, Denver Colorado, (April 2014)

Skumatz, L. (c) *"Non-Energy Impacts / Non-Energy Impacts and Their Role and Values in Cost Effectiveness Tests, State Of Maryland*" SERA Inc. (March 2014), Available at: http://energyefficiencyforall.org/resources/non-energy-benefitsnon-energy-impacts-nebsneis-and-their-role-values-cost-effectiveness

Skumatz, L (d) *Non-Energy Benefits: Status, Findings, Next Steps, and Implications for Low Income Program Analyses in California,* SERA Inc. (2010), Available at: http://liob.cpuc.ca.gov/docs/LIEE%20Non-Energy%20Benefits%20Revised%20report.pdf

Skumatz, L., (e), et al. *Non-Energy Benefits in the Residential and Non-Residential Sectors- Innovative and Results for Participant Benefits.* (2000), Available at: http://aceee.org/files/proceedings/2000/data/papers/SS00_Panel8_Paper29.pdf

Skumatz, L. et al., *Lessons Learned and Next Steps in Energy Efficiency Measurement and Attribution: Energy Savings, Net to Gross, Non-Energy Benefits, and Persistence of Energy Efficiency Behavior*, California Institute for Energy and Environment, (2009). Available at: https://library.cee1.org/system/files/library/10517/CIEE_Behavior_White_Paper_-_Skumatz_2009.pdf

Synapse, Appendix D: Energy Efficiency Cost-Effectiveness Test, Available at: http://www.synapse-energy.com/sites/default/files/Appendix%20D%20from%20Michigan%20Report.pdf

The National Efficiency Screening Project, The Resource Value Framework: Reforming Energy Efficiency Cost-Effectiveness Screening, (August 2014), Available at: https://nationalefficiencyscreening.org/wp-content/uploads/2017/03/The-Resource-Value-Framework-Reforming-EE-Cost-Effectiveness-14-027.pdf

Three[3] and NMR, *Massachusetts Special and Cross-Cutting Research Area: Low-Income Single-Family Health- and Safety-Related Non-Energy Impacts (NEIs) Study,* Prepared for Massachusetts Program Administrators, (5 August 2016), Available at: http://ma-eeac.org/wordpress/wp-content/uploads/Low-Income-Single-Family-Health-and-Safety-Related-NonEnergy-Impacts-Study.pdf

University of Delaware, *Water Rates in Delaware and Surrounding States,* Draft, (September 2014), Available at: http://www.seafordde.com/library/WaterRatesinDelawareandSurroundingStatesDraftReport2014.pdf

VEIC and Optimal Energy, Cost Effectiveness Report on National Grid's 2015-2017 Energy Efficiency and System Reliability Procurement Plan, RI Energy Efficiency & Resource Management Council, (September 2014), Available at: https://betterbuildingssolutioncenter.energy.gov/sites/default/files/tools/2015-17%20Plan%20Cost-Effectiveness%20Report_4522-EERMC-Report_9-16-14.pdf

Woolf, T., et al., *Cost-Effectiveness Screening Principles and Guidelines: for Alignment with Policy Goals, Non-Energy Impacts, Discount Rates, and Environmental Compliance*, Northeast Energy Efficiency Partnerships and Synapse Energy Economic, Inc. (November 2014), Available at: http://www.neep.org/sites/default/files/resources/Forum_C-E_Screening_Guidelines_Final_No_2014.pdf

Appendix 1: State Summarized NEI Values

Table 18. *Previous New Hampshire Cost-Effectiveness Methodology*

New Hampshire Cost-Effectiveness Test	
Benefits	
Avoided generation, transmission & Distribution costs for:	
• Program Participants	Yes
• Market effects (e.g. spillover, post-program adoptions)	Yes
Customer Benefits (Including O&M)	Yes
Quantifiable avoided resource costs (e.g. water, natural gas)	Yes
Adder for other non-quantified benefits (e.g. environmental and other)	15 percent
Costs	
Program Costs (e.g. incentives, admin, monitoring, evaluation) for:	
A. Program participants	Yes
B. Market effects (e.g. spillover, post-program adoptions)	Yes
Customer Costs (including O&M)	Yes
Quantifiable additional resource costs (e.g. water, natural gas)	Yes
Utility performance incentives	Yes[59]

Raab (b), at 15

[59] The target rate of utility performance incentives (e.g. 8% of program and evaluation budget) will be considered at the program portfolio level but not at the individual program level.

Table 19. *Estimated Massachusetts Low Income Household and Societal NEIs per Weatherized Unit both With and Without Avoided Death Benefit—Annual per Unit*

NEI Value	Annual Per Unit Benefit*				
	Household w/ Avoided Death Benefit	Household w/o Avoided Death Benefit	Societal	Total w/ Avoided Death Benefit	Total w/o Avoided Death Benefit
Tier 1	**A**	**B**	**C**	**A+C**	**B+C**
Reduced asthma symptoms	**$9.99**	$9.99	$322.01	**$332.00**	$332.00
Reduced cold-related thermal stress	**$463.21**	$4.67	$33.73	**$496.94**	$38.40
Reduced heat-related thermal stress	**$145.93**	$8.28	$27.00	**$172.93**	$35.28
Fewer missed work days	**$149.45**	$149.95	$37.36	**$186.81**	$186.81
Tier 2					
Reduced use of short-term, high interest loans	**$4.72**	$4.72	$0	**$4.72**	$4.72
Reduced CO poisoning (5-year life)	**$36.98**	$0.25	$1.87	**$38.35**	$2.12
Tier 3					
Increased Home Productivity	**$37.75**	$37.75	$0	**$37.75**	$37.75
Reduced Home Fires	**$93.84**	$9.77	$17.87**	**$111.71**	$27.77***
Annual Total - Per weatherized home	**$941.87**	**$224.88**	**$439.84**	**$1,381.71**	**$664.45**

Source: E4TheFuture, Occupant Health Benefits of Residential Energy Efficiency, Pg. 24

*For CO poisoning, the annual NEI is to be applied over the 5-year life of the CO monitor. The remaining NEIs are to be applied annually over the life of the relevant measure (e.g., 20 years for weatherization).

**For home fires, the societal benefit value of $17.87 includes avoided injuries ($17.60) and deaths ($0.27) to firefighters only ($17.60 + 0.27= $17.87). Avoided injuries and deaths to occupants are categorized as a household benefit (as with all other applicable NEIs).

***The value in this column ("Total W/O Avoided Death Benefit") has been adjusted to remove not only the household avoided death benefit but the firefighter avoided death benefit of $0.27 reflected in Column C; therefore, this value is not a true sum of Column B + C. The calculation that reflects the adjustment is as follows: $9.77 + ($17.87- $0.27) = $27.37.

Red text indicates the estimate excludes the avoided death benefit

Table 20. *Weatherization Non-Energy Impact Value Ranges*[60]

NEI Estimates from Multiple Weatherization Studies: Dollar and Percentage Analysis	Dollar NEI Values [61]Range low-high			Typical Value	Percentage NEI Values Range low-high			Typical Value
UTILITY PERSPECTIVE								
Payment-related								
Carrying cost on arrearages	$1.50	-	$4.00	$2.50	0.6%	-	4.4%	2.0%
Bad Debt write-offs	$0.50	-	$3.75	$1.75	0.4%	-	2.0%	0.7%
Reduced LI subsidy payment/discounts	$3.00	-	$25.00	$13.00	3.9%	-	29.0%	16.4%
Shutoff / reconnects	$0.10	-	$3.65	$0.65	0.1%	-	4.4%	0.5%
Notices	$0.05	-	$1.50	$0.60	0.1%	-	1.8%	0.9%
Customer calls/collections	$0.40	-	$1.50	$0.90	0.2%	-	1.9%	0.6%
Service Related								
Emergency/ safety	$0.10	-	$8.50	$3.25	0.1%	-	2.7%	0.8%
Other Primary Utility								
Insurance savings	$0.00	-	$0.00	$0.00	1.2%	-	1.2%	1.2%
T&D savings	$0.13	-	$2.60	$1.40	0.9%	-	2.1%	1.2%
Fewer substations/infrastructure	$0.00	-	$0.00	$0.00	0.0%	-	0.0%	0.0%
Power quality / reliability	$0.00	-	$0.00	$0.00	0.0%	-	0.0%	0.0%
Other Primary Utility	$0.00	-	$0.00	$0.00	0.0%	-	0.0%	0.0%
Total Utility NEIs	**$5.78**	**-**	**$50.60**	**$24.05**	**7.4%**	**-**	**49.5%**	**24.4%**
Utility NEI Multiplier	**3%**	**-**	**25%**	**12%**	**0.4%**	**-**	**14.8%**	**3.3%**
SOCIETAL PERSPECTIVE								
Economic	$8.00	-	$340.00	$115.00	3.0%	-	237.6%	31.1%
Environmental/ Emissions	$3.00	-	$180.00	$60.00	70.0%	-	57.9%	7.1%
Tax effects- unemply; tax invest. Credits	$0.00	-	$0.00	$0.00	0.0%	-	0.0%	0.0%
H&S equipment/ fires	$0.00	-	$0.30	$0.00	30.0%	-	30.0%	0.0%

[60] Findings in this table are based on 20 studies of weatherization programs across the country. In some cases there has been little done in terms of research on NEI values, particularly where a zero dollar value is seen.
[61] Dollars are added net benefit value per household per year; percentage figures should be applied to the dollar value of the kWh savings

Health care	$0.00	-	$0.00	$0.00	0.0%	-	0.0%	0.0%
social welfare indicators	$0.00	-	$0.00	$0.00	0.0%	-	0.0%	0.0%
water/ wastewater infrastructure	$2.00	-	$28.00	$15.00	90.0%	-	33.1%	17.0%
Fish/ wildlife mitigation	$0.00	-	$0.00	$0.00	0.0%	-	0.0%	0.0%
National Security	$0.00	-	$0.00	$0.00	0.0%	-	0.0%	0.0%
Other	$0.00	-	$0.00	$0.00	0.0%	-	0.0%	0.0%
Total Societal NEIs	**$12.00**	**-**	**$548.00**	**$190.00**	**5.0%**	**-**	**329.0%**	**55.3%**
Societal NEIs Multiplier	**6%**	**-**	**274%**	**95%**	**4%**	**-**	**296%**	**37%**
PARTICIPANT PERSPECTIVE								
Water and Other bills								
Water/ wastewater bill savings	$2.85	-	$54.00	$15.00	4.5%	-	63.4%	20.0%
Other non-energy operating costs	$0.00	-	$0.00	$0.00	0.0%	-	0.0%	0.0%
Financial/ Customer Service								
Shutoff / reconnects	$0.21	-	$7.00	$1.60	0.2%	-	4.1%	1.4%
Bill-related calls to utility	$0.06	-	$10.00	$2.00	0.3%	-	4.0%	1.9%
Collection costs, intrusions	$0.00	-	$19.70	$0.00	8.3%	-	8.3%	0.0%
Economic Development/ Hardship								
Low income economic development	$0.00	-	$0.00	$0.00	0.0%	-	0.0%	0.0%
Hardship improvement/ family stability	$0.00	-	$65.00	$60.00	25.7%	-	25.9%	0.0%
Fewer moves (LI)	$0.00	-	$50.00	$15.00	0.6%	-	29.5%	8.0%
Equipment Operations								
Maintenance	$8.00	-	$43.00	$22.00	7.0%	-	9.7%	8.8%
Lifetime extension of equipment	$7.00	-	$20.00	$20.00	3.2%	-	7.0%	5.7%
Equipment functionality	$11.00	-	$64.00	$40.00	6.9%	-	26.0%	13.9%
Comfort, Noise, Related								
Comfort/ thermal	$12.50	-	$49.00	$30.00	3.2%	-	22.1%	10.1%
Noise reduction	$6.75	-	$34.00	$25.00	6.0%	-	15.2%	8.5%
light quality	$6.75	-	$64.00	$14.00	3.0%	-	14.0%	8.0%
Health and Safety								
Health/ fewer sick days work & school	$0.00	-	$44.00	$9.00	1.4%	-	36.1%	7.4%
IAQ	$0.00	-	$0.00	$0.00	0.0%	-	0.0%	0.0%
Chronic and other illnesses	$0.00	-	$27.50	$0.00	0.0%	-	12.4%	0.0%
Improved safety/ reduced fires/ insurance	$0.02	-	$29.00	$7.50	0.1%	-	11.0%	5.4%
Control/ education and Contributions								
Knowledge/ control over bills	$6.75	-	$52.00	$35.00	6.0%	-	19.8%	15.7%

