Title

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May 2020

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Applying Non-Energy Impacts from Other Jurisdictions in Cost-Benefit Analyses of Energy Efficiency Programs: *Resources for States for Utility Customer-Funded Programs*

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Abstract

Non-energy impacts (NEIs) of energy efficiency are impacts not directly, or commonly recognized as, associated with energy production, transmission, and distribution. On balance, researchers have found that NEIs have positive impacts for utility systems, consumers, and society. Sometimes, they represent substantial benefits—for example, for grid reliability, comfort, air quality, and public health. Considering whether and how to include NEIs is an important component of cost-benefit analyses (CBA) for energy efficiency, potentially leading to acquisition of more cost-effective energy choices than otherwise would be achieved.

This report is for state public utility commissions (PUCs), utilities, and stakeholders engaged in CBA for energy efficiency programs funded by utility customers. The information also is relevant for assessing energy efficiency in utility resource planning and acquisition. Section 1 describes NEIs, explains why they are important, and offers practical considerations for PUCs as they decide which NEIs to include and how to determine appropriate NEI values for their jurisdiction. Section 2 identifies NEIs used in 30 states, with a focus on NEIs for energy efficiency programs targeted at the general public, then offers considerations on transferability of both NEI values and methods used to develop values, based on publicly available documents. States can use such NEI research conducted in other jurisdictions as a starting point for advancing their own CBA practices.

The references section provides citations to these studies and other NEI-related documents. Appendix A summarizes NEI information in the reports reviewed. Appendix B describes study methods for this report.

Acknowledgements

The National Efficiency Screening Project's Database of State Efficiency Screening Practices (DSESP)[1] served as the starting point for this research. The authors of this report acknowledge the researchers who developed and maintained the database, including Julie Michals of E4theFuture and Tim Woolf of Synapse Energy Economics, who also reviewed a draft of this report. Other peer reviewers include Tom Eckman, Lisa Skumatz of Skumatz Economic Research Associates, Noel Stevens of DNV GL, and Michael Li (formerly with DOE). The authors thank these reviewers and David Nemtzow, DOE Building Technologies Office, for his support of this project.

All opinions, errors, and omissions remain the responsibility of the authors. All reference URLs were accurate as of the date of publication.

[1] https://nationalefficiencyscreening.org/state-database-dsesp/

Table of Contents

List of Tables

Abbreviations

CBA	Cost-benefit analysis
DSESP	Database of State Efficiency Screening Practices
NEI	Non-energy impact
PUC	Public utility commission

1 Introduction to Non-Energy Impacts

This report reviews existing literature on non-energy impacts (NEIs) of energy efficiency (Appendix A) for states that want to consider applying these methods or values to their own jurisdiction. Appendix B discusses the approach we used to prepare this report.

1.1 What Are NEIs?

NEIs is a broad term for a wide range of costs and benefits that are not clearly associated with energy generation, transmission, and distribution. This report defines NEIs as follows:

(a) *Costs* - All costs beyond those associated with directly implementing energy efficiency programs and projects
(b) *Benefits* - All participant, utility system, and societal[2] benefits beyond those directly associated with the utility system's provision of energy and capacity, transmission, and distribution.

The report covers 16 categories of NEIs:

- Water resource costs and benefits
- Other fuels costs and benefits
- Avoided environmental compliance costs
- Environmental impacts
- Productivity
- Health and safety
- Asset value
- Energy and/or capacity price suppression effects
- Avoided costs of compliance with Renewable Portfolio Standard (RPS) requirements
- Avoided credit and collection costs
- Avoided ancillary services
- Comfort
- Economic development and job impacts
- Public health impacts
- Energy security impacts
- Increased reliability

[2] Traditionally, energy efficiency impacts have been categorized into three groupings:

1. *Utility* – Some NEIs affect the utility system and may reduce utility costs. For example, energy efficiency programs may reduce utility customer credit and collection costs.
2. *Participant* – Some NEIs affect the customers who participate in energy efficiency programs. For example, if a customer installs attic and wall insulation to reduce electric air-conditioning costs, their home may be more comfortable and their bills for heating fuels also may be reduced.
3. *Societal* – Some NEIs affect the population at large. These impacts, such as economic development from local energy efficiency jobs or improved public health, are benefits everyone shares, regardless of whether an individual participates in a program.

Due to some overlaps in participant and societal benefits, in this report impacts are simply differentiated between those affecting the utility system and those affecting everything else (participants and society).

All of these categories can be important considerations in cost-benefit analysis (CBA) of energy efficiency programs, and they are the most commonly considered NEIs. More limited definitions of NEIs may not include some of these categories, such as avoided costs for ancillary services or complying with environmental regulations. Instead, these more limited definitions consider such impacts to be directly related to generating, transmitting, or distributing energy.

NEIs are considered and quantified for comprehensive comparisons of costs and benefits of energy efficiency with other resources. Including NEIs in CBA is not only a good practice, and in some cases required by a jurisdiction's policies or regulations; it also can help integrate analysis of all types of energy resources.[3] In addition, NEIs are important for program design and outreach—for example, by emphasizing comfort, productivity, air quality, and health benefits of energy efficiency.

1.2 Why Are NEIs Valuable?

NEIs can be positive (reduce costs/increase benefits) or negative (increase costs/reduce benefits), although virtually all recognized NEIs provide positive impacts (i.e., benefits). At the same time, specific NEI values vary substantially between types of NEIs and from one jurisdiction to another. Studies reviewed for this report indicate that NEIs can have substantial or negligible effects on cost-effectiveness calculations for energy efficiency. For example, the national average cost to save a kilowatt-hour (kWh) is 2.5 cents.[4] In some jurisdictions, the value of individual NEIs can offset close to half of that cost (about 1 cent/kWh for public health or increased reliability) or virtually none of it (about 0.05 cent/kWh for Renewable Portfolio Standard compliance).

1.3 What Are the Practical Considerations for Considering NEIs?

Some states have legislative requirements establishing which types of NEIs to include in CBA for energy efficiency. In other states, public utility commissions (PUCs) have set guidance for utilities on which NEIs to consider in analysis of energy efficiency investments. In addition to any required NEIs, other NEIs may be considered important or relevant for inclusion in CBA.[5] Practical considerations include:

- *Double-counting.* For CBA that relies on utility avoided costs to define the economic value of energy and demand savings, PUCs can explore which cost categories are included. For example, avoided costs already may include cost of complying with environmental regulations. If such costs were considered NEIs and added to avoided cost values, that would be double-counting.
- *Cost and time.* While CBA should include all relevant NEIs, the cost and time to develop valid cost and benefit values are a factor. For example, existing data to calculate NEIs may be limited. However, substantive NEIs should not be excluded or ignored because they are difficult to quantify and monetize. Approximating hard-to-quantify impacts is usually preferable to assuming that those substantive costs and benefits do not exist or have no value.

[3] For example, see Converge 2019 for analytical practices for assessing DERs' resilience value; Raab et al. 2017 for NEI research needs for DERs (methods and specific studies), including reliability; and Synapse Energy Economics 2018b for existing and potential uses of NEIs for energy efficiency in Rhode Island.
[4] Hoffman et al. 2018. Levelized costs—incurred over the lifetime of the installed measures, amortized over that lifetime, and discounted back to the first year—in $2016 dollars.
[5] See National Efficiency Screening Project (NESP) 2017 for a detailed discussion.

The National Standard Practice Manual (NSPM) defines five approaches to account for relevant impacts, including approaches for hard-to-monetize impacts:

1. jurisdiction-specific studies
2. studies from other jurisdictions
3. use of proxies
4. use of quantitative and qualitative information
5. use of alternative thresholds in the CBA.

This report supports using studies from other jurisdictions as a means for including NEI values in CBA.

2 Using NEI Values from Other Jurisdictions

2.1 Can a NEI Value or Method Be Transferred to Another Jurisdiction?

Many states have included NEIs in CBA and several have documented in publicly available reports the NEI values they applied as well as methods used to develop the values.[6] With proper consideration, NEI values and methods can be transferred for use in other jurisdictions. The following information can be used to determine which values or methods might be applicable in other jurisdictions. The References section provides citations to relevant reports, and Appendix A summarizes these reports.