Contribution to the environment	$6.00	-	$48.00	$21.75	2.8%	-	29.2%	10.6%
Satisfaction	$13.50	-	$52.50	$33.00	0.0%	-	12.0%	0.0%
Ability to pay other bills	$0.00	-	$24.50	$0.00	11.0%	-	11.0%	0.0%
Home Improvements								
Property value/ ease of selling	$2.50	-	$48.00	$18.00	2.3%	-	20.0%	10.0%
Aesthetics in home	$8.00	-	$29.00	$18.00	6.0%	-	18.4%	8.8%
Home durability	$0.00	-	$0.00	$0.00	0.0%	-	0.0%	0.0%
Special/ Reliability/ other								
Transaction cost	$0.00	-	$4.05	$0.00	0.0%	-	4.8%	0.0%
Svc. Reliability/ avoid interruptions	$0.00	-	$9.00	$0.00	0.0%	-	0.0%	0.0%
Other	$0.00	-	$9.00	$0.00	0.0%	-	0.0%	0.0%
Total Participant NEIs	**$94.89**	**-**	**$796.85**	**$386.85**	**98.5%**	**-**	**403.8%**	**144.1%**
Participant NEIs Multiplier	**47%**	**-**	**398%**	**193%**	**98.5%**	**-**	**403.8%**	**144.1%**
Subtotals- NEI Multipliers by Types								
Relative to Participant Bill Savings								
Utility NEI Multiplier	3%	-	25%	12%	0%	-	15%	3%
Societal NEI Multiplier	6%	-	274%	95%	4%	-	296%	37%
Participant NEIs Multiplier	47%	-	398%	193%	99%	-	404%	144%
TOTAL	**300%**	**-**	**698%**	**300%**	**103%**	**-**	**714%**	**184%**

Source: Table 3.4: Non-Energy Impacts / Non-Energy Impacts and Their Role and Values in Cost Effectiveness Tests, State Of Maryland, SERA Inc., March 2014, pgs. 28-30

Table 21. Quantifying Non-Energy Benefits (NEBs) in Illinois

Program Administrators Using NEBs Adders			
Program Administrator	**Adder**	**Description**	**Description Source**
Ameren IL	7.5% gas; 10% electric		
ComEd	No NEBs adder	CO_2 costs at $0.0139/kWh. The primary environmental benefit that could be included in the Illinois TRC test is the value of avoided CO_2 emissions. ComEd included the average carbon value proposed by the NRDC within our analysis. This value ($18.50/tonne) was applied to PJM's 2009 marginal power plant emission rate to arrive at an average value of $0.0139/kWh. DSMore does not provide escalation factors for externalities and emissions.	C/E Report, EPY5
DCEO	10%	DCEO reports TRC results with and without NEBs, assuming at 10% adder, not distinguishing between gas/electric NEBs. EPY4/GPY1: Participant non-energy benefit (NEB) adders were applied to calculated benefits. A 15% default non-low income benefits adder was applied to Public Sector and Market Transformation Programs. A 30% default low-income benefits adder was applied to Low Income Programs. TRC scores were calculated with and without the non-energy benefit adders. Environmental benefits of avoided CO_2 emissions from electricity generation were valued at $0.013875 / kWh and included in the calculation of benefits.	C/E Report, EPY4/GPY1
Nicor Gas	7.5% gas		
Peoples Gas - North Shore Gas	7.5% gas		
Other Methods			
Method	**Description**		**Description Source**

Include non-energy (electric/gas) benefits in the IL-TRM	Water savings is quantified in the IL-TRM. Measures include: Clothes Washer; showerhead; aerator; thermostatic restrictor valve; dishwasher; ozone laundry; and HE pre-rinse spray valve measures. IL-TRM also quantifies operations and maintenance savings where differences exist between baseline and efficient measures.	ICC Staff
Include carbon in TRC analysis		ICC Staff

Source: Illinois research

Table 22. *NEI Values in Massachusetts & Rhode Island, and Maryland (propose) ($ per household)*

Perspective/NEI Category	Maryland (SERA 2014) Dollar Range	Typical Value	Massachusetts Dollar Range	Rhode Island Dollar Range	Average Cross All NEIs
Financial and Accounting	$2.55 - $25.00		$9.70	$2.61 - $39.90	$2.61 - $3.74
Customer Service	$0.10 - $8.50		$3.25	$0.34 - $8.43	$0.34 - $8.43
Other Utility Impacts	$0.13 – $2.60		$1.40	N/A – N/A	N/A – N/A
Participant-Perspective					
Participant Utility Savings	$0.27 - $36.70		$3.60	N/A – N/A	N/A – N/A
Low-Income/Economic Development	$0 - $115		$75	N/A – N/A	N/A – N/A
Improved Operations	$26 - $126		$82	$0.96 - $124	$0.96 – 102.40
Comfort	$26 - $104		$69	$31 - $125	$1.42 - $125
Health & Safety	$26 - $105		$16.50	$4 - $45	$0.13 - $45
Education and Contributions	$3.02 - $100.50		$89.75	N/A – N/A	N/A – N/A
Home Improvements	$26.25 - $177.00		$36	$17* -$1,998*	$0.32* - $678.52*
Other Participant Perspective	$10.50 - $76		$0	N/A – N/A	-$0.015 per kWh saved
Societal Perspective					
Economic Development	$8 - $340		$115	N/A – N/A	$0.39 per kWh saved*
Environmental/Emissions	$3 - $180		$60	N/A – N/A	N/A – N/A

Health Care/Health & Safety	$0 - $0.30	$0	N/A – N/A	$0 $172.53*
Tax Impacts	N/A – N/A	N/A	N/A – N/A	N/A – N/A
National Security	N/A – N/A	N/A	N/A – N/A	$1.83 per MMBtu oil saved
Other Societal-Perspective NEIs	N/A – N/A	N/A	N/A – N/A	N/A –N/A
Financial and Accounting	$2.55 - $25.00	$9.70	$2.61 - $39.90	$2.61 - $3.74
Customer Service	$0.10 - $8.50	$3.25	$0.34 - $8.43	$0.34 - $8.43

Source: NEEP, at 68

Table 23. *Summary of NEI Values by Customer Sector – District of Columbia*

Sector	NEIs ($)	Participants or units	NEI $/ Unit	Lifetime Electric Savings (MWh)	NEI$ / MWh	Lifetime Energy Savings (MMBtu)	NEI $ / MMBTU	% Adder
Residential	$557,183	38,472	14	14,008	40	99,024	5.63	10%
Low-Income	$949,464	7,645	124	6,776	140	62,751	15.13	10%
Commercial & Industrial	$5,020,822	241	20,833	29,587	170	303,844	16.55	10%

Source: NEEP, at 70

Table 24. *Summary of NEI values by Customer Sector- Vermont*

Sector	NEIs ($)	Participants or units	NEI $/ Unit	Lifetime Electric Savings (MWh)	NEI$ / MWh	Lifetime Energy Savings (MMBtu)	NEI $ / MMBTU	% Adder
Residential	$4,473,900	35,171	127	316,289	14	2,868,299	1.56	15%
Low-Income	$714,380	2,080	343	20,948	34	194,075	3.68	32%
Commercial & Industrial	$8,404,306	2,297	3,659	694,792	12	6,313,387	1.33	15%

Source: NEEP, at 70

Table 25. *NEI values from Literature for Delaware Energy Efficiency Advisory Council*

Category or Type of NEI	Value (2016$)	Source	Notes
Weatherization			
LI Weatherization single family	$1,382 per home (annual)	Massachusetts (2014)	$942 participant, $440 societal
HPwES, comfort	$136 per home (annual)	Maryland (2014)	
Reduced arrearages	2 percent of benefits	Maryland (2014)	
Air Emissions			
Avoided emissions/ air quality	$0.04 per kWh	Vermont	
Air emissions	$0.011 per kWh	Maryland (2014)	Includes health impacts; may double-count NO_x/SO_2
Measure-based			
Prescriptive C&I	$0.027 per kWh, $8.34 per MMBtu	Massachusetts (2012)	Includes lighting, HVAC, motors, refrigerators
Custom C&I	$0.037 per kWh, $2.47 per MMBtu		
Carbon			
All	$15 per ton	Oregon, New York	
Combined/unspecified			
"Difficult to quantify"	+15% on avoided costs	Vermont	Not duplicative of specific value above
"General"	+10% on avoided costs	IA, CO, OR, WA, DC	Not necessarily duplicative of specific values above

Source: DE EEAC EM&V working group presentation by Optimal Energy, October 2016, DE EEAC meeting

Table 26. *Estimated Emissions Outputs and Values per MWh, Simplified Calculation, Maryland*

Greenhouse Gas	GHG equivalencies, in CO_2 equivalencies	Pounds per MWh generated, "NEB-It" factors, avg. Maryland generation mix	Pounds per MWh generated using EIA Maryland factors
Sulfur Dioxide	0	1.805	2.3
Nitrogen Oxides	310	1.956	1.3
Carbon Dioxide	1	1054	1333
Total pounds Carbon dioxide equivalents per MWh using Maryland generation mix		1660	1736
Value per kWh saved at $X per ton CO2 10 per ton CO2 (very conservative) $20 per ton CO2 (conservative/used in remainder of report**) $100 per ton (used by environmental groups, etc.) (NOTE: Alternate values for $/ton may be selected)		0.84 cents/kWh 1.7 cents/kWh** 8.4 cents/kWh	
Multiplied times 1271 average kWh saved by MD pgm		$22/hh at $20/ton** (Alternates: CO2 ($11/hh at $10/ton CO2; $110/hh at $100/ton CO2)	
Multiplier per kWh compared to residential rates of 13.7 cents per kWh in Maryland		12% adder** (6% adder at $10/ton; 60% adder at $100/ton)	

Source: Skumatz (c), at 48

Table 27. *Estimated Emissions Outputs and Values per MWh, Simplified Calculation, Colorado*

Greenhouse Gas	GHG equivalencies, in carbon dioxide equivalencies	Pounds per MWh generated, "NEB-It" factors, avg. Colorado generation mix	Pounds per MWh generated using EIA Colorado factors
Sulfur Dioxide	0	2.4	2.0
Nitrogen Oxides	310	2.6	2.4
Carbon Dioxide	1	1,615	1,760
Total pounds Carbon dioxide equivalents per MWh using Colorado generation mix		2,429	2,504
Value per kWh saved at: $10 per ton CO2 (very conservative) $20 per ton CO2 (conservative) (Used in remainder of report**) $100 per ton (used by environmental groups, etc.) (NOTE: Alternate values for $/ton may be selected)		1.24 cents/kWh (at $10/ton) 2.47 cents/kWh (at $20/ton)** 12.34 cents/kWh (at $100/ton)	
Multiplied times 1000 kWh (saved commonly by Wx programs)		$12.35/hh (@$10); $24.70/hh**; $123.40/hh (@$100)	
Multiplier per kWh compared to residential rates of 11.44 cents per kWh in Colorado		10.8% adder (@$10) / 21.6% adder**(@$20); 100.8% adder (@$100)	

Source: Skumatz (b), at 49

Appendix 2: Reported NEIs in Evaluation Research

***Table 28**. Mean NEI Values* [62]

NEI	Sample Size	Non-Low-Income (NLI)		Low-Income (LI)	
		Unscaled Value	Scaled Value	Unscaled Value	Scaled Value
Comfort	165 (NLI); 172 (LI)	$272	$125	$205	$101
Noise Reduction	183 (NLI); 193 (LI)	$53	$31	$63	$30
Property Value[63]	157 (NLI); 143 (LI)	$1,998	N/A	$949	N/A
Equipment Maintenance[64]	117 (NLI); 122 (LI)	$175	$124	$116	$54
Durability	173 (NLI); 185 (LI)	$57	$49	$78	$35
Total NEIs	208 (NLI); 208 (LI)	$472	$261	$431	$242

Source: Clendenning, G., et al., at 6

[62] The values in this table are weighted to strata and income group. In addition, cases that are at least three times the standard deviation of percent bill savings of the total scaled NEI value are excluded. The following weights were applied to the non-low-income population: a weight of 1.53 for the heating & cooling strata, a weight of 1.40 for the shell strata a weight of 0.10 for the shell plus heating and cooling strata. For the low-income sample, the following weights were applied: a weight of 1.22 for the heating and cooling strata, a weight of 0.98 for the shell strata a weight of 0.79 for the shell plus heating and cooling strata.
[63] Property Value was not scaled because, as a one-time NEI value, it was excluded from the survey question about total annual value of NEIs. Property value was limited to respondents who own their home.
[64] Equipment maintenance was only asked of respondents who installed heating or cooling equipment.

Table 29. Summary of Average Annual NEI Estimates for Commercial & Industrial

Electric Measures	n	Average Annual NEI per Measure[65]	NEI/kWh	90% C&I Low	90% C&I High	Stat Sig
Prescriptive						
HVAC	27	$7,687	$0.0966	$0.0544	$0.1389	Yes
Lighting	163	$1,636	$0.0274	$0.0176	$0.0372	Yes
Motors and Drives	50	$541	$0.0043	$(0.0005)	$0.0091	No
Refrigeration	30	$5	$0.0013	$(0.0002)	$0.0028	No
Other	32	$28	$0.0039	$(0.0002)	$0.0079	No
Total	302	$1,439	$0.0274	$0.0188	$0.0360	Yes
Custom						
CHP/Cogen	6	($12,949)	$(0.0147)	$(0.0247)	$(0.0047)	Yes
HVAC	20	$5,584	$0.0240	$0.0003	$0.0047	Yes
Lighting	89	$5,686	$0.0594	$0.0318	$0.0871	Yes
Motors and Drives	42	$1,433	$0.0152	$0.0005	$0.0309	No
Refrigeration	90	$1,611	$0.0474	$0.0244	$0.0705	Yes
Other	29	$15,937	$0.0562	$0.0038	$0.1087	Yes
Total	276	$4,454	$0.0368	$0.0231	$0.0506	Yes
Prescriptive						
Building Envelope	2	$1,551	$3.6151	$2.6418	$4.5885	Yes
HVAC	50	$755	$1.3464	$0.5433	$2.1496	Yes
Water Heaters	47	$129	$0.2604	$(0.0012)	$0.5221	No
Total	99	$439	$0.8344	$0.3634	$1.3053	Yes
Custom						
Building Envelope	46	$922	$0.4774	$0.1258	$0.8290	Yes
HVAC	41	$2,798	$0.2291	$0.1522	$0.3060	Yes
Water Heaters	23	$803	$0.1824	$0.4953	$0.8601	No
Other	2	$1,905	$0.5253	$(5.6577)	$6.7083	No
Total	112	$1,940	$0.2473	$0.1490	$0.3455	Yes

Source: DNV KEMA, at 11

[65] Equals (NEI/kWh) x (Average annual kWh)

Table 30. *Comparison of NMR (2011) and Three[3] (2016) NEI Values ($ per unit)*

Category or Measure	Annual		NPV (20 years at 0.44%	
	NMR (2011)	Three[3] (2016)[66]	NMR (2011)	Three[3] (2016)[67]
By NEI Category				
Health Benefits	$19	$768.58	$363	$14,683.78
Thermal Comfort	$101	$119.88	$1,929.61	$2,290.22
Improved Safety	$45.05	$94.46	$860.68	$1,281.40
By Key Measure				
Weatherization, electric or gas[68]	$10.46	$551.37	$199.84	$10,010.70
Heating system retrofit/ replacement, electric or gas[69]	$50.32	$30.73	$961.37	$5,355.98

Source: Three[3], Table 10.3 at 75

Table 31. *Residential Participant-Side Non Energy Benefit Categories by Type of Measure or Program*

<table>
<tr><th>Central A/C</th><th>Window Measures</th><th>Refrigerators</th><th>Weatherization Measures</th><th>Multifamily Lighting</th></tr>
<tr><td rowspan="2">Higher value in house, house nicer</td><td>Higher value in house/house nicer</td><td rowspan="2">More features, bigger</td><td rowspan="3">Insulation was ranked in order with less drafty, environmental, save money, and higher house value</td><td>Building is nicer</td></tr>
<tr><td>Save money/lower bill/use less energy</td><td>Replacing less frequently</td></tr>
<tr><td rowspan="2">More features, bigger, faster</td><td>Feel good about environment</td><td rowspan="2">Save Money/ lower bill, use less energy</td><td rowspan="2">Better safety was ranked with high value (especially in common areas)</td></tr>
<tr><td>House less drafty – more comfort</td><td>CO monitors – very strong feelings of improved safety</td></tr>
</table>

[66] Three[3] 2016 annual NEI estimate for Improved Safety, Weatherization, and Heating System Retrofit includes annual estimate for CO monitors of $38.67 (5-year life).

[67] Three[3] 2016 NPV NEI estimate for Improved Safety, Weatherization, and Heating System Retrofit includes 5-yr (not 20-yr) NPV estimate for CO monitors of $183.30

[68] Weatherization includes health, thermal comfort, and safety NEIs apportioned for air sealing, insulation, smoke detectors, and CO detectors

[69] Heating System Retrofit/Replacement includes Health, Thermal Comfort, and Safety NEIs apportioned for heating system, smoke detectors, and CO detectors

Save money, lower bill, use less energy	May not have to move	Quieter	Weather-stripping and caulking: greater comfort and fewer drafts, quieter	Bill savings was ranked high by this sector
	Less worried about bills	Kitchen nicer	Greater awareness/ learned strategies from weather awareness programs	
House less drafty – more comfort	Easier to clean	Expect less repair	Lower bill	Environmental Benefits
	Windows now open and didn't before	Environmental	Better water flow from new bath/faucet replacements	
Quieter	New coatings reduce upholstery			

Source: Skumatz, L. et al. (e) at 6

Table 32. *Commercial/Industrial Participant-Side Non-Energy Benefit Categories by Type of Measure*

Lighting Measures	HVAC Measures	Water Measures	Refrigeration
Better Lighting	Lower maintenance and longer equipment lifetimes	Reduced water losses and bills	Lower maintenance
Safety/security	Greater comfort	Greater efficiency and control of water use	Longer equipment lifetimes
Lower maintenance	Better air quality, airflow, quality	Reduced over watering of landscaping	
Improved work environment	Better productivity	Labor savings	Reduced noise
Better aesthetics	Higher tenant satisfaction	Better aesthetics	Greater control of equipment, temperatures, etc.
Reduced glare, eyestrain	Better aesthetics	Greater tenant/guest satisfaction	
Improved productivity	Better control		Greater product life, lower losses of product
Better control	Environmental Benefits		
Other	No extra benefits	Better water flow	Reduced water use
No extra benefits			Better aesthetics

Skumatz, L. et al. (e) at 8

Table 33. *Inputs and NEB Estimates for Thermal Stress- Cold*

Thermal Stress-Cold			
Self-Reported decrease in medical care for thermal stress due to weatherization (WAP occupant survey – cold climate zone)	**1.9%**		
	Office Visits	ED Visits	Hospitalizations
Insurance coverage ratio, specific to ICD-9 diagnostic codes, for payment of treatment type a, b, and c (*adjusted for MA LI population)			
Medicare	21%	22%	60%
Medicaid	11%	20%	23%
Private/Other	56%	22%	10%
Uninsured	11%	37%	7%
Percent of medical cost that is out of pocket	10.34%	8.87%	3.26%
Percent of medical care for thermal stress (national rate)	50.1%	39.9%	10.0%
Reduction in medical care visits due to weatherization, per 1,000 weatherized units	9.5	7.6	1.9
Average Medicare cost (MA-adjusted, 2014)	$185.12	$1,069.59	$13,700.80
Average Medicaid cost (MA-adjusted, 2014)	$132.79	$419.41	$19,111.45
Average Private/Other cost (MA-adjusted, 2014)	$321.68	$1,577.17	$16,249.09
Average Uninsured cost (MA-adjusted, 2014)	$114.70	$870.02	$11,671.41
Household NEB$, per weatherized unit, per year (OOP costs)	$0.30	$2.65	$1.72
Societal NEB$, per weatherized unit, per year	$2.06	$4.78	$26.90

Source: Three[3] and NMR, at 79

Table 34. Inputs and NEB Estimates for Avoided Deaths Related to Thermal Stress- Cold

Avoided Deaths: Thermal Stress-Cold	
Percent of hospitalizations from thermal stress resulting in death (national rate)	2.511774%
Rate of reduction in thermal stress deaths due to weatherization	0.00477237%
Reduction in thermal stress deaths per 1,000 weatherized units	0.047723705
VSL (USDOT)	9,600,000
Household avoided death NEB$, per weatherized unit, per year	**$458.54**
Total Household NEB$, per weatherized unit, per year	**$463.21**
Total Household NEB$ without avoided deaths, per weatherized unit, per year	**$4.67**
Total Societal NEB$, per weatherized unit, per year	**$33.73**
Discount rate (real)	0.0044
Life of Benefit (years)	20
Household NEB$, PV per weatherized unit	**$8,849.71**
Household NEB$, PV per weatherized unit (without avoided deaths)	**$89.30**
Societal NEB$, PV per weatherized unit	**$644.47**

Source: Three[3] and NMR, at 80

Table 35. Inputs and NEB Estimates for Thermal Stress- Hot

Thermal Stress-Hot			
Self-Reported decrease in medical care for thermal stress due to weatherization (WAP occupant survey – cold climate zone)	**2.80%**		
	Office Visits	ED Visits	Hospitalizations
Insurance coverage ratio, specific to ICD-9 diagnostic codes, for payment of treatment type a, b, and c (*adjusted for MA LI population)			
Medicare	21%	25%	65.5%
Medicaid	11.5%	16.5%	10.2%
Private/Other	55.9%	25.5%	10.2%
Uninsured	11.3%	32.9%	5.9%
Percent of medical cost that is out of pocket	10.3%	8.9%	3.3%
Percent of medical care for thermal stress (national rate)	11.5%	84.5%	4.0%

Reduction in medical care visits due to weatherization, per 1,000 weatherized units	3.2	23.6	1.1
Average Medicare cost (MA-adjusted, 2014)	$185.00	$1,070.00	$9,169.00
Average Medicaid cost (MA-adjusted, 2014)	$133.00	$419.00	$12,400.00
Average Private/Other cost (MA-adjusted, 2014)	$322.00	$1,577.00	$7,515.00
Average Uninsured cost (MA-adjusted, 2014)	$115.00	$870.00	$7,726.00
Household NEB$, per weatherized unit, per year (OOP costs)	**$0.10**	**$7.62**	**$0.56**
Societal NEB$, per weatherized unit, per year	**$0.70**	**$16.65**	**$9.64**

Source: Three[3] and NMR, at 80

Table 36. *Inputs and NEB Estimates for Avoided Deaths Related to Thermal Stress- Hot*