We apply a five-point system that uses colors and numbers to indicate rating levels for transferring an NEI value or method (see Table 1):

- Orange icons (and the numbers 1 and 2) indicate NEIs where the per-unit value, in our opinion, could be transferred.
- Gray icons (and the numbers 3, 4, and 5) indicate that the value should not be transferred, but the method used to determine the NEI value could be applied in a different jurisdiction.

The numerical rating levels (1 to 5) represent ease of transferring an NEI—moving from easiest to hardest—and are a loose proxy for costs associated with determining an NEI value.[7] Some of the data in the studies are measured in different units (e.g., $/household, $/metric tons, or $/showerhead). Program-specific information may be required to calculate the benefits.

Table 1. Transferability Rating Scale

Use the per-unit NEI value		Use the study method	
Icon	Key	**Icon**	**Key**
1	**Use as Is** - NEI value is most likely similar across multiple jurisdictions and can be transferred as is	3	**Easy Method -** NEI value is unique to the researched jurisdiction and should not be transferred, but analytical staff in a different jurisdiction could apply the relatively easy method deployed by the underlying study
2	**Use with Caution** - NEI value is most likely similar across multiple jurisdictions and can be transferred, but should be explored and used with caution as potential underlying differences could affect the value	4	**Easy Method, Specialized Expertise** - NEI value is unique to the researched jurisdiction and should not be transferred, but a different jurisdiction could use analysts with specialized expertise to apply the relatively easy method deployed by the underlying study
		5	**Complex Method, Specialized Expertise** - NEI value is unique to the researched jurisdiction and should not be transferred, but a different jurisdiction could use analysts with specialized expertise to apply the complex method deployed by the underlying study

[6] See Database of State Efficiency Screening Practices: https://nationalefficiencyscreening.org/state-database-dsesp/.
[7] A more detailed set of factors may be needed to consider differences such as economics, weather, or housing types when transferring per-unit values, especially when we assign a "use with caution" rating.

2.2 Which NEI Values and Methods Are Transferrable?

Table 2 lists NEIs included in cost-effectiveness tests for energy efficiency programs funded by utility customers, in descending order based on percentage of jurisdictions that use each NEI.[8] The number of NEIs a state includes, and the manner in which they are included, vary. While we describe specific NEIs, some jurisdictions broadly include NEIs through a defined "percentage adder"—blanket coverage of any and all NEIs that could occur through energy efficiency programs. For example, Colorado and Idaho apply a 10 percent adder to energy cost savings.[9]

The studies we reviewed for this report include 38 NEI values, covering 15 NEIs.[10] We determined that about 40% of those values, covering 8 NEIs, had the potential to be transferred from one jurisdiction to another. These NEIs tended to be participant or societal NEIs.

Some NEI values would not be expected to vary by state—for example, comfort. However, states use different methods, inputs, and assumptions to derive NEI values, and PUCs exercise independent judgment.

Often, the NEI *value* represents a unique set of circumstances and cannot be directly transferred. The studies, however, usually provide *methods* that can be replicated. These methods range from relatively simple lookups of region-specific rates or costs that can be applied to the amount of energy, water, or resources saved, to conducting sophisticated studies or running sophisticated models that consider economic patterns and wages.

NEI Definitions

NEI definitions in Table 2 are from the Database of State Efficiency Screening Practices (DSESP). The database provides information on state cost-effectiveness screening practices for efficiency programs funded by electric utility customers.

In practice, definitions of NEIs vary, in part depending on context. For example, the U.S. DOE Grid Modernization Laboratory Consortium's Reference Manual defines reliability, an important NEI, as follows (Pacific Northwest National Laboratory 2017):

> *Maintain the delivery of electric services to customers in the face of routine uncertainty in operating conditions*

The DSESP defines reliability as the value of reduced probability and/or likely duration of customer service interruptions from efficiency, which lowers loads on the grid. While resilience is not specifically included in the DSESP, it can be an important NEI for energy efficiency and is sometimes comingled with reliability. As this example demonstrates, some caution should be used when applying the NEI definitions in this report.

Two of the NEIs most often included by jurisdictions (water resource savings and other fuel savings as Table 2 shows) can be determined from relatively easy methods—a 3 in our rating scale. For example, participant water bill savings from measures vary based on specific water costs, with different jurisdictions having different rate schedules. As such, transferring an NEI value from one jurisdiction to another would over- or under-estimate the value of savings. Determining local water rates and applying the local rate to the water saved by measures is relatively easy.

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[8] As identified in the DSESP for states included in our analysis—30 as of the date we completed this analysis. The current version of the database contains information for 52 states and jurisdictions.

[9] Other jurisdictions with percentage adders are District of Columbia, Iowa, Oregon, Vermont, and Washington. Oregon and Washington use one value to cover multiple NEIs. See section 7.4 in the National Standard Practice Manual (2017) for discussion of proxy values. For more information about adders, see Skumatz 2018 and Malmgren and Skumatz 2014.

[10] With respect to values associated with one of the 16 NEIs, health and safety, see related footnote in Table 2.

NEIs for Low-Income Programs

This report focuses on NEIs associated with energy efficiency programs for the general public, not programs focused on low-income households. While impacts associated with low-income programs typically are not transferrable to programs for the general public, these impacts have been well studied. For example, Oak Ridge National Laboratory has conducted rigorous studies on NEIs associated with weatherization of low-income housing. See https://weatherization.ornl.gov/reports/.

About one-third of the NEI values in the studies we reviewed use a method that is complex and requires specialized expertise—a 5 in our rating scale. The cost of applying these methods and conducting jurisdiction-specific studies varies and can sometimes be high.[11]

In addition to percentage of jurisdictions using an NEI, Table 2 provides bibliographic reference(s). Letters (e.g., A, B, C) identify their designation in the References section. Because a single study can include multiple NEIs, a bibliographic entry may show up several times in Table 2. Also, while multiple states may include an NEI, we may include only a single study in the table.

Studies may cover more than a single NEI. For each NEI, Appendix A provides the method used in the study, the range of NEI values cited, where the values are applicable, how to apply the values, and information about using the NEI value specific to the study.

[11] For example, one report described potentially spending from $300,000 to $500,000 on a single study. The researchers also estimated possible benefits of $2-8 million associated with the NEI (Tetra Tech 2018).

Table 2. NEIs, Definitions, and Studies that Address Each NEI, and Transferability Ratings[12] [13]

(Letters under transferability ratings reference studies reviewed. See References and Appendix A.)

Percent of Jurisdictions Using NEI *(N=30)*	NEI	NEI Definition	Transferability Ratings: Consider Values		Transferability Ratings: Consider Method		
			1 *(use value as is)*	2 *(use value with caution)*	3 *(easy method)*	4 *(easy method, needs expertise)*	5 *(complex method, needs expertise)*
60%	**Water resource costs and benefits** ***(non-utility impact)***	Costs and benefits associated with changes in water consumption and wastewater treatment resulting from efficiency resources			E, G, H, Q		
53%	**Other fuels costs and benefits** ***(non-utility impact)***	Costs and benefits resulting from reduced consumption of electricity and non-electric energy sources, or from increased consumption of other fuels, resulting from energy efficiency			G, H	M	E
47%	**Avoided environmental compliance costs** ***(utility impact)***	Reduction in future costs of complying with environmental regulations from efficiency, which reduces the amount of energy that needs to be generated	I, F				C, P
43%	**Environmental impacts** ***(non-utility impact)***	The range of environmental costs and benefits that result from efficiency resources					J
37%	**Productivity** ***(non-utility impact)***	Includes changes in labor costs and productivity, waste streams, spoilage/defects, operations and maintenance, and changes in product sales as a result of changes in aesthetics, comfort, etc.		B, J, Q, X		A, AA	
33%	**Health and safety**[14]	Includes improved "well-being" due to reduced incidence					

[12] While the DSESP included three additional NEIs (satisfaction, economic well-being, and reduced risk), we did not find associated studies, so these NEIs are not included here.

[13] Table 2 does not include three Minnesota studies (K, L, and N), with values used for assessing environmental impacts, as we could not rate the method. However, we include these studies in the Appendix for completeness.

[14] There is overlap between the category of health and safety (which refers to participant impacts) and public health benefits (which refers to impacts for society as a whole).

Percent of Jurisdictions Using NEI *(N=30)*	NEI	NEI Definition	Transferability Ratings: Consider Values 1 *(use value as is)*	Consider Values 2 *(use value with caution)*	Consider Method 3 *(easy method)*	Consider Method 4 *(easy method, needs expertise)*	Consider Method 5 *(complex method, needs expertise)*
	(non-utility impact)	of illness, medical costs, sick days, deaths, and insurance costs (e.g., from reduced fire risk)					
30%	**Asset value *(non-utility impact)***	Includes equipment functionality/performance improvement, equipment life extension, change in building value, change in ease of selling building		Q			
30%	**Energy and/or capacity price suppression effects *(utility impact)***	Reduced market clearing prices resulting from efficiency resources; may extend outside service territory because of regional nature of wholesale markets					E; Z
27%	**Avoided costs of compliance with RPS requirements *(utility impact)***	Reduction in absolute amount of renewable resources that must be purchased resulting from efficiency				E; Z	C
23%	**Avoided credit and collection costs *(utility impact)***	Value of reduced probability of customers falling behind or defaulting on bill payment obligations as a result of lowered energy use and customer energy bills from efficiency programs		J; Q; Y			
23%	**Avoided ancillary services *(utility impact)***	Value of reduction in services required to maintain electric grid stability and security	W		T	E	
23%	**Comfort *(non-utility***	Includes thermal comfort, noise reduction, improved light		J, R, Q			

The studies we found in state CBA documentation for this category relate to benefits associated with low-income programs. NEIs specific to low-income programs are not covered in this report. However, two reports (Q and Y) include this NEI and are summarized in Appendix A. In addition, a few related reports are included in the "Other Documents" portion of the References section. A 2016 Massachusetts study assessed health- and safety-related NEIs for low-income, single-family households (Three3 and NMR Group 2016), and a 2014 Baltimore study quantified public health NEIs (e.g., reduction in hospitalizations due to asthma) for weatherization of low-income homes (Norton and Brown 2014; Klein 2019).

Percent of Jurisdictions Using NEI *(N=30)*	NEI	NEI Definition	Transferability Ratings				
			Consider Values		Consider Method		
			1 *(use value as is)*	2 *(use value with caution)*	3 *(easy method)*	4 *(easy method, needs expertise)*	5 *(complex method, needs expertise)*
	impact)	quality					
20%	**Economic development and job impacts *(non-utility impact)***	The economic development and jobs that are associated with investment in energy efficiency including job creation and increases in disposable income resulting from energy bill savings for customers					O, U
13%	**Public health impacts *(non-utility impact)***	The range of public health impacts resulting from efficiency resources	D				V
10%	**Energy security impacts *(non-utility impact)***	The impacts on energy security and energy independence resulting from energy efficiency investments		Q			
7%	**Increased reliability *(utility impact)***	Value of reduced probability and/or likely duration of customer service interruptions from efficiency, which lowers loads on the grid					Z

Source of "Percent of Jurisdictions Using NEI" and "NEI Definition" is the March 3, 2019, version of the DSESP.

3 References

The following references are divided into: (1) those listed in Table 2 and summarized in Appendix A and (2) those that are referred to only in other sections of this report.

3.1 Documents Summarized in Appendix A

A. DNV GL. 2016. *Stage 2 Results—Commercial and Industrial New Construction Non-Energy Impacts Study—Final Report.* March 24. 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

B. DNV GL. 2018. *AEP Ohio Non-Energy Impact. Final Report.* https://www.aepohio.com/global/utilities/lib/docs/save/business/nonenergy/NEIFinalReport7-25-18.pdf

C. Energy and Environmental Economics, Inc. (E3). 2016. "Avoided Costs 2016 Interim Update." https://www.ethree.com/public_proceedings/distributed-energy-resources-der-avoided-cost-proceedings/

D. EPA. 2019. *Public Health Benefits per kWh of Energy Efficiency and Renewable Energy in the United States: A Technical Report.* https://www.epa.gov/sites/production/files/2019-07/documents/bpk-report-final-508.pdf

E. Exeter Associates, Inc. 2014. *Avoided Energy Costs in Maryland. Assessment of the Costs Avoided through Energy Efficiency and Conservation Measures in Maryland.* http://ilsagfiles.org/SAG_files/Subcommittees/IPA-TRC_Subcommittee/6-16-2015_Meeting/Followup_Documents/AvoidedEnergyCostsinMaryland1.pdf

F. Idaho Power. 2018. *Demand Side Management 2018 Annual Report. Supplement1: Cost Effectiveness.* https://docs.idahopower.com/pdfs/EnergyEfficiency/Reports/Supplement1.pdf

G. Illinois Energy Efficiency Stakeholder Advisory Group (SAG). 2017. *Illinois Statewide Technical Reference Manual for Energy Efficiency Version 6.0. Volume 1: Overview and User Guide.* February 8 (Effective January 1, 2018). http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_6/Final/IL-TRM_Version_6.0_dated_February_8_2017_Final_Volumes_1-4_Compiled.pdf

H. Independent Evaluation Monitor (IEM). 2017. "Arkansas TRM Version 7.0 Volume 1: EM&V Protocols Applicable for Program Year 2018." http://www.apscservices.info/EEInfo/TRMv7.0.pdf

I. Iowa Administrative Code (IAC). 2010. § 199-35.9(7)(a) and (b) and 199-35.10(4)(a) and (b) Chapter 35 Energy Efficiency Planning and Cost Review. https://www.legis.iowa.gov/docs/ACO/chapter/199.35.pdf

J. Itron. 2014. *Development and Application of Select Non-Energy Benefits for the EmPOWER Maryland Energy Efficiency Programs.* https://rpsc.energy.gov/sites/default/files/publication/0C-1411_NonEnergyBenefitsReport-Itron-022415.pdf

K. Minnesota. 2014. In the Matter of the Quantification of Environmental Costs. "Findings of Fact, Conclusions, Recommendation and Memorandum." PUC Docket E-999-CI-93-583. https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={A609DFC7-9361-4522-B43E-C0BAE1842319}&documentTitle=20148-102561-02

L. Minnesota Investigation into Environmental and Socioeconomic Costs. 2015. "Notice of Updated Environmental Externality Values." PUC Docket E-999-CI-93-583 and E----/CI-00-1636. https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId=%7B254A80F2-3888-4E40-AB4A-B97FD516BA60%7D&documentTitle=20155-110748-01

M. Minnesota Department of Commerce. 2016. "Decision in the Matter of Great Plains Natural Gas Company's 2017-2019 Natural Gas Conservation Improvement Program Plan." https://drive.google.com/file/d/1L4F2YL9JmuCkzqaZGxeJj8NtGRjwR1Nt/view

N. Minnesota Investigation into Environmental and Socioeconomic Costs. 2018. "In the Matter of the Further Investigation into Environmental and Socioeconomic Costs Under Minnesota Statutes Section 216B.2422, Subdivision 3." https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId=%7B5066BD60-0000-C71B-9B5B-305CF65BCAE1%7D&documentTitle=20181-138585-01

O. National Grid Customer Department. 2014. "REMI Analysis of National Grid's Energy Efficiency Programs." http://rieermc.ri.gov/wp-content/uploads/2018/03/macroeconomic-impacts-of-rhode-island-energy-efficency-investments.pdf

P. New York Independent System Operator (NYISO). 2018. *2017 Congestion Assessment and Resource Integration Study. Comprehensive System Planning Process. CARIS – Phase 1.* https://www.nyiso.com/documents/20142/2226108/2017-CARIS2017-Report-FINAL.pdf/7d228b1b-eb5a-8288-370d-1d4d07bc5168

Q. NMR Group Inc. 2011. *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation.* http://ma-eeac.org/wordpress/wp-content/uploads/Special-and-Cross-Sector-Studies-Area-Residential-and-Low-Income-Non-Energy-Impacts-Evaluation-Final-Report.pdf

R. NMR Group Inc. 2013. HVAC NEIs of Early Replacement or Burnout (Memo). July 15. http://ma-eeac.org/wordpress/wp-content/uploads/HVAC-Replace-on-Failure-Non-Energy-Impacts-Memo-7.15.13.pdf

S. NMR Group Inc. 2016. *CT PAs Program Savings Documentation and NMR, 2016, Project R4 HES/HES-IE Process Evaluation and R31 Real-time Research.* April 13. https://www.energizect.com/sites/default/files/R4_HES-HESIE%20Process%20Evaluation,%20Final%20Report_4.13.16.pdf