Avoided Deaths: Thermal Stress-Hot	
Percent of hospitalizations from thermal stress resulting in death (national rate)	1.28%
Rate of reduction in thermal stress deaths due to weatherization	0.00143382%
Reduction in thermal stress deaths per 1,000 weatherized units	0.014338224
VSL (USDOT)	$9,600,000
Household avoided death NEB$, per weatherized unit, per year	**$137.65**
Total Household NEB$ without avoided deaths, per weatherized unit, per year	**$145.93**
Total Household NEB$ without avoided deaths, per weatherized unit, per year	**$8.28**
Total Societal NEB$, per weatherized unit, per year	**$27.00**
Discount rate (real)	0.0044
Life of Benefit (years)	20
Household NEB$, PV per weatherized unit	**$2,787.95**
Household NEB$, PV per weatherized unit (without avoided deaths)	**$158.19**
Societal NEB$, PV per weatherized unit	**$515.86**

Source: Three[3] and NMR, at 81

Table 37. *Inputs and NEB Estimates for Missed Days of Work*

Missed Days of Work	
Self-reported decrease in missed work days due to weatherization (WAP occupant survey – cold climate zone)	4
Percent of LI households with an employed primary wage earner	34.0%
Average Hourly wage (renter, MA – adjusted to 2014)	$17.17
Work Hours per day	8
Total	**$186.81**
Percent of LI workers without sick leave (national)	80.0%
Total Household NEB$, per weatherized unit, per year	**$149.45**
Percent of LI workers with sick leave	20.0%
Total Societal NEB$, per weatherized, per unit year	**$37.76**
Discount Rate (real)	0.0044
Life of Benefit (years)	20
Household NEB$, PV per weatherized unit	**$2,855.21**
Societal NEB$, PV per weatherized unit	**$713.80**
Total NEB$	**$3,569.01**

Source: Three[3] and NMR, at 83

Table 38. *Inputs and NEB Estimates for Short-Term, High Interest Loans*

Short-Term, High Interest Loans	
Self-reported decrease in use of short term, high interest loans due to weatherization (WAP occupant survey – cold climate zone)	6.45%
Average interest/loan fees (national, 2014 adjusted)	$73.18
Total Household NEB$, per weatherized unit, per year	**$4.72**
Discount rate (real)	0.0044
Life of Benefit (years)	20
Household NEB$, PV weatherized unit	**$90.18**

Source: Three[3] and NMR, at 83

Table 39. *Input and NEB Estimates for Increased Productivity at Home Due to Improved Sleep*

Increased Home Productivity	
Percent increase in respondents reporting no sleep problems in the last 30 days	5.0%
Cost in lost productivity per year for employees with sleep problems	$2,500
Average national hourly wage	$22.62
Average hourly wage rate for general housekeeping (MA-adjusted, 2014)	$12.71
Average hours per week on non-paid housework (BLS)	21.5
No. of hours per work week	**40**
Total Household NEB$, per weatherized unit, per year	**$37.75**
Discount rate (real)	0.0044
Life of Benefit (years)	20
Household NEB$, PV weatherized unit	**$721.26**

Source: Three[3] and NMR, at 84

Appendix 3: Rhode Island Cost-Effectiveness Framework, Docket 4600

Table 40: *Rhode Island Cost-Effectiveness Framework*

	Mixed Cost-Benefit, Cost, or Benefit Category	System Attribute Benefit/Cost Driver	Candidate Methodologies (Includes options with increasing specificity where multiple methods per driver)	Potential Visibility Requirements
Power System Level	Energy Supply & Transmission Operating Value of Energy Provided or Saved (Time- & Location-specific LMP)	Bids, Offers, Marginal Losses, Constraints, & Scarcity in Time & Location specific LMP (+ Reactive Power requirements & Impacts on Distribution Assets in DLMP)	AESC Seasonal On- & Off-Peak Energy Price Forecasts	
			Expected Time- & Location-specific Bulk Power LMP for forecast period of resource operation	Requires interval data and/or advanced metering functionality & Tracking of ISO Nodal Prices
			Expected Time-, Location-, & Product-specific Distribution LMP for forecast period of resource operation	Requires interval data and/or advanced metering functionality & analysis of actual power flows
	Renewable Energy Credit Cost / Value	Cost of REC Obligation or REC Revenue Received	AESC Forecast of REC prices	
	Retail Supplier Risk Premium	Differential between retail prices and ISO market prices * retail purchases	Absent advanced metering functionality + dynamic retail pricing, AESC estimate or risk adjusted observed differentials	Quantitative estimation requires detailed economic modeling
	Forward Commitment: Capacity Value	Whether an FCM Qualified Resource &, if so, FCA bid and Provision of Qualified Capacity	Estimate of likely FCA Auction bid capacity from FCM Qualified Resources	Quantitative estimation requires detailed economic modeling
		Change in Demand reflected (~4 yr. later) in a Revision of FCM forecast Capacity Requirements	Review of FCM capacity requirements & estimate of likely future impacts (Same as Capacity DRIPE below)	Quantitative estimation requires detailed economic modeling
	Forward Commitment: Avoided Ancillary Services Value	Whether it is a Qualified Ancillary Service Resource &, if so, Qualified Capacity	Forecasts of AS requirements / Provision of AS net of Energy supplied * Forecast AS prices	

	Utility / Third Party Developer Renewable Energy, Efficiency, or DER costs	Direct Cost of New Non-customer Resources (Capital & Operating costs of resources) + Customer Program costs (Participant recruitment, administrative, incentive and EM&V costs)	Cost Estimates	
	Electric Transmission Capacity Costs / Value	Change in transmission capacity requirements associated in change in resource mix	Annualized statewide transmission capacity value associated with load growth * change in net demand (ICF)	
			Forecast impacts of specific resources on transmission planning requirements	Requires detailed planning studies
	Electric transmission infrastructure costs for Site Specific Resources	Cost to develop new transmission (For peak output + any contingency requirement)	Direct cost estimates for remotely sited resources (e.g. offshore wind)	Requires detailed planning studies
	Net risk benefits to utility system operations (generation, transmission, distribution) from 1) Ability of flexible resources to adapt, and 2) Resource diversity that limits impacts, taking into account that DER need to be studied to determine if they reduce or increase utility system risk based on their locational, resource, and performance diversity	Flexible DERs (storage, flexible demand) can reduce risk by enabling the system to respond to disruptive events	Use proxy value for ability of system to respond to disruptive events	
			Model system with additional flexible resources	Quantitative estimation requires detailed economic modeling
		DERs need to be studied to determine if they reduce or increase utility system risk based on their locational, resource, and performance diversity.	Use proxy values for size and locational and resource diversity.	
			Portfolio analysis with risk assessment technique	Quantitative estimation requires detailed economic modeling
	Option value of individual resources	Impacts of individual resources on the cost of other potential resources	Estimates of impacts of one resource on the costs of others	Quantitative estimation requires detailed economic modeling

			Option value calculation based on scenario analysis of potential future resource choices	Quantitative estimation requires detailed economic modeling
			Portfolio analysis - comparison of alternative portfolios	Quantitative estimation requires detailed economic modeling
	Investment under Uncertainty: Real Options Cost / Value	Impacts of reduced flexibility / discovery of new information	Scenario analysis: calculation of real option value associated with different decision times & resources	Quantitative estimation requires detailed economic modeling
	Energy Demand Reduction Induced Price Effect	Change in Energy price, Net of Any Capacity Cost Change from Net CONE	AESC Estimate of DRIPE (Need to clarify whether accounts for impact on Net CONE)	
			Estimate of Energy Price change with an adjustment of impacts on Net CONE in ISO FCM	Quantitative estimation requires detailed economic modeling
Power System Level	Greenhouse gas compliance costs	Forecast prices under RGGI and other market-based regulations (e.g. Clean Power Plan) + changes other compliance costs under likely environmental regulations	Forecasts of RGGI and CPP prices + estimates of likely compliance costs under any other GHG regulation	Quantitative estimation requires detailed economic modeling
		Forecast compliance costs associated with meeting the GHG emission targets in the Resilient Rhode Island Act	Estimates of likely compliance costs under RI GHG regulation	Quantitative estimation requires detailed economic modeling
		Net marginal emissions or emissions avoided from changes in resource use	Forecast of net emissions impacts from change in regional dispatch and resource mix	Quantitative estimation requires detailed economic modeling
	Criteria air pollutant and other environmental compliance costs	Changes in forecast compliance costs under air pollution or other environmental regulations	Forecasts of the costs of compliance under affected environmental regulations	Quantitative estimation requires detailed economic modeling

		Net marginal emissions or emissions avoided from changes in resource use	Forecast of net environmental impacts from change in regional dispatch and resource mix	Quantitative estimation requires detailed economic modeling
	Innovation and Learning by Doing	Experimentation Costs	Direct costs of innovation / demonstration programs	
		Anticipated rate of cost reduction or performance improvement	Qualitative assessment	
Power System Level	Distribution capacity costs	Change in distribution capacity requirements generally with change in resources	Annualized statewide distribution capacity value associated with load growth * change in net demand (ICF)	
		Forecasted change peak distribution circuit requirements	Distribution planning studies	Requires detailed planning studies
		Location-specific DER hosting capacity	Analysis of capability to host DER with existing and already-planned facilities	Requires detailed planning studies
		Impacts on system performance, thermal and reactive power constraints, and associated investment and operating costs	Distribution planning studies	Requires detailed planning studies
	Distribution delivery costs	Location-specific distribution constraints, losses, equipment cycling, DLMP	Dynamic, multi-layered forecasts as a basis for circuit specific DER and Distribution System Plans	Requires interval data and/or advanced metering functionality, modeling, and planning studies
			Analysis of time-, location-, and product-specific DLMP value, potentially leading toward DLMP markets	Requires interval data or advanced metering functionality & analysis of actual power flows
	Distribution system safety loss/gain	Changes in risks, real-time information on system conditions, and training	Qualitative Assessment, Tracking and Assessment of Safety Metrics	Distribution system safety loss/gain

	Distribution system performance	Performance metrics include: voltage stability and equalization, conservation voltage reduction, operational flexibility, fault current / arc flash avoidance, and effective asset management	Distribution planning and benchmarking to best practices	Requires advanced metering functionality and / or distribution sensors
	Utility low income	Energy efficiency impacts on reducing utility arrearage carrying costs, uncollectibles, customer service and collection costs	Marginal impacts on arrearages, uncollectibles, and other utility costs	
		Incremental utility costs for low income efficiency programs net of system energy cost savings	Direct costs net of system general system benefits	
		Expected impacts on customer voltages and power quality	Voltage and power quality measurement and assessments	Requires advanced metering functionality and / or distribution sensors
Power System Level	Distribution system and customer reliability / resilience impacts	Customer-specific & critical facility outage costs and value of uninterrupted service	US DOE Interruption Cost Estimator	
			Customer value of uninterrupted service studies	Requires customer surveys
		Expected impacts on the probability of outage	Distribution system risk assessment studies	Requires detailed planning studies
		Expected impacts on the duration of outages	Distribution system / microgrid resilience studies	Requires detailed planning studies
		Expected impacts on customer voltages and power quality	Voltage and power quality measurement and assessments	Requires advanced metering functionality and / or distribution sensors
		Costs of distribution improvements & microgrids	Distribution planning and costing	Requires detailed planning studies
	Distribution system safety loss/gain	Changes in risks, real-time information on	Qualitative Assessment, Tracking and	

		system conditions, and training	Assessment of Safety Metrics	
Customer Level	Mixed Cost-Benefit, Cost, or Benefit Category	System Attribute Benefit/Cost Driver	Candidate Methodologies (Includes options with increasing specificity where multiple methods per driver)	Potential Visibility Requirements
	Program participant / prosumer benefits / costs	Direct participant / prosumer cost of technology, investment, and/or program participation costs	Estimates of net direct costs	
		Participant indirect costs (includes required behavioral changes and inconvenience costs)	Qualitative assessment	
			Willingness to accept / pay estimates (observation or surveys)	Requires customer surveys
		Participant non-energy impacts (includes value of improvements in quality of life)	Qualitative value	
			Deemed Benefits Not Reflected in Other Categories - Efficiency Technical Reference Manual	
			Willingness to pay estimates (observation or surveys)	
	Participant non-energy costs/benefits: Oil, Gas, Water, Waste Water	Value of Energy and Water Savings / Requirements	AESC Estimate of Avoided Natural Gas, Oil, and Other Fuel Costs	
			Estimate of Net Costs or Cost Savings	Requires customer surveys
Customer Level				
	Low-Income Participant Benefits	Improved comfort, reduced noise, increased property value, increased property durability, lower maintenance costs, improved health, and reduced tenant complaints.	Begin with values from Rhode Island EE cost-effectiveness analyses.	
				May require interval data and/or advanced metering functionality
	Consumer Empowerment & Choice	Retail Competition, Facilitation of Flexible Demand, Integration of Commodity & Energy Services, Development	Qualitative Assessment	