T. Ohio. 2009. Finding and Order in the Matter of Protocols for the Measurement and Verification of Energy Efficiency and Peak Demand Reduction Measures. Case No. 09-512-GE-UNC. http://dis.puc.state.oh.us/TiffToPDf/A1001001A09J15B23707E63875.pdf

U. Peregrine Energy Group. 2016. *Analysis of Job Creation from 2015 Expenditures for Energy Efficiency in Rhode Island by National Grid.*

https://www.puc.nh.gov/Regulatory/Docketbk/2017/17-136/INITIAL%20FILING%20-%20PETITION/17-136_2017-09-01_NHUTILITIES_ATT_DTESTIMONY_GOLDMAN.PDF

V. RTF Staff. 2014. *Preliminary Report: Quantifying the Health Benefits of Reduced Wood Smoke from Energy Efficiency Programs in the Pacific Northwest.* https://nwcouncil.app.box.com/s/xzv62pp132mk0ibkgmvn0upc5x9m204e

W. Rutgers. 2018. Energy Efficiency Cost-Benefit Analysis Avoided Cost Assumptions. http://njcleanenergy.com/files/file/Library/Market%20Research/Avoided%20Cost%20Memo%20(3-13-18).pdf

X. Schwartz, Peter, Brian Gerke, Jennifer Potter, Alastair Robinson, David Jagger, Kelly Sanders, Yao-Jung Wen, Jasmine Shepard, and Teddy Kisch. 2019. *The Value Proposition for Cost-Effective, DR-Enabling, Nonresidential Lighting System Retrofits in California Buildings.* Lawrence Berkeley National Laboratory. California Energy Commission. Publication Number: CEC-500-2019-041. https://www.energy.ca.gov/2019publications/CEC-500-2019-041/CEC-500-2019-041.pdf

Y. Skumatz Economic Research Associates, Inc. (SERA). 2014. *Non-energy Benefits / Non-energy Impacts (NEBs/NEIs) and their Role & Values in Cost-Effectiveness Tests: State of Maryland.* https://assets.ctfassets.net/ntcn17ss1ow9/7hSd2GZVRtPoZKuks9WxDc/99f7076a6561f1fb44644756e6bf5707/2014__NEBs_report_for_Maryland.pdf

Z. Synapse Energy Economics, Resource Insight, Les Deman Consulting, North Side Energy, and Sustainable Energy Advantage. 2018a. *Avoided Energy Supply Components in New England: 2018 Report.* http://www.synapse-energy.com/sites/default/files/AESC-2018-17-080-June-Release.pdf

AA. Tetra Tech. 2012. *MA Program Administrators Final Report – Commercial and Industrial Non-Energy Impact Study.* June 29. https://library.cee1.org/system/files/library/9929/CEE_DNV_KEMA_FinalMA_NEI_Rpt_29Jun2012.pdf

3.2 Other Documents Referenced

Converge Strategies. 2019. *The Value of Resilience for Distributed Energy Resources: An Overview of Current Analytical Practices.* https://pubs.naruc.org/pub/531AD059-9CC0-BAF6-127B-99BCB5F02198

Hoffman, I., C. Goldman, S. Murphy, N. Mims, G. Leventis, and L. Schwartz. 2018. *The Cost of Saving Electricity Through Energy Efficiency Programs Funded by Utility Customers: 2009-2015.* https://emp.lbl.gov/publications/cost-saving-electricity-through

Klein, Will. 2019. Health and Energy Efficiency. Presentation to the Illinois Stakeholder Advisory Group. http://ilsagfiles.org/SAG_files/Meeting_Materials/2019/February-25-2019_Meeting/Illinois_SAG_Health_and_EE_GHHI_2-25-19_vF.pdf (at slide 26)

National Efficiency Screening Project (NESP). 2017. *National Standard Practice Manual for Assessing Cost-Effectiveness of Energy Efficiency Resources.* https://nationalefficiencyscreening.org/wp-content/uploads/2017/05/NSPM_May-2017_final.pdf

Norton, Ruth Ann and Brendan Wade Brown. 2014. "Green & Healthy Homes Initiative: Improving Health, Economic, and Social Outcomes Through Integrated Housing Intervention." *Environmental Justice* 7(6). https://s3-us-west-2.amazonaws.com/mcf-redesign-assets/multimedia/Environmental-Justice-journal-article-on-GHHI-2014.pdf?mtime=20170117142828

Pacific Northwest National Laboratory. 2017. "Grid Modernization: Metrics Analysis (GMLC1.1) Reference Document, Version 2.1." https://gmlc.doe.gov/sites/default/files/resources/GMLC1%201_Reference_Manual_2%201_final_2017_06_01_v4_wPNNLNo_1.pdf

Malmgren, Ingrid and Lisa Skumatz. 2014. Lessons from the Field: Practical Applications for Incorporating Non-Energy Benefits into Cost Effectiveness Screening. 2014 ACEEE Summer Study on Energy Efficiency in Buildings. https://aceee.org/files/proceedings/2014/data/index.htm

Raab Associates, Ltd., Paul Centolella & Associates, Tabors Caramanis Rudkevich. 2017. "Docket 4600: Stakeholder Working Group Process." http://www.ripuc.org/eventsactions/docket/4600-WGReport_4-5-17.pdf

Skumatz Economic Research Associates, Inc. (SERA). 2018. Non-energy Benefits in State Cost-Effectiveness Tests – Reducing Bias in Consideration of Energy Efficiency as a Resource. 2018 ACEEE Summer Study on Energy Efficiency in Buildings. https://aceee.org/files/proceedings/2018/index.html#/paper/event-data/p127

Synapse Energy Economics. 2018b. The Rhode Island Cost-Effectiveness Framework. Methodologies for Developing Inputs for Distributed Energy Resources. http://www.ripuc.org/eventsactions/docket/4600A-DIV-DraftRept-FrameworkMethodology(10-3-18).pdf

Tetra Tech, NMR, and DNV GL. 2018. *Program Administrators of Massachusetts Non-Energy Impact Framework Study Report.* http://ma-eeac.org/wordpress/wp-content/uploads/NEI-Framework-Study-Report.pdf

Three3, Inc. and NMR Group Inc. 2016. *Massachusetts Special and Cross-Cutting Research Area: Low-Income Single-Family Health- and Safety-Related Non-Energy Impacts (NEIs) Study.* August 5. http://ma-eeac.org/wordpress/wp-content/uploads/Low-Income-Single-Family-Health-and-Safety-Related-NonEnergy-Impacts-Study.pdf

U.S. Environmental Protection Agency. 2019. *Public Health Benefits per kWh of Energy Efficiency and Renewable Energy in the United States: A Technical Report.* July. https://www.epa.gov/statelocalenergy/public-health-benefits-kwh-energy-efficiency-and-renewable-energy-united-states

Appendix A: Summary of Individual Studies With Specific NEI Values and Calculation Methods

This appendix summarizes select studies included in our research for this report: the study name, year, and URL; NEI(s) discussed; range of values; study methods; NEI application; and other information. Following Table A - 1 is additional information about each study.