		of Platform Market, & Third Party DER Development		
	Non-participant (equity) rate and bill impacts	Utility revenue requirements, cost allocation and rate design	Long-term rate and bill analysis	
			Analysis of non-participant usage, price elasticity, and income patterns	May require interval data and/or advanced metering functionality
Societal Level	Mixed Cost-Benefit, Cost, or Benefit Category	System Attribute Benefit/Cost Driver	Candidate Methodologies (Includes options with increasing specificity where multiple methods per driver)	Potential Visibility Requirements
	Greenhouse gas externality costs	GHG Externality Value net of RGGI costs	Customer willingness to pay for reductions in excess of compliance levels (observation or WTP surveys)	Requires customer surveys
			Societal cost estimates	
		Net marginal emissions or emissions avoided from changes in the use of resources	Forecast of net emissions impacts from change in regional dispatch and resource mix	Quantitative estimation requires detailed economic modeling
	Criteria air pollutant and other environmental externality costs	Criteria Pollutant (e.g. Fine Particulates) and other Environmental Externality Value Net of any Emission Allowance / Emission Credit Value	Customer willingness to pay for reductions in excess of compliance levels (observation or WTP surveys)	Requires customer surveys
			Societal cost estimates	
		Net marginal emissions or emissions avoided from changes in the use of resources	Forecast of net environmental impacts from change in regional dispatch and resource mix	Quantitative estimation requires detailed economic modeling
	Conservation and community benefits	Land use impacts (net of property costs for resource deployments): Loss of sink, habitat, historical value, sense of place	Value of carbon sink per acre	
			Environmental and historical conservation easement cost	
		Equity in distribution of harmful or nuisance infrastructure	Qualitative assessment	
			MW of infrastructure per acre, $ of infrastructure per value of property	

	Non-energy costs/benefits: Economic Development	Estimate of Impacts on State Product or Employment, Effects of land use change on property tax revenue	Qualitative Assessment	
			Economic modeling (e.g. input / output life-cycle analysis, property tax base studies)	Quantitative estimation requires detailed economic modeling
	Innovation and knowledge spillover (Related to demonstration projects and other RD&D preceding larger scale deployment)	RD&D, Strength of innovation eco-system, knowledge capture & sharing from public / utility/private sector funded initiatives	Qualitative Assessment	
	Societal Low-Income Impacts	Poverty alleviation, reduced energy burden, reduced involuntary disconnections from service, reductions in the cost of other social services, local economic benefits, etc.	Qualitative assessment or Adder	
			Direct estimate of cost savings	
			Alternate input factor in modeling of local economic impacts	Quantitative estimation requires detailed economic modeling
	Public Health	Indoor air quality, heating, cooling, and noise impacts of efficiency programs (Additional environmental and economic impacts on vulnerable customers addressed elsewhere)	Qualitative Assessment	
	National Security and US international influence	Impacts on oil imports	Analysis of oil imports into Rhode Island and the region	

Source: Docket 4600 Report, Pgs. 22-34

Appendix 4: NEI categories, definitions, and specific examples

NEI Category	Definition	Specific Examples
Utility-Perspective		
Financial and Accounting	Electricity generation can have a variety of environmental impacts. By reducing the need to generate, transmit, and distribute electricity, energy efficiency can result in a variety of significant environmental benefits that will accrue to society as a whole (NMR 2011; SERA 2010).	reduced arrearages; reduced carrying costs on arrearages; reduced bad debit write offs; reduced low-income subsidy payment/discounts
Customer Service	Timely customer bill payments can result in fewer collection activities, such as customer calls, late payment notices, shut-off notices, terminations, reconnections. The utility realizes savings in staff time and materials.	shutoffs and reconnects; notices; customer calls and collections; emergency and safety
Other Utility Impacts	Utilities may realize savings from their efficiency programs due to a reduction in safety-related emergency calls and insurance costs due to reduced fires and other emergencies (NMR 2011). Efficiency also increases the utility's system reliability and power quality.	insurance savings; T&D savings; fewer substations/infrastructure; power quality / reliability; other primary utility
Participant Perspective		
Participant's Utility Savings	Just as utilities incur costs associated with making bill-related calls to payment-troubled participants or service terminations and reconnections, participants also incur opportunity costs of time spent addressing utility billing issues. (NMR 2011; SERA 2010; Hall and Riggert 2002).	Shutoffs / reconnects; bill-related calls to utility; collection costs, intrusions; financial / customer service; greater control over their utility bills; reduced termination and reconnections; reduced transaction costs; buffers against energy price increases.
Low-Income / Economic Development	Low-income households spend a disproportionate amount of their income on energy costs when compared to the population at large. Reducing energy costs decreases rates of mobility among low-income households, and allows income to be made available for other uses, such as healthcare (NMR 2011; SERA 2010). Owners of low-income	economic development (low-income); economic stability; hardship improvement / family stability (low-income); benefits unique to low-income customers; fewer moves (low-income);

	rental properties can experience NEIs such as marketability/ease of finding renters, reduced tenant turnover, property value increases, reduced equipment maintenance for heating and cooling systems, reduced maintenance for lighting, greater durability of property, and reduced tenant complaints (NMR 2011).	benefits for owners of low-income rental housing
Improved Operations	Participants often experience efficient equipment performing better than previous equipment or inefficient equipment, resulting in reduced (or increased) maintenance costs, improved lighting quality, and so on (NMR 2011; SERA 2010). There are a variety of these NEIs that pertain specifically to C&I customers (Tetra Tech 2012). Improvements in comfort and lighting can result in increased worker and student productivity.	equipment cost, performance, and functionality; lifetime extension of equipment; O&M cost savings; reduced administration costs; reduced labor costs; increased sales revenue; improved employee productivity; reduced spoilage/defects
Comfort	Participants in energy efficiency programs commonly experience greater perceived comfort, either due to fewer drafts and more steady temperatures with HVAC equipment or reduced noise from better equipment. Improved (or worsened) aesthetics can also be considered a comfort NEI (NMR 2011; SERA 2010).	thermal comfort; noise reduction; light quality
Health and Safety	Energy efficiency programs may have direct impacts on health through improved home environments. Reduced incidence of fire and carbon monoxide exposure are also commonly identified as safety-related benefits resulting from weatherization. Safety is also improved from better, more durable lighting equipment. Health and safety benefits can result in reduced student and worker sick days. (NMR 2011; SERA 2010; NZ EEAC 2012).	health / fewer sick days work and school; improved safety; reduced incidence of fires and related insurance; reduced chronic illnesses; reduced exposure to hypothermia or hyperthermia – particularly during heat waves and cold spells; improved indoor air quality; reductions in moisture and mold, leading to amelioration of asthma triggers and other respiratory ailments; reduced carbon monoxide exposure
Education and Contributions	Customers that participate in energy efficiency programs improve their knowledge of their utility bills and usage. Customers also feel better about reducing their environmental footprint from energy efficiency programs.	knowledge and control over bills; contribution to the environment; satisfaction; ability to pay other bills

Home Improvements	Increased property value is frequently recognized as a non-energy benefit associated with program participation. The benefit of increased property value has been estimated through the value of anticipated ease of selling or renting, or in some cases, increased resale or rental value. The improved durability and reduced maintenance for the home is also taken into consideration. (NMR 2011; SERA 2010).	property value increase; ease of selling house; aesthetics in home; home durability
Other Participant-Perspective NEIs	Participants experience additional impacts from energy efficiency improvements, such as increased reliability.	special / reliable / other; service reliability / avoid interruptions
Property Values	Investments in energy efficiency, increase the value of the property	
Societal-Perspective		
Economic Development	Efficiency programs can impact economic conditions such as employment, earnings, and economic output (NMR 2011; SERA 2010). Energy efficiency can offer significant benefits in terms of creating jobs, even relative to alternative supply-side resources.	job creation; economic output
Tax Impacts	Energy efficiency programs provided to government facilities, including public schools, town halls, libraries, police and fire stations, military facilities, and others, will help lower the costs of supporting those facilities. These lower costs will often translate into lower taxes to the local, state, or federal taxpayers. Efficiency programs can also impact taxes as it relates to economic development, so there can be some overlap between these NEI categories.	social welfare indicators; tax investment credits; tax revenue
Environmental / Emissions	Electricity generation can have a variety of environmental impacts. By reducing the need to generate, transmit, and distribute electricity, energy efficiency can result in a variety of significant environmental benefits that will accrue to society as a whole (NMR 2011; SERA 2010).	fish / wildlife mitigation; reductions of emissions like GHGs, SO2, NOX, particulates, and air toxics; emissions of solid wastes; consumption of water; land use; mining impacts; aesthetic impacts
Health Care / Health & Safety	To the extent that energy efficiency programs can improve health and reduce healthcare costs, they provide a benefit to society (NMR 2011; SERA 2010; NZ EEAC 2012). Healthcare costs can fall on individuals, insurance providers (which are generally passed to individuals through higher premiums), or taxpayers.	health and safety equipment / fires; improve health; reduce healthcare costs; reduced hospitalization and visits to doctors due to reduced incidences of illness or reduced incidence rates of chronic conditions

National Security	A benefit of efficiency comes from reducing the need for energy imports, thereby enhancing national security (NMR 2011; SERA 2010).	reduced energy imports; increased national security
Other Societal-Perspective NEIs	Energy efficiency can have additional impacts to society.	determined on a case-by-case basis
Air Quality Impacts	Clean, efficient energy measures rid the risk of potential air quality impacts and also force the retirement of power plants with the most severe effect.	A recent EPA report calculated that each ton of reduced emissions from power plants has the following public health benefits: $130,000 to $290,000 for PM2.5, $35,000 to $78,000 for SO2, and $5,200 to $12,000 for NOX (US EPA 2013 Report).
Water Quantity and Quality Impacts	In order to operate, utilities tend to use massive amounts of water	Though, most pollutants are regulated, all steam electric power plants produce risk that could cause adverse health effects
Coal Ash Ponds and Coal Combustion Residuals (CCRs)	CCRs consist of fly ash, bottom ash, coal slag, and flue gas desulfurization residue	In 2007 the EPA identified 67 cases in which sites had damaged groundwater or surface water
Employment Impacts	Energy efficiency typically generates more jobs than fossil fuel based production.	Investments in energy efficiency create opportunities for workers in industries that tend to be more labor intensive

Source: updated from the NEEP 2014 paper

Appendix 5: Annotated bibliography of key studies

1. E4TheFuture. *Occupant Health Benefits of Residential Energy Efficiency*. E4The Future Inc. (2016). Available at: https://e4thefuture.org/wp-content/uploads/2016/11/Occupant-Health-Benefits-Residential-EE.pdf

E4The Future is a nonprofit organization that works to advance safe, efficient energy solutions to residential customers. E4 encompasses: the promotion of clean efficient **Energy**; growing low carbon **Economy**; ensuring **Equity** to all Americans by providing clean efficient, affordable energy; and restoring a healthy **Environment** for people, prosperity and the planet. To help inform and spark discussion across a wide range of audiences on the health co-benefits from residential EE, E4The Future reviewed 14 research studies of residential EE investments and discussed ways that these programs have monetized occupant health co-benefits. Some of these benefits include: reduced allergy and respiratory symptoms such as throat irritation, asthma, and sinusitis and reduced emergency department visits or hospitalizations caused by asthma. These results were determined by occupant health self-reports using validated health questionnaires. Twelve of these studies, evaluated EE and the remaining two studies focused on related ventilation strategies. Each study tracked several similar outcome metrics, one of which is occupant health.The paper concludes by providing a roadmap for future actions to help improve occupant health outcomes. It calls upon the further research to help define and determine the best practices of residential EE benefits and collaboration among EE program regulators along with other health partners.