Table A - 1. Mapping Specific NEIs to Studies in Table 2 and Appendix A

Study *(in order as it appears in this appendix)*	1 Asset Value	2 Avoided Ancillary Services	3 Avoided Cost of RPS	4 Avoided Credit/ Collections	5 Avoided Enviro. Compliance	6 Comfort	7 Economic Development and Jobs	8 Energy Security	9 Environmental	10 Health and Safety	11 Increased Reliability	12 Other Fuel	13 Price Suppression	14 Productivity	15 Public Health	16 Water Resources
A. DNV GL 2016														X		
B. DNV GL 2018														X		
C. E3 2016			X	X												
D. EPA 2019															X	
E. Exeter Associates, Inc. 2014		X	X									X	X			X
F. Idaho Power 2018					X											
G. Illinois Energy Efficiency SAG 2017												X				
H. IEM 2017												X				X
I. IAC 2010					X											
J. Itron 2014									X					X		
K. Minnesota 2014									X							
L. Minnesota 2015									X							
M. Minnesota Department of Commerce 2016												X				
N. Minnesota 2018									X							
O. National Grid Customer Department 2014							X									
P. NYISO 2018					X											
Q. NMR Group Inc. 2011	X					X		X		X*				X		

Study *(in order as it appears in this appendix)*	1 **Asset Value**	2 **Avoided Ancillary Services**	3 **Avoided Cost of RPS**	4 **Avoided Credit/ Collections**	5 **Avoided Enviro. Compliance**	6 **Comfort**	7 **Economic Development and Jobs**	8 **Energy Security**	9 **Environmental**	10 **Health and Safety**	11 **Increased Reliability**	12 **Other Fuel**	13 **Price Suppression**	14 **Productivity**	15 **Public Health**	16 **Water Resources**
R. NMR Group Inc. 2013	X					X										
S. NMR Group Inc. 2016						X										
T. Ohio 2009		X														
U. Peregrine Energy Group 2016							X									
V. RTF Staff 2014															X	
W. Rutgers 2018		X	X													
X. Schwartz, Peter, et al. 2019														X		
Y. SERA 2014				X		X	X		X	X*						X
Z. Synapse Energy Economics et al. 2018a			X						X		X		X			
AA. Tetra Tech 2012														X		

**We do not rate the transferability of this NEI as it focuses on low-income programs. We keep the information in this appendix for completeness only.*

A. DNV GL. 2016. Stage 2 Results. Massachusetts Electric and Gas Program Administrators C&I New Construction Non-Energy Impacts Study. March 24.

This study provided NEIs for O&M as part of certain measures in new construction and rolled several possible NEIs into a single value that we label O&M for other measures in new buildings. Specifically, for new buildings, the NEI included administration costs, material movement, other costs, other labor, O&M, product spoilage and waste disposal. The report provides significantly more detail than what we provide below, including an appendix that describes the CostLab software and information outlining the lifecycle costs and sources of NEIs for each measure category. We encourage interested parties to review this document closely.

Participant – Productivity - O&M

Method Used to Determine Values: Engineering lifecycle cost analysis supported by information from interviews, published employment data and program tracking data. Analysis covered 255 of the 957 new construction measures installed by the program in 2013.

Range of Values: Table 2 provides a list of multiple NEIs by program type (custom/prescriptive) and measure category that we do not include here, but the values range from $0.001/kWh for custom HVAC to $0.038/kWh for prescriptive compressed air. Gas values (found in Table A - 1) range from $0.242/therm (HVAC/Heat Recovery) to $3.399/therm (Commercial Kitchen). Additionally, there are negative gas NEIs for gas boilers (-$0.084/therm for prescriptive and -$0.006/therm for custom), custom gas other (-$0.032), and custom comprehensive design (-$0.004/therm).

The current MA TRM includes the following productivity NEIs (which are a subset of values from the study) as related to the following: Compressed Air (customer and prescriptive), HVAC (custom), Lighting (custom and prescriptive), Process (custom), Refrigeration (custom), Comprehensive Design (custom[15]), Commercial Kitchen (custom and prescriptive), Boilers (custom and prescriptive), Other (custom), HVAC/Heat Recovery (Prescriptive) and Other Gas Heating (Prescriptive).

Values Applicable to: Newly constructed buildings or buildings with major renovations.

Application of Values: Multiply the NEI value by the measure category saving by fuel type.

Using this Information: These NEIs are focused on operational cost changes only and do not include productivity or revenue changes. This is because the engineering that was the method deployed to determine NEIs did not find these types of changes. While the values found in this study appear to be applicable across many jurisdictions, any utility choosing to use these values should carefully review the appendix describing how the engineering analysis occurred to ensure that the engineering analysis includes information pertinent to their specific area.

[15] The TRM value of $0.00 does not match the study value of -$0.004/therm, and we are unsure why this is the case.

B. DNV GL. 2018. AEP Ohio Non-Energy Impact. Final Report.

Participant – O&M Cost Savings (Commercial & Industrial Productivity)

Method Used to Determine Values: The study authors applied three different approaches. They used a lifecycle cost / engineering-based approach to estimate NEIs resulting from O&M costs savings, in-depth interviews with industrial/manufacturing program participants to identify production/revenue changes, and an extensive literature review to estimate less tangible, non-O&M or production-related NEIs. Only the O&M lifecycle cost/engineering-based approach provided NEI monetized values, but the study provided information from the other approaches as well (e.g., increase in comfort and safety, decrease in downtime or labor costs, etc.).

Range of Values: Varied by sector (retail, manufacturing, grocery, hospital, office) and measure (custom, lighting, VSD). Examples: office lighting NEI of $0.02/kWh saved by measure, hospital VSD NEI of $0.0087/kWh, and manufacturing lighting of 11% of average incremental investment cost. Note that the study also provided NEI quotes from their literature review and in-depth interviews for the utility to use within marketing.

Values Applicable to: Specific segments and measures included in study, as noted above.

Application of Values: Multiply the per-unit values by the appropriate units to derive O&M monetized benefits. However, according to the study authors, "the life-cycle cost analysis was performed on a sample of measures stratified by measure category. While the sample was designed to provide relative precision at the measure category level, maintenance cycles and costs for measures not included in the sample are not known. Applying NEI estimates to measures not included in the sample can result in increased error." As such, information in this study appears to be able to be transferred to other jurisdictions, but with caution, and the study should be read thoroughly prior to use.

Using this Information: Study authors indicated that further research is required to obtain reliable NEI associated with productivity gains, sales increases, health and safety impacts and other non-O&M impacts before such impacts are suitable for regulatory cost effectiveness testing.

C. Energy and Environmental Economics, Inc. (E3) 2016. Avoided Cost Interim Update

Utility – Avoided RPS Compliance Cost

Method Used to Determine Values: A Renewable Portfolio Standard (RPS) adder is a function of the avoided premium on renewable purchases needed to comply with an RPS, given the reduction in retail load. Those purchases are valued using the marginal renewable resource (here, the energy-only resource for tracking solar PV), net of the market price for conventional resources. Requires surveys of renewables costs and the cost of wholesale conventional energy and capacity that would have been purchased in the absence of the RPS and the saved energy.

Range of Values: $14.78/kWh in 2018, flat across all hours but rising as the compliance obligation rises. The avoided cost calculator shows this value in 2018 is nearly half of the average avoided energy cost, roughly equal to average avoided capacity cost and about 17% of the total average avoided costs.

Values Applicable to: Used to calculate one component of avoided costs in CA, but the method could be used wherever the marginal renewable and conventional resources are the same and similarly priced.

Application of Values: To calculate the RPS premium, the method identifies cost of the marginal renewable resource from the latest RPS Calculator spreadsheet model and subtracts the market energy value from the levelized cost of the renewable resource.

To calculate the adder, the RPS premium is multiplied by the RPS compliance requirement. For example, in 2021 the RPS adder is equal to the renewable premium * 33% CA RPS requirement; that is, for each 1 kWh of avoided retail sales, 0.33 kWh of renewable purchases are avoided. The RPS adder increases linearly between a 2016 compliance obligation of 25% and a 2030 compliance obligation of 50%.

Using this Information: This NEI only applies where a renewable portfolio standard or clean energy standard allowing renewables is in place. This value is based on renewable and wholesale market prices in CA, so the value itself only would be transferable if those prices were very similar. The method is easily transferable.

Avoided Environmental Compliance Cost (Carbon Dioxide [CO_2] and Criteria Pollutants)

Method Used to Determine Values: The CA Energy Commission projects carbon allowance prices under the state's cap-and-trade program as part of the CEC's Integrated Energy Policy Report process. The avoided cost calculator uses these projections to calculate avoided energy costs and to decompose those costs into energy costs and environmental costs (which include sulfur oxides [SOx] and nitrogen oxides [NOx]).

Range of Values: None provided**.**

Values Applicable to: Used to calculate one component of avoided costs in CA. The CO_2 cost is unique to the CA as long as its cap-and-trade market is limited to the state.

Application of Values: These environmental compliance costs are embedded in the energy portion of the avoided costs in CA.

Using this Information: This NEI is already included in the avoided costs for California, so it should not be used separately.

D. EPA. 2019. Public Health Benefits per kWh of Energy Efficiency and Renewable Energy in the United States: A Technical Report.

This document provides a set of benefits-per-kWh (BPK) values developed by the EPA that help state and local government policymakers and other stakeholders estimate the monetized public health benefits of investments in energy efficiency and renewable energy (EE/RE) using methods consistent with those EPA uses for health benefits analyses at the federal level. The document indicated that is it appropriate to use these values when:

- Estimating the public health benefits of regional, state or local-level investments in EE/RE projects, programs and policies
- Understanding the cost-effectiveness of regional, state or local-level EE projects, programs and measures
- Incorporating health benefits in short-term regional, state or local policy analyses and decision-making

Societal – Public Health

Method Used to Determine Values: Study authors drew on multiple sources to estimate health benefits per kWh of project/programs/ and policies. Specifically, they created scenarios and then used the Agency tool Avoided Emissions and generation Tool (AVERT) to (1) estimate changes in fossil-based electricity generation due to representative EE/RE projects, programs and policies and (2) estimate changes in air pollution emissions (NOx, SO_2, and particulate matter $[PM]_{2.5}$) due to changes in fossil-based generation. They then used AVERT outputs as inputs into the Co-Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping tool (another Agency tool) to (1) estimate changes in ambient concentrations of air pollution due to changes in emissions of primary $PM_{2.5}$ and precursors of secondary $PM_{2.5}$, (2) estimate changes in public health impacts due to changes in ambient concentrations of $PM_{2.5}$, and (3) estimate the monetary value of changes in public health impacts. Lastly, they divided the monetized public health benefits by the change in generation to determine the health benefits per kWh (¢/kWh).

Range of Values: Table ES.1 shows 2017 benefits-per-kWh values by region and project type for two different discount rates (3% and 7%). For energy efficiency programs and a 3% discount rate, these values range from 0.48 ₵/kWh to 7.95 ₵/kWh depending on the region.

Values Applicable to: Savings from energy efficiency or renewable projects within specified regions.

Application of Values: As per the document: “States and communities interested in having screening-level estimation of outdoor air quality related health impacts of energy efficiency or renewable energy can multiply the BPK values, presented in Table ES. 1 in cents per kilowatt hour, by the number of kWh saved from EE or generated from RE to estimate potential health benefits from projects in dollars saved. Users should keep in mind there are uncertainties associated with any modeled estimates when interpreting or reporting results.”

Using this Information: The document indicates that these values “are not a substitute for sophisticated analysis and should not be used for federal regulatory decisions.” The savings represent the benefits from avoided fossil fuel-based generation and therefore represent the type of generation in place within the different regions at the time of the analysis.

E. Exeter Associates, Inc. 2014. Avoided Energy Costs in Maryland.

Participant – Other fuels costs and benefits

Method Used to Determine Values: This study used various public records specific to the state and an Integrated Power Model (IPM)[16] to determine per-unit costs for other fuels. For the avoided costs of natural gas, they used the projected Henry Hub wholesale gas prices; projected transmission costs from the IPM; and projected distribution costs from the IPM to estimate avoided costs for the residential, commercial and industrial sectors (See Section 8). For the avoided costs of propane and distillate fuel oil costs, the study used the federal annual energy outlook (AEO) for the Mid-Atlantic region. The AEO is an annual update by the federal energy information administration and can be found here: https://www.eia.gov/outlooks/aeo/data/browser/.

Range of Values: Values are specific to sector. The first-year values in the study (2013) were that residential customers have avoided costs of $11.96 (natural gas), $26.88 (propane) and $26.60 (fuel oil). Commercial customers have avoided costs of $10.14 (natural gas), $21.01 (propane) and $25.52 (fuel oil). Industrial customers have avoided costs of $6.97 (natural gas), $19.70 (propane) and $26.42 (fuel oil). NYMEX futures provided near-term projections of gas prices, after which consultants relied upon AEO and Ventyx projections, both of which are modeled in part based on demand and supply in the Mid-Atlantic region. Projections for propane and distillate fuel oil were similarly drawn from the AEO 2013 Mid-Atlantic Reference Case for those fuels.

Values Applicable to: The jurisdiction.

Application of Values: The DE and NEEP TRMs specify application of these NEIs for specific measures.

Using this Information: Fuel costs vary across regions. As such, the information in this document indicates a possible range of savings, but they are not directly transferrable. The method is transferrable, and a utility could use internal or external resources to research the AEO information that best fits their utility. Avoided costs must be aligned with other information used within utility power modeling.

Participant – Avoided Water Costs

Method Used to Determine Values: Draws on the American Water Works Association biennial survey of water providers to obtain rates and monetize water savings. AWWA trends data also can be used to estimate escalation of water costs into the future.

Range of Values: Wide range of rates, expressed as $2012 per 1,000 gallons. For 2019, values are $12.30 for residential water costs/1,000 and $20.13 for C&I water costs.

Values Applicable to: Monetizing water and wastewater savings for low-flow showerheads, faucet aerators, dishwashers, washing machines and sometimes water heaters.

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[16] The IPM is a set of models designed by a consultant (ABB/Ventyx) to reflect the market factors affecting power prices, emissions, generation, power plant development (and retirements), fuel choice and other power market characteristics. The IPM contains a detailed database that includes current generation capacity in the U.S., including capacity, heat rate, fixed operation and maintenance (O&M) costs, variable O&M costs, fuel costs and emissions rates.

Application of Values: Reduction in water, wastewater usage.

Using this Information: Reduction in usage compared to standard measure multiplied by rate for the jurisdiction or a weighted average for a territory or region. In the Northwest, RTF guidance is to use the marginal volumetric rate only, i.e., the cost of the last or next 1,000 gallons. In MD and DE, most recent reported annual increases in national average rates are used to project state average water rates into the future.

Utility – Ancillary Services

Method Used to Determine Values: Review of documents, specifically the PJM's Open Access Transmission Tariff and a confidential contract documents related to the provision of retail electric power in the PJM and MISO areas.

Range of Values: $0.007 per kWh (7 mills)

Values Applicable to: Avoided kWh in Maryland.

Application of Values: The value is added to each of the avoided kWh associated with implementation of energy conservation and energy efficiency projects to account for retail market prices rather than wholesale local marginal prices. It is the same value for all electric distribution company service areas or customer classes.

Using this Information: The value includes more than just the cost for ancillary services. It includes the PJM avoided charges, compensation for business risk and retail supplier margin. The study authors indicate that this value has "some degree of uncertainty" because of the different provisions for the pass-through of cost elements found in the confidential contracts and differences in the incurrence of risk and sharing of risk between seller and buyer.

Utility – Price Suppression (DRIPE)

Method Used to Determine Values: Study authors used two approaches, one for energy and the other for capacity. They used a Ventyx model to estimate baseline electric hourly energy costs, then estimated the change in prices by zone, calculated the energy price differentials, allocated price reduction benefits to ratepayers, and applied a decay rate. For demand, study authors calculated supply elasticities and capacity price differentials, applied a decay rate, and then calculated total DRIPE.

Range of Values: Varied by year, location, time of day and underlying programs. Examples of $1.76/MWh to $3.04/MWh ($2012) for 2019 and $7.65/MW-day to $420.37/MW-day for 2019.

Values Applicable to: Maryland utilities.

Application of Values: Multiply costs found in study tables by MWh or MW saved by energy efficiency programs.

Using this Information: Information in this study is specific to the jurisdiction and should not be used directly, although the method could be applied elsewhere.

Utility – Avoided RPS Compliance Costs

Method Used to Determine Values: A reduction in the amount of renewable energy required to satisfy the RPS based on the energy efficiency savings.

Range of Values: Depends on the energy efficiency portfolio MWh savings.

Values Applicable to: Jurisdictions that have a RPS, but specific values will vary by jurisdiction. This study showed the RPS requirements for Maryland as solar, Tier 1 or Tier 2 renewable. For 2019, it was 1.75% for solar and 15.65% for Tier 1 (no Tier 2 value provided in Table 8).

Application of Values: When one MWh of electric energy consumption is avoided, the amount of renewable energy (Solar, Tier 1 and Tier 2) required to satisfy the Maryland RPS is reduced in proportion to the percentage required for that year.

Using this Information: This is a straightforward calculation, but the study was silent on whether the energy efficiency savings were gross savings or net savings, and any jurisdiction applying the method will need to decide and clearly document.