2. Norton, R., et al. *Non-Energy Benefits, the Clean Energy Plan, and Energy Policy for Multi-Family Housing*. Green and Healthy Homes Initiative. (2016). Available at: http://www.greenandhealthyhomes.org/sites/default/files/Binder3.pdf

In this paper the Green and Healthy Homes Initiative provide an in-depth look into how home-based energy efficiency and health interventions can result in positive economic, health and environmental non-energy benefits at the individual and community level. Throughout the United States (US), there is a considerable lack of energy efficient and affordable housing options for low income residents. Poor housing conditions can often lead to considerable health implications, such as asthma and lead poisoning. In order to alleviate some of these health concerns and provide residents with better housing opportunities, this paper identifies the pairing of weatherization and energy efficiency programs as a potential solution to improve energy efficiency, and health within low income communities. It concludes with a detailed assessment of current Federal and State Energy Plans, while also providing their own policy recommendations.

3. Woolf, T., et al. *Best Practices for Screening Energy Efficiency Programs.* Synapse Energy Economics Inc. (2012). Available at: http://www.synapse-energy.com/sites/default/files/SynapseReport.2012-07.NHPC_.EE-Program-Screening.12-040.pdf

This report by Synapse Energy Economics serves as a response to the National Home Performance Coalition's (NHPC) 2011 white paper, *Measure it Right*. Synapse Energy Economics continues NHPC's discussion on the understanding of cost effectiveness tests and determines ways, by which they can be improved to better complement energy efficiency programs. The purpose of this report was to provide energy efficiency program regulators, administrators and stakeholders with a reference document when considering new energy efficiency programs. Throughout the report, Synapse provides recommendations for the best practices to use when applying these tests when screening energy resources. The report concludes with an assessment detailing the issues with current screening methodologies. The authors provide great insight into the screening process, and even shed light on specific factors several stakeholders may be overlooking.

4. Woolf, T., et al. Energy Efficiency Cost-Effectiveness Screening: How to Properly Account for 'Other Program Impacts' and Environmental Compliance Costs. Synapse Energy Economics Inc. (2012). Available at: http://www.synapse-energy.com/sites/default/files/SynapseReport.2012-11.RAP_.EE-Cost-Effectiveness-Screening.12-014.pdf

Synapse's report on the cost effectiveness of energy efficiency programs, aims to address two elements of energy efficiency screening that are frequently used improperly: (1) Other Program Impacts (OPIs), and (2) the costs of complying with environmental regulations. The authors first provide a detailed summary of each of the tests appropriate for screening efficiency programs. The report later discusses how these tests are currently being used today, while also determining the different limitations associated their implementation. After providing their own recommendation as to, which test best suits efficiency screening, the authors consider environmental compliance costs in response to current EPA and environmental regulations.

5. NMR Group, Inc. Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation. Tetra Tech. (2011). Available at: http://www.rieermc.ri.gov/documents/evaluationstudies/2011/Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation(76).pdf

In this report, NMR Group Inc. discusses the findings of the Massachusetts Cross-Cutting Non-Energy Benefits [NEBs] Evaluation. It incorporates findings from more than 125 sources of Non-Energy Impacts (NEI) literature, and a series of telephone surveys and in-depth interviews with 13 different energy efficiency program administrators (PAs). In the report NMR provides an extensive assessment of several recent NEI studies (from 1997-2005) of Low-Income Programs, and categorize their findings into three types of NEI benefits (Utility, Participants and Societal).

6. Three[3]. Massachusetts Special and Cross-Cutting Research Area: Low-Income Single-Family Health- and Safety-Related Non-Energy Impacts (NEIs) Study, Prepared for Massachusetts Program Administrators. (2016). Available at: http://ma-eeac.org/wordpress/wp-content/uploads/Low-Income-Single-Family-Health-and-Safety-Related-NonEnergy-Impacts-Study.pdf

Findings from a 2011 evaluation of the Weatherization Assistance Program (WAP) by NMR led Massachusetts State Utility Program Administrators (PA) to assess and evaluate a set of health and safety-related non-energy impacts (NEIs). Each home involved in the study received weatherization assistance, through the installation of clean, energy efficient tools and services. Some of these services include: air sealing, insulation, and HVAC replacement and repair. In addition to researching the effects of weatherization services, this study included an estimation of NEIs specific to recipients of energy efficiency services living in low income households in Massachusetts. The results of this study were presented in three tiers. Results of the Tier 1, were based on findings from the initial WAP study. Tier 2 and 3 results were based on counts of installed CO monitors. The study concludes by providing an in-depth comparison of the results found in each of the three studies.

7. Gudbjerg, E., et al. *Spreading the Word – An Online Non-Energy Benefit Tool.* ECEEE Industrial Summer Study Proceedings. (2014). Available at: file:///C:/Users/sjean-baptiste/Downloads/2-020-14_Gudbjerg_PR.pdf

This paper presents and promotes the development of a new web based tool used for evaluating the importance of the NEBs in energy efficiency projects. Because there is not currently a uniform, commonly agreed upon method for calculating the value of NEBs, non-energy benefits are often difficult to assess. This tool provides a method for assessing NEBs of energy efficiency projects, contains a NEB database, and also provides its users with Case examples of energy efficiency projects and a Questionnaire for identification and assessment of NEBs. The paper concludes by detailing the functions of the web based tool and discusses how it should be used by its clients.

8. International Energy Agency. *Capturing the Multiple Benefits of Energy Efficiency*. (2014). Available at: http://www.iea.org/publications/freepublications/publication/Captur_the_MultiplBenef_ofEnergyEficiency.pdf

The International Energy Agency's report (IEA), *Capturing the Multiple Benefits of Energy Efficiency,* discusses the quantification of non-energy benefits within the industrial sector. Though relatively complex, this report identifies the type of benefits that can occur from energy efficiency projects. Industrial energy efficiency measures are typically calculated in terms of energy demand reduction and greenhouse gas abatement. This report provides a brief overview of the full range of benefits associated with energy efficiency policies and measures.

9. Tetra Tech. *Massachusetts Program Administrators Final Report – Commercial and Industrial Non-Energy Impacts Study*. Clear Solutions, (2012). Available at: http://ma-eeac.org/wordpress/wp-content/uploads/Stage-2-Results%E2%80%94Commercial-and-Industrial-New-Construction-Non-Energy-Impacts-Study%E2%80%95Final-Report.pdf

This report presents the findings of the Massachusetts Cross-Cutting Evaluation Team's analysis of Non-Energy Impacts (NEI) in relation to the 2010 commercial and industrial (C&I) retrofit programs implemented by MA state utility Program Administrators (PA). The evaluation team sought to update and improve non-energy impact estimates for use in their 2013-2015 energy efficiency three year plan by: (1) conducting in depth interviews with approximately 505 program participants in Massachusetts with extensive backgrounds in energy efficiency measures with program support, (2) analyzing the relationship between NEIs and program attribution, and (3) identifying any incidence of participant spillover, which can be defined as energy savings developed from energy efficiency measures that did not receive any program incentives. Results of the study were used to assess the cost effectiveness of the C&I programs in Massachusetts.

10. Skumatz, L., et al. Non-Energy Benefits in the Residential and Non-Residential Sectors- Innovative and Results for Participant Benefits. (2000). Available at: http://aceee.org/files/proceedings/2000/data/papers/SS00_Panel8_Paper29.pdf

This paper presents the results of an innovative survey approach used to determine the participant-side benefits of non-energy impacts (NEIs) in residential homes. In this survey, authors asked utility consumers to assess the value of NEIs experienced through energy efficiency programs, in relation to the savings accrued in their monthly energy bill. A group of participants were contacted by telephone. Respondents were given a list of potential benefits experienced through the energy efficiency programs. Each individual was then asked whether or not they valued the benefit more than or less than the monthly bill savings associated with the energy efficiency program. The survey was very well responded to. The results of this survey demonstrated that benefits are not only felt by the utility and its ratepayers, but also energy consumers experience a great deal of benefits as well.

11. Peters, J. et al. Non-Energy Benefits Accruing to Massachusetts Electric Company From the Appliance Management Program. Research into Action, Inc., (1999).

This report presented the findings of a Massachusetts Electric Company (MECo) study to assess the non-energy benefits developed through the Appliance Management Program (AMP) a low income comprehensive home treatment program. In 1995, MECO along with the Massachusetts local low-income weatherization and fuel assistance network of Community Action Program (CAP) agencies sought to develop a new low-income conservation program. This program, known as AMP, was implemented throughout the MECo service territory. Three years after implementation Research Into Action and Quantec, joined MECo to fully quantify the non-energy benefits from the AMP program. The study first consisted of a literature review focused on low-income energy benefits. Researchers also assessed the payment behavior of 800 participants and non-participants with at least six months of billing and payment data involved in the AMP program. At the conclusion of the study Research Into Action, and Quantec evaluate the AMP program and provide estimates of arrearage reduction benefits and also provide some recommendations for future implementation.

12. Titus, E. et al. *How Do We Measure Market Effects? Counting the Ways, and Why It Matters*. ACEEE, (2004). Available at: http://aceee.org/files/proceedings/2004/data/papers/SS04_Panel6_Paper28.pdf

This paper analyzes different methods to cost-effectiveness by energy efficiency organizations in the US. The paper also discusses the rate of market transformation, and also provides a comparison on the different state approaches to energy efficiency. It is based on research conducted by the Consortium for Energy Efficiency (CEE) and Northeast Energy Partnerships (NEEP) in which both organizations identified the type of cost effectiveness test currently in use by each state. CEE and NEEP provide a general description of the types of cost effectiveness test. Each description consists of a general definition of each test, as well as their associated costs and benefits.

13. TecMarket Works. *The Low Income Public Purpose Test.* Skumatz Research, Inc. and Megdal and Associates, (2001). Available at: http://liob.cpuc.ca.gov/docs/The%20Low%20Income%20Public%20Purpose%20Test%20(LIPPT)%20May%2025,%202001.pdf

This report discusses the findings of the California Low Income Public Purpose Test (LIPPT), a test used to assess the "public" benefits of California's low income energy efficiency programs. The report provides an in-depth look into the workings of the test. The LIPPT includes three cost benefit categories, these would include: program costs, energy benefits and non-energy benefits. In order to determine the value of each benefit, a different equation is assigned to each category. One example is the cost effectiveness test, where cost effectiveness is equal to the sum of energy benefits and non-energy benefits divided by its relative cost.

14. Freed, M. et al. Non-energy benefits: Workhorse or unicorn of Energy Efficiency programs? Elsevier Inc., (2016). Available at:

The authors of this article dive into the findings of past NEB research and attempt to determine the significance of non-energy benefit evaluation in relation to environmental policy. NEBs have long been a topic of interest within the utility sector, but in this article it is revealed that most papers and reports fail to fully assess the impact of NEBs when evaluating the cost-effectiveness of energy efficiency (EE) programs. The article presents the findings of three NEB papers, each providing insight into the introduction of NEB to energy efficiency programs and its ongoing evolution. In addition to discussing NEB development, the authors of this article conclude by providing detailed recommendations needed to improve EE programs.