F. Idaho Power. 2018. Demand Side Management 2018 Annual Report. Supplement 1: Cost Effectiveness.

Utility – Avoided Environmental Compliance Costs

Method Used to Determine Values: Agreement with the Northwest Power Act and how other Northwest utilities apply the adder (OPUC Order No. 94-590).

Range of Values: 10% adder to energy efficiency cost-effectiveness analyses.

Values Applicable to: Utilities in Idaho.

Application of Values: Not specifically stated.

Using this Information: The values are stated to be a “conservation adder.”

G. Illinois SAG. 2017. Illinois Statewide Technical Reference Manual for Energy Efficiency Version 6.0 Volume 1: Overview and User Guide. Also see: http://ilsagfiles.org/SAG_files/Meeting_Materials/2018/June_21_2018_Teleconference/Elevate_Energy_Presentation_Overview_Energy_per_Gallon_Factor_6-21-18_SAG.pdf

Other Fuel Savings

Method Used to Determine Values: Values for hot-water savings of other fuels were derived by algorithm and data from the U.S. DOE 2009 Residential Energy Consumption Survey for the Midwest or Illinois.

Range of Values: Depends on fuel.

Values Applicable to: Savings of thermal fuels used to heat water after switch to electric water heater.

Application of Values: Fuel cost data obtained from 2009 RECS and employed in algorithms such as this one:

ΔTherms = %FossilDHW * ((GPM_base * L_base - GPM_low * L_low) * NSPD* 365.25) * EPG_gas * ISR
Where: %FossilDHW = proportion of water heating supplied by fossil fuel heating.

For gas or other fossil fuel, value of %FossilDHW is 100%; for unknown fuel, 84%.

EPG_gas = Energy per gallon of Hot water supplied by gas = (8.33 * 1.0 * (ShowerTemp - SupplyTemp)) / (RE_gas * 100,000) = 0.0063 Therm/gal

Where: RE_gas = Recovery efficiency of gas water heater = 67% and 100,000 = Converts Btus to Therms (btu/Therm)

Using this Information: Quantify saved hot water and then apply algorithm to estimate other fuel savings for heating the water and use the RECS values to monetize those other fuel savings.

H. Independent Evaluation Monitor (IEM). 2017. Arkansas Technical Reference Manual Version 7.0. August 31, 2017.

Participant – Water resource costs and benefits *– costs and benefits associated with changes in water consumption and wastewater treatment resulting from efficiency resources.*

Method Used to Determine Values: Study researchers determined retail water and sewage rates in 2016 from six jurisdictions around the state and averaged them. While the marginal water rates may include the avoided electricity costs of water treatment, pumping, and other uses of electricity to supply potable water and dispose of wastewater, the study researchers did not confirm this specifically (although added a footnote).

Range of Values: Based on sector, with the avoided water costs for residential at $6.18/1,000 gallons, commercial at $6.90/1,000 gallons, and industrial at $6.54/1,000 gallons. These are marginal costs that include both potable and sewage rates. Increase the value annually by using the assumed escalation rate for lifetime of the specific installed measure and using the same discount rate as used for the TRC (See Table 8. Avoided Water Costs in Arkansas).

Values Applicable to: The State.

Application of Value: Measure specific water savings as described within the Technical Reference Manual (TRM). Determine benefits by using the algorithm:

Benefit = Water Savings x Avoided Water Costs

Using this Information: Water rates vary considerably within a state and across regions. As such, the information in this document indicates a possible range of savings but cannot be directly transferred. The method is transferrable, as a utility could use internal or external resources to choose relevant water jurisdictions, gather rate data, and average values to use as avoided water costs. Application of avoided water costs presupposes that there is agreement regarding the saved water by measure. If a utility does not yet have agreed upon water savings values, a literature review of various TRMs to determine and use the gallons saved by measure is helpful, as these values tend to be transferable.

Utility – Other fuels costs and benefits *– costs and benefits resulting from reduced consumption of electricity and non-electric energy sources, or from increased consumption of other fuels, resulting from energy efficiency.*

Method Used to Determine Values: When the other fuel is either electricity or natural gas, gather and use the avoided cost of the associated electric or gas utility (i.e., the utility providing the other fuel benefit). When a measure saves propane, both electric and gas utilities use a state specific value determined from the EIA reflecting actual past propane prices.

Range of Values: Utility specific costs for natural gas and electricity; $2.00/gallon of propane.

Values Applicable to: The jurisdiction.

Application of Value: This NEI is applicable to single fuel utilities, but only for those measures that save both fuels. For example, an electric utility may apply NEIs associated with gas savings if the measure installed through the electric program saves both electricity and natural gas. Measure specific savings areas are described within the Technical Reference Manual (TRM). Determine "other" fuel benefits by using the algorithm:

Benefit = Energy Savings x Avoided Other Fuel Costs

For any electric or gas utility where measures save propane, assume that the equipment was natural gas-fueled and convert to propane savings using the following conversion factor:

Propane savings (gallons) = Therm Savings x 1.1

Using this Information: Fuel rates vary within a state and across regions. As such, the information in this document indicates a possible range of savings but cannot be directly transferred. The method is transferrable, as a utility could use internal or external resources to determine other fuel costs as described above. Application of avoided fuel costs presupposes that there is agreement regarding the saved other fuel by measure. If a utility does not yet have agreed upon other fuel savings values, a literature review of various TRMs to determine and use the value saved by measure is helpful, as these values tend to be transferable.

I. Iowa Administrative Code (IAC). 2010. Chapter 35 Energy Efficiency Planning and Cost Review.

Utility – Avoided Environmental Compliance Costs

Method Used to Determine Values: Legislative decree (called externality factor of the societal cost of supplying energy).

Range of Values: 10% adder to avoided capacity costs, 10% adder to avoided energy costs for electric utilities, 7.5% adder to avoided capacity costs for gas utilities.

Values Applicable to: Utilities in Iowa.

Application of Values: Multiply the avoided costs by 1.1 (for electric) or 1.075 (for gas). Reference the document for their specific algorithm.

Using this Information: There is no information on how Iowa determined these externality factors.

J. Itron. 2014. "[Development and Application of Select Non-Energy Benefits for the EmPOWER Maryland Energy Efficiency Programs]"

Societal – Environmental Impacts – Air Quality

Method Used to Determine Values: Algorithm with multiple other documents used for inputs.

Range of Values: $0.0115 per kWh ($2014) was recommended, although the study performed several scenarios that ranged from $0.001 to $0.0286 per kWh.

Values Applicable to: All portfolio savings.

Application of Values: Itron estimated emissions benefits separately for NOx, SO_2 and CO_2 and added them together to determine total benefits. The estimated value did not include limited income programs but did include commercial and industrial programs, as well as residential programs.

Air Emissions Benefits = MWh Savings x Emissions Intensity (lbs/MWh) x [Unit Damage Costs ($/lb) – Unit Emissions Taxes/Fees Paid by Utilities ($/lb)] = Total Benefits ($)

- Emission intensities were from the PJM Environmental Information Services Electricity Generation Attribute Tracking System (EGAT https://gats.pjm-eis.com/gats2/PublicReports/PJMSystemMix).
- Itron based the NOx and SOx unit damage costs inputs on the 2010 National Academy of Sciences Hidden Costs Study https://www.nap.edu/catalog/12794/hidden-costs-of-energy-unpriced-consequences-of-energy-production-and. Itron used damages from coal and gas generation plants.
- For CO_2, Itron used the 2013 social cost of carbon estimated from the federal government. (Note that this value, at $63/metric ton for 2.5% average in $2007, most likely has been updated.)
- While Maryland generators are subject to permit fees for EPA criteria emissions, Itron determined that these were minimal, and with no impact to the benefits estimate.
- Itron analyzed Regional Greenhouse Initiative allowances per ton, removing costs that were already included in avoided costs, to determine the feed paid by utilities.

Itron then estimated a per kWh value:

Benefits per kWh ($/kWh) = Total Benefits ($) / [Total MWh Savings (MWh) x 1000]

Using this Information: Itron analyzed different data sources to arrive at the ultimate inputs to the algorithm. The study goes into detail about choices made within this analysis and described the concerns about double counting raised by stakeholders. A jurisdiction desiring to include this NEI can use the same method but will need to update the inputs so they are locally relevant. It is noteworthy that Itron indicated that "Even in the aggressive case, our analysis concludes the sum of criteria emissions benefits totals less than one cent per kWh saved, which is unlikely to materially affect [utility] cost effectiveness either at the program or portfolio levels – i.e., only rarely, will a TRC B/C ratio go from less than one to greater than one if given additional benefits of 0.8 cents per kWh."

Participant – Productivity – O&M

Method Used to Determine Values: Algorithm with multiple other documents used for inputs.

Range of Values: The study provided values with and without labor benefits included, by prescriptive and Small Business Direct Install program types and for five specific utilities. For example, benefits of a linear fixture replacement on a burnout measure for a prescriptive program ranged from $0.001 to $0.005/lifetime kWh saved. When adding in labor for this measure, the NEI ranged from $0.003 to $0.008/lifetime kWh saved. Refer to tables 4-8 and 4-9 in the report to see all values.

Values Applicable to: Specific lighting measures and program types.

Application of Values: Multiply the discounted lifetime benefit per lighting measure by the number of corresponding measures.

Using this Information: The study goes into detail about choices made within this analysis. Any jurisdiction could use these values, but with caution, and should review the study assumptions to see if they agree to the them and if their programs are similar enough to apply the provided values.

K. Minnesota. 2014. In the Matter of the Quantification of Environmental Costs. 2014. Minnesota Investigation into Environmental and Socioeconomic Costs.

Societal – Environmental Impacts

Method Used to Determine Values: MN used an expedited generic regulatory proceeding to originally determine values. Parties were directed to submit proposed values and to address a list of questions related to quantification of environmental costs and then the commission held full evidentiary hearings.

Range of Values: Low and high values for SO_2 (sulfur dioxide), PM_{10} (particulate matter smaller than 10 microns), NOx, Pb (lead), CO (carbon monoxide), and CO_2 (carbon dioxide). An example of a high value for PM_{10} was $6,054/ton, while a high value for CO_2 was $2.92/ton. (See MN 2015 for updated values.)

Values Applicable to: Minnesota.

Application of Values: Multiply the tons of emissions removed due to an energy efficiency portfolio by the dollar value per ton to derive the dollar savings.

Using this Information: The expedited regulatory process began in March 1994 and completed in March 1996 with specific recommendations for costs in urban, metropolitan fringe, and rural areas. This document is good for understanding the regulatory process that took place to derive the environmental cost values.

L. Minnesota. 2015. Minnesota Investigation into Environmental and Socioeconomic Costs.

Societal – Environmental Impacts

Method Used to Determine Values: See 2014 MN for creation of the original values. The study used documents specific to the Gross Domestic Product (GDP) Price Deflator index. The environmental externality values were updated using the 2014 GDP Deflator index values published by the United States Department of Commerce on April 30, 2014.

Range of Values: Low and high values for SO_2, PM_{10}, CO, NOx, Pb, and CO_2. Examples of high values for PM_{10} are $9,376/ton in urban areas and $1,248/ton in rural areas. Examples of high values for CO are $3.31/ton in urban areas and $0.60/ton in rural areas.

Values Applicable to: Minnesota. Values separated by urban, metropolitan-fringe, rural, and within 200 miles of MN.

Application of Values: Multiply the tons of emissions removed due to an energy efficiency portfolio by the dollar value per ton to derive the dollar savings.

Using this Information: Information specific to Minnesota. This document does not include information on how to derive the tons of emissions that an energy efficiency portfolio may remove, but it is helpful for understanding the regulatory process that took place to derive the environmental cost values.

M. Minnesota Department of Commerce. 2016. "Decision in the Matter of Great Plains Natural Gas Company's 2017-2019 Natural Gas Conservation Improvement Program Plan"

***Utility – Other fuels costs and benefits** – costs and benefits resulting from reduced consumption of electricity and non-electric energy sources, or from increased consumption of other fuels, resulting from energy efficiency.*

Method Used to Determine Values: Commerce staff calculated the non-gas fuel cost ($/MWh) as "equal to the average of daily average locational marginal prices (LMP) at the Minnesota Hub from January 1, 2015 to December 24, 2015 using data from Midwest Independent System Operator (MISO). This cost is multiplied by the Annual Escalation Rate of 3.22 percent…." Commerce Staff did not include any proxy information for electric T&D costs (which MD did, see document above).

Range of Values: $21.53/MWh

Values Applicable to: the jurisdiction.

Application of Values: Electrical cost savings applied to natural gas projects within the Natural Gas Conservation Improvement Program. The utility was required to identify and fully explain in their filing all calculations and underlying assumptions (including references to any supporting documents) used in determining the input.

Using this Information: The values here are not transferrable, but the method can be transferred.

N. Minnesota. 2018. Minnesota Investigation into Environmental and Socioeconomic Costs.

Utility – Avoided Environmental Costs

Method Used to Determine Values: This document is a continuation of Minnesota's ongoing effort to monetize various environmental costs. These values supersede those found and indicated in the 2015 document above. It is a regulatory document where various parties brought forward specific values with evidence to support the values. The administrative law judge ruled on these values.

Range of Values: Low and high values for SO_2, $PM_{2.5}$, NOx, and CO_2. Examples of high values for $PM_{2.5}$ are $25,137/ton in urban areas and $8,441/ton in rural areas (2014$/ton). Examples of a low end for NOx are $1,985/ton for rural areas and $2,760/ton for urban areas.

Values Applicable to: Minnesota. Values are separated by urban, metropolitan-fringe and rural.

Application of Values: Multiply the tons of emissions removed due to an energy efficiency portfolio by the dollar value per ton to derive the dollar savings.

Using this Information: Information is specific to Minnesota. This document does not include information on it is helpful for understanding the regulatory process that took place to derive the environmental cost values.

O. National Grid Customer Department. 2014. "REMI Analysis of National Grid's Energy Efficiency Programs"

Societal – Economic Development & Jobs

Method Used to Determine Values: The study used an economic model (Regional Economic Models, Inc, REMI) to assess monetary benefits from jobs created by the Rhode Island National Grid energy efficiency portfolio, as well as the increase in gross domestic product (GDP), personal income and sale tax revenue. They also used Massachusetts data to estimate NEIs from combined heat and power projects.

Range of Values: 221 jobs/year for electric program funding and 37 jobs/year for natural gas funding. For both electric and gas funding, net economic gains ranged from $1.1 million to $24 million per year for 14 years. [GDP ($24 M), personal income ($17 M), state tax revenue ($1.1 M)]. CHP projects showed 28 job years/$million, a GDP of $2.73 /dollar spent, and personal income of $2.00/dollar spent.

Values Applicable to: The 2014 energy efficiency programs for National Grid in Rhode Island.

Application of Values: Used the values found in the report as multipliers for evaluating future energy efficiency and CHP plans and projects in Rhode Island.

Using this Information: The output of the REMI model is specific to the underlying programs and to the CHP projects. These provide a sense of the magnitude of benefits possible but should not be used directly. However, the method of an economic model is transferrable, but it is complex and requires specialized expertise.

P. New York Independent System Operator (NYISO). 2018. Congestion Assessment and Resource Integration Study Comprehensive System Planning Process (CARIS) - Phase 1, April 2018

Utility – Avoided environmental compliance costs

Method Used to Determine Values: Modeled projections in NY of costs for emissions allowances for CO_2 (Regional Greenhouse Gas Initiative prices), SO_2 and NOx.

Range of Values: Various per-ton values that vary by year and emission. See Figure 18 in the report for details, but in 2019, SO_2 was ~$2/ton, CO_2 $5/ton, Annual NOx $4/ton, and Ozone NOx $5/ton.

Values Applicable to: Monetization of the costs of current and projected emissions compliance costs. NY applies an adder to the SO_2 allowance price (~$1/MWh) to approximate the additional cost of compliance with the Mercury and Air Toxics Standards.

Application of Values: The values are applied within the NY ISO footprint.

Using this Information: The method is highly transferable. The allowance values for SO_2 and NOx are based on national auction values and should be transferable for current years, possibly out to seven years for forward purchases in the auction.

Q. NMR Group Inc. 2011. Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation. August 15, 2011

This study collected information from more than 125 reports and academic papers, 13 program administrator staff, 213 low-income households, 209 non-low-income households, and 21 owners and managers of low-income rental properties. The report covered multiple NEIs. Below, we include only those NEIs where the study authors recommended an NEI