15. Skumatz, L. et al. Lessons Learned and Next Steps in Energy Efficiency Measurement and Attribution: Energy Savings, Net to Gross, Non-Energy Benefits, and Persistence of Energy Efficiency Behavior. California Institute for Energy and Environment, (2009). Available at: https://library.cee1.org/system/files/library/10517/CIEE_Behavior_White_Paper_-_Skumatz_2009.pdf

This paper presents the extensive findings of a 2009 study, which sought to examine and identify the current methodologies of energy efficiency (EE) program implementation. During this study, authors reviewed the current state of literature regarding four broad topics dealing with EE programs. They had hopes of identifying any program inconsistencies, and where possible provide solutions for those issues. These four topics of discussion are as follows: (1) estimates of program savings (gross), (2) net savings derivation through free ridership/ net to gross analyses, (3) indirect non-energy benefits/impacts, and (4) persistence of savings. Authors contacted more than 100 researchers in the energy evaluation and related fields throughout the U.S., by detailed interviews, and surveys. In addition to assessing EE programs, the paper also details the different types of NEBs currently utilized in each state. Some of these include: participant-based, utility, and societal. The authors discuss the methods currently used to evaluate NEBs and later provide recommendations to improve state adoption and evaluation of energy efficiency.

Appendix 6: Arkansas Protocol L

After reviewing the guidance from the Parties Working Collaboratively, the Arkansas Public Service Commission (Commission) issued Order No. 30 on December 10, 2015, which provides further direction and guidance regarding the inclusion of Non-Energy Benefits ("NEBs") in the Technical Reference Forum (p. 21 of 21):

> *"The Commission therefore directs that the IEM be requested to recommend an approach for quantification of deferred equipment replacement NEBs in individual instances when they are material and quantifiable. Approval of deferred customer equipment NEBs, however, is conditioned as follows: The Commission directs that each recommended approach for customer deferred equipment replacement NEB quantification shall be included within the annual TRM update filing, and that its reasonableness shall be addressed in testimony by the IEM and/or Staff, and may be addressed by other parties, so that the Commission may approve or disapprove such proposed NEB quantifications.*
>
> *The Commission therefore orders and directs that the following three categories of NEBs be consistently and transparently accounted for in all applications of the TRC test, as it is applied to measures, programs, and portfolios:*
>
> - *benefits of electricity, natural gas, and liquid propane energy savings (i.e., other fuels);*
> - *benefits of public water and wastewater savings; and*
> - *benefits of avoided and deferred equipment replacement costs as conditioned herein."*

Therefore, this protocol describes the recommended approach to quantify the NEBs in these three categories. This recommended approach has been developed jointly by the IEM and the PWC for each category as directed by the commission.

Protocol L1: Non-Energy Benefits for Electricity, Natural Gas, and Liquid Propane ("Other fuels")

With many energy efficiency measures installed under Arkansas DSM programs, energy savings is often achieved for more than one fuel type. For example, installing duct sealing or insulation in a building not only reduces natural gas or propane consumption, but also reduces electricity consumption through either reduced fan use or – for homes with air-conditioning – reduced cooling load. Similarly, low flow showerheads and faucet aerators provided to customers through gas energy efficiency programs will provide electric savings for homes with electric water heating.

The benefits of these "other fuel" savings may not be fully captured in current utility cost-effectiveness tests. Protocol L1 describes a consistent methodology for utilities to quantify and document the benefits resulting from reduced energy use of the other fuel-type they do not provide in their program service territory, specifically when this benefit is not already being claimed by another investor-owned utility.[70]

The other fuel NEB is calculated using the following equation:

$$Benefit = Energy\ savings\ X\ Avoided\ other\ fuel\ costs \tag{1}$$

[70] For example, in joint programs the dual fuel benefits would normally be claimed by both utilities, but in programs run by a single fuel utility that lead to secondary fuel savings these additional benefits can be claimed as NEBs.

Where:

Benefit = avoided economic costs per unit of energy savings of the other fuel savings over the lifetime of the measure, expressed in current dollars

Energy savings = annual number of other fuel kWh, therms or gallons of propane saved per measure installed [71]

Avoided costs = present value of the avoided cost per unit energy savings, which is a function of the measure specifications (including measure life) and the avoided cost data provided by other utilities for regulated fuels (e.g. electricity and natural gas) or the market price of unregulated fuels (e.g. liquid propane)

Where applicable, the most current Arkansas TRM should be used as the basis for calculating the secondary fuel electric and natural gas energy savings. Applicable TRM algorithms should also be used to calculate liquid propane savings, with appropriate adjustments for the efficiency of energy conversion at the end use. When this information is not included in the TRM, other fuel savings should be calculated through the use of EM&V. In addition, EM&V should be used to determine the number of applicable homes or business facilities that qualify for other fuel benefits (e.g., the number of homes with electric water heat that have been provided water-saving devices by a gas utility), and the quantity should be adjusted by any applicable in-service rates, net-to-gross ratios, or other adjustments applied to the primary fuel savings.

The avoided costs for other fuel electric and gas benefits should be calculated as follows:

- When available, avoided cost forecasts should be collected from the associated electric or gas utility (i.e., the utility providing the other fuel benefit) where the participating home or businesses are located.[72] The avoided costs calculated for the other fuel benefit should be identical to the avoided costs being utilized by those same utilities for their own DSM benefit-cost calculations for each program year.
- For municipal utilities or cooperatives, where avoided cost data may be more difficult to collect, the program administrator can use the avoided cost forecasts from the nearest investor-owned utility.
- The discount rates used to calculate the NPV of the avoided cost benefits should be the same as those used for the corresponding cost-effectiveness tests (e.g., when calculating the TRC test, the NPV of the other fuel benefits should be discounted at the same rate as the primary fuel avoided cost benefits).

For propane systems, savings should be calculated per TRM Version 6.0 Volume 2, as if the equipment were natural gas-fueled. To convert natural gas savings to propane savings, use the following conversion factor:

$$Propane\ savings\ (gallons) = Therm\ savings\ X\ 1.1 \tag{2}$$

[71] Note that for simplicity this Protocol focuses on other fuel energy savings, rather than demand savings. To the extent a measure also produces secondary demand savings (e.g., insulation could lead to summer peak cooling load reductions), these benefits can also be quantified and claimed through the avoided cost assumptions. Similarly, some avoided costs are calculated using different load shapes, so the associated measure avoided cost – which may be higher for certain measures that also lead to peak demand reductions – can alternatively be used.

[72] Where not available, avoided cost forecasts from another Arkansas utility should be used as a proxy (e.g., if EAI avoided cost forecasts are not publicly-available, SWEPCO avoided costs can be used). As discussed at the June 7, 2016 PWC meeting, however, many of the program administrator utilities have been able to access avoided cost data from the associated investor-owned utility in which the other fuel benefits are occurring.

This protocol establishes the base price of propane at $2.00/gallon in 2016, based on 2014-2016 weekly data of retail propane rates in Arkansas from the U.S. Energy Information Administration (EIA).[73] When a measure saves propane, both electric and gas utilities shall use the deemed avoided cost of $2.00 per gallon in 2016 and escalate it per annum (using a common assumption for the rate of inflation) for the lifetime of the installed measure. This base value and rate of escalation should be updated at the beginning of each three-year program cycle, using the latest EIA data available at the time of the update.

Protocol L2: Non-Energy Benefits for Water Savings

Many measures that utilities install to reduce energy consumption also reduce water consumption. In Order 30, the PSC directed the IEM to develop an algorithm for calculating the value of avoided water and wastewater consumption due to measures installed under electric and gas utility efficiency programs (p. 20 of 21).

The actual quantities of avoided water consumption (in gallons) associated with specific measures are provided elsewhere in this TRM. Protocol L.2 uses the marginal retail water rates and average water sewage rates (both on per-gallon basis) to residential and commercial consumers to calculate a statewide, average proxy value for all avoided water usage benefits to be considered under Order No. 30.[74]

Marginal retail water rates charged to end-use customers vary considerably across regions of Arkansas, across water utilities, and across customer classes. For example, many water utilities sell water to their customers in price tiers based on individual usage (e.g., the first 1,000 gallons are sold at one rate, and then the next 1,000 gallons are sold at another rate; sometimes the price charged for the second 1,000 gallons is higher than the first 1,000 gallons, and sometimes lower). Residential customers are also charged different rates than commercial, industrial and agricultural (irrigation) customers, and in many jurisdictions customers located inside city limits are charged differently than customers outside city limits. Finally, these rates vary from utility to utility.

To calculate the marginal cost of water, the IEM collected water and sewage rates from six jurisdictions around the state in 2015, the averages of which are shown in the table below.[75]

[73] From U.S. Energy Information Agency, https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=W_EPLLPA_PRS_SAR_DPG&f=W

[74] These marginal water rates ideally should account for the avoided electricity costs of water treatment, pumping, and other uses of electricity to supply potable water and dispose of wastewater.

[75] Bentonville, Rogers, Jonesboro, Central Arkansas, Searcy, and Springdale.

State of Arkansas	Water Rates (per 1,000 gallons)		Sewage Rates (per 1,000 gallons)		Total Combined Water Rates (per 1,000 gallons)	
Customer Class	**First 1,000 Gallons**	**Additional Gallons**	**First 1,000 Gallons**	**Additional Gallons**	**First 1,000 Gallons**	**Additional Gallons**
Residential	$4.13	$2.86	$3.82	$2.72	$7.95	$5.58
Commercial	$2.93	$2.79	$4.29	$4.29	$7.22	$7.08
Average Cost $/Gallon	$3.53	$2.83	$4.06	$3.50	$7.59	$6.33

(Source: Based on primary research conducted by the IEM of six Arkansas water districts)

Protocol L2 takes the marginal cost per 1,000 gallons of both potable water ($2.83) and sewage ($3.50) and adds them together to estimate the base cost in 2016: $6.33 per 1,000 gallons, or $0.0063/gallon. To calculate future annual avoided water costs, utilities shall use the marginal rate of $0.00558/gallon for programs that serve the residential sector shall use, $0.0078/gallon for programs that serve the commercial or industrial sector, and $0.00633/gallon for programs where the sector is unknown as the base cost per gallon of water in 2016, and increase it per annum by the assumed escalation rate for the lifetime of an installed measure. This estimated base cost of water and escalation rate shall be revisited at the beginning of each three-year program cycle. In addition, program administrators have the option of using alternative water costs if those costs are believed to be more appropriate for the electric and gas service territory, and are made transparent in PSC filings.[76]

Water savings allowed in this protocol only includes direct savings from measures as calculated in the TRM, or as a custom measure that is subject to EM&V.

The avoided cost resulting from the water savings is calculated as follows:

$$Benefit \;=\; Water\ savings\ X\ Avoided\ water\ costs \tag{3}$$

Where:

Benefit = avoided cost of water and waste-water savings (per gallon) over the lifetime of the measure, in current dollars

Water savings = annual number of gallons saved, per measure

Avoided water costs = present value of the avoided costs resulting from the savings, which is a function of the measure life and prevailing water rates

[76] For example, program administrators can use water rates more specific to their service territories, or use long-run marginal costs of water/wastewater supply (which, rather than using water rates, would be more accurate and consistent with the avoided energy cost methodology).

The discount rates to calculate the net present value of the avoided water cost benefits should be the same as those used for the corresponding cost-effectiveness tests (e.g., when calculating the TRC test, the NPV of the water benefits should be discounted at the same rate as the primary fuel avoided cost benefits). In addition, as with the other fuel savings, the quantity of measures for which water savings are claimed should be adjusted by any applicable in-service rates, NTG ratios, or other adjustments applied to the primary fuel savings.

Protocol L3: Non-Energy Benefits of Avoided and Deferred Equipment Replacement Costs[77]

In addition to reducing annual energy consumption, new energy efficient technologies offered through Arkansas investor-owned utility efficiency programs may have longer estimated useful lives ("EULs") than the technologies they are replacing, meaning they will require fewer replacements over the efficient equipment lifetime (i.e., avoiding purchase of baseline efficiency equipment). In addition, some measures may qualify for early replacement ("ER"), and thus have replacement costs that differ from a replace-on-burnout ("ROB") scenario since they shift the replacement cycle by accelerating the purchase of new equipment (i.e., deferring the replacement of baseline equipment).

Order No. 30 directs the utilities to calculate the benefits of avoided and deferred equipment replacement to the customer over time, and to include these costs in utility program cost-effectiveness tests.[78] The avoided and deferred equipment costs are derived from the material and installation labor costs required to provide continued end-use service beyond the Baseline EUL (or RUL in the case of ER measures) through the end of the EUL of the efficient measure. This component of the Baseline Cost is often not accounted for in the TRC calculation of incremental measure cost. It is therefore classified as a "Non-Energy Benefit" (NEB) because its inclusion has the effect of decreasing the incremental measure cost, thereby increasing the TRC net benefit of the program or measure.

This protocol includes three examples, using actual Arkansas program offerings that generate avoided and deferred equipment replacement costs:[79]

- ROB 1 – baseline and efficient measures that have different useful lifetimes under *static* baselines over the lifetime of the measures;
- ROB 2 - baseline and efficient measures that have different useful lifetimes under *changing* baselines over the lifetime of the measures; and
- Early Replacement measures (with static or changing baselines).

[77] Special thanks to Stephen Waite for presenting much of the material in this section in a memo delivered to the PWC entitled: "Avoided and Deferred Replacement Costs ('Non-Energy Benefits')".

[78] Note the scope of this discussion is limited to the incremental installed (capital plus labor) cost of energy efficiency program measures, taking into account the assumed cost of baseline equipment replacements that would occur if the measure were not installed. Other categories of NEBs, such as avoided operation and maintenance (O&M) expenditures, avoided repair costs, and avoided equipment refurbishment are not included here due to the challenge in quantifying these factors, and the directive from the PSC that the NEBs should be limited to the three NEB categories listed above.

[79] The IEM has also supplied an example of these calculations in an accompanying workbook. Note the original workbook was prepared by Stephen Waite, and modified by the IEM to include examples that incorporate values from the Arkansas TRM and the EM&V studies, where possible.

The avoided and deferred replacement costs, summarized hereafter as the Deferred Replacement Cost, can be summarized mathematically for the three examples as:

$$\textit{Deferred Baseline Replacement Cost} = NPV(RDR, ML, RLCC_t) \quad (4)$$

$$NPV = \textit{Net Present Value function} \ \sum_{t=1}^{ML} \frac{RLCC_t}{(1+RDR)^t} \quad (5)$$

Where:

RDR = Real Discount Rate = (NDR-ER)/(ER+1) where:

NDR = nominal discount rate

ER = baseline installed cost annual escalation rate

ML = Program Measure Life (EUL)

$RLCC_t$ = Real Levelized Carrying Charge in year t (annualized baseline installed cost at RDR)[80]

The general formula allows for the baseline installed cost to vary over the life of the program measure, so that each future replacement could be a different product or technology. As discussed in the examples below, these adjustments to the cost assumptions (i.e., incorporating the avoided and deferred replacement costs) make the avoided costs consistent with the TRM energy savings calculations.

Case 1. Replace-On-Burnout 1: Measures with Different Useful Lifetimes (EULs) Under Static Baselines

A number of efficient measures, particularly screw-based LED and linear LED lighting, have longer lifetimes than the baseline technology they are assumed to replace. The incremental cost calculations for the efficient measure, therefore, needs to be reduced by the value of the avoided replacement costs for multiple baseline technologies (i.e., the costs associated with replacing the baseline technology over the lifetime of the efficient measure).

If the efficient measure life is greater than or equal to twice the baseline measure life, then the cost of at least one replacement will be avoided and the corresponding incremental cost reduced accordingly. Unless the efficient measure life is divisible by the baseline equipment life, the last baseline replacement will still be in operation at the end of the program measure life. Because the program energy benefits are limited to the avoided cost of energy savings over the useful life of the measure, the present value of the installed cost of the measure does not account for any replacement cost beyond the initial installation cost at the time of participation.[81] The full cost of a baseline replacement that continues to operate beyond the end of the program

[80] In ER applications the RLCC is equal to zero before the time of normal replacement of the existing equipment.

[81] The formulas presented here are based on the assumption that the maximum duration of energy savings is equal to the elapsed time between initial efficient measure installation and the time of first replacement of the efficient measure, which is typically assumed to equal the effective useful life of the efficient equipment.

measure life is therefore not avoided and must be reduced accordingly to account for the remaining useful life (RUL) beyond the last year of energy savings attributed to the measure. The last replacement is effectively deferred by the program measure until the end of the measure life.

As an example of this, assume a program is offering commercial customers an incentive on linear LED lamps. The AR TRM Version 6.0 assumes the baseline for calculating savings is a T8 linear fluorescent.[82] While the AR TRM assumes a 15 year expected useful life (EUL) for the LED, the expected lifetime for T8's is shorter. For example, assuming a lifetime of 28,000 hours for T8s, and the AR TRM assumption of commercial hours of use of 9.71 hours/day, would provide an EUL of approximately seven years. This means that over the lifetime of the linear LED, the customer would actually have to make two purchases of T8 lamps, paying both the cost of the lamps as well as the labor to install them.

Because the efficient measure life exceeds the life of the baseline equipment, the incremental cost is the difference in the initial installed cost (efficient measure – standard measure) minus the present value of the avoided or deferred baseline replacement costs. This can be shown mathematically as:

$$\textit{Deferred Baseline Replacement Cost} = -PV(RDR, ML-EUL_B, RLCC_B)/(1+RDR)^{EUL_B}$$

Where:

RDR = Real Discount Rate
ML = Program Measure Life
EUL_B= Baseline Equipment Life
$RLCC_B$ = -PMT (RDR,EUL_B,Baseline Installed Cost)

Case 2. Replace-On-Burnout 2: Baseline and Efficient Measures with Different Lifetimes and Changing Baselines

Similar to the example above, screw-based LED lamps have a substantially longer expected useful life than the baseline technology, which for general service lamps in the AR TRM Version 6.0 is a halogen bulb. For example, the AR TRM currently assumes lifetime hours of 25,000 for omnidirectional LEDs, whereas most halogen bulbs only last for approximately 2,000 hours.[83] For an upstream program that assumes a weighted mix of residential and commercial sales, the expected annual hours of use would be 2.68 hours/day[84], providing an EUL of over 20 years for LEDs and two years for halogens. Capping the EUL of the halogen at 20 years (as TRM Version 6.0 does), a customer would need to install approximately ten halogen bulbs in the same socket in which a single LED would be installed.

Unlike the T8 example, however, the baseline may change over the lifetime of the LED bulb, which this example illustrates: the AR TRM Version 6.0 incorporates a baseline shift beginning after 2022 to account for the

[82] Note beginning with AR TRM Version 6.0 T8 linear fluorescents, rather than T12's, are defined as the linear fluorescent baseline.

[83] Note the ENERGY STAR® 2.0 specification, effective January 1, 2017, lowers the lifetime requirement, requiring ENERGY STAR® certified LED lamps last for at least 15,000 hours.

[84] EAI PY2015 Evaluation, p. 40.

backstop provision of the 2007 Energy Independence and Security Act.[85] The savings, therefore, are divided into two streams, one with a delta watts reflecting the difference between LEDs and halogens (for 2016 through 2022), and one reflecting a more stringent baseline that approximates the usage of a CFL for 2023 and beyond, through the remaining lifetime of the LED. The incremental cost calculation, therefore, needs to also incorporate the dual stream of avoided baseline technology requirements for both the halogen and the CFL.

Deferred Baseline Replacement Cost = Deferred Baseline Replacement Cost (Tier 1)+ Deferred Baseline Replacement Cost (Tier 2)

$$\textit{Deferred Baseline Replacement Cost (Tier I)} = -PV(RDR, NY-EUL_{T1}, RLCC_{T1})/(1+RDR)^{EUL_{T1}} \quad (7a)$$

$$\textit{Deferred Baseline Replacement Cost (Tier 2)} = -PV(RDR, ML-NY, RLCC_{T2})/(1+RDR)^{NY} \quad (7b)$$

Where:

RDR= Real Discount Rate

ML = Program Measure Life

EUL_{T1}= Baseline Equipment Life (Tier 1)

$RLCC_{T1}$ = -PMT(RDR,EUL_{T1}, Baseline Installed Cost (Tier 1))

EUL_{T2}= Baseline Equipment Life (Tier 2)

$RLCC_{T2}$ = -PMT(RDR,EUL_{T2}, Baseline Installed Cost (Tier 2))

NY = Number of years of Tier 1 installation

Case 3. Early Replacement Measures

As a third example, the AR TRM Version 6.0 allows for early replacement of certain measures, which has been verified through a number of evaluations.[86] Early replacement measures have the benefit of being able to claim higher energy savings for the remaining useful life (RUL) of the equipment (the efficiency difference between the new, efficient equipment and the existing equipment), and then dropping to lower energy savings rates (under higher baselines) only for the period of the EUL that exceeds the RUL (the difference between new, efficient equipment and a code baseline).

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[85] Note that the Department of Energy issued a draft ruling in 2016 that proposes to enforce and actually expand the backstop provision (e.g., tightening the future efficacy requirements to that of an LED, rather than a CFL), which is to take effect beginning January 1, 2020. As explained in the residential lighting section of the AR TRM Version 6.0, however, savings in AR are allowed to be claimed through 2022 before shifting to the new baseline. The example in the spreadsheet includes both the current TRM Version 6.0 assumptions for savings (which are based on the preliminary backstop provision, not the proposed revision), as well as an example should the proposed ruling become law.

[86] For example, the PY2015 CenterPoint EM&V Report (page 4-19) found that 60% of all furnaces replaced through the Space Heating Program qualified for early replacement.

The incremental cost calculation needs to not only reflect this dual savings stream, including a component for the cost of replacing the equipment prior to the end of its EUL, then another component for the incremental cost above normal (ROB) replacement. In addition, the incremental cost needs to reflect that the replacement cycle has been shifted for perpetuity.[87] For ER that assumes the existing equipment would have been replaced at the end of its RUL with standard efficiency equipment, the following equation is used:

$$Deferred\ Baseline\ Replacement\ Cost = -PV(RDR,ML\text{-}RUL_B,RLCC_B)/(1+RDR)^{RUL_B} \quad (6)$$

Where:

RUL_B = RUL of baseline (existing) equipment
$RLCC_B$ = -PMT(RDR,EUL_B, Baseline Installed Cost)

For ER that assumes the existing equipment would have been replaced at the end of its RUL with efficient equipment (e.g., due to incorporation of a new code/standard), the following equation is used:

$$Deferred\ Baseline\ Replacement\ Cost = -PV(RDR,ML\text{-}RUL_B,RLCC_M)/(1+RDR)^{RUL_B} \quad (7)$$

Where:

RUL_B = RUL of baseline (existing) equipment
$RLCC_M$ = PMT(RDR,EUL_B, Installed Cost of Measure)

Calculation of the NEB When the Avoided or Deferred Replacement Cost is Greater Than the Incremental Cost

Note that in some cases it is possible for the avoided and deferred replacement cost to be greater than the simple first cost difference between efficient and standard equipment. For example, if screw-based LED lamps were to drop to $2/bulb, and halogens were $1/bulb, a customer would spend more money on halogens in just a few years (prior to the end of the useful life of the LED) than the cost of a single LED.[88] In these cases the incremental cost can continue to be calculated as the simple first cost different (e.g., $1 in this case), and the avoided replacement costs of multiple halogens – which will sum to over a dollar – can be treated in the cost-effectiveness calculation as an additional benefit (i.e., in the numerator of the Total Resource Cost test).

Other Cases

The extension of the formulas presented above to measures that combine elements of the three cases is straightforward, e.g., early replacement of equipment with a changing baseline

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[87] The savings and incremental cost assumptions, including the calculations, are explained very well in "Early Replacement Measures Study: Phase II Research Report", Northeast Energy Efficiency Partnerships, November 2015, p. 36.

[88] In other words, a customer would have to purchase three halogens prior to 2022, thus spending $3, when they could have only spent $2 and purchased a single LED that would last beyond 2022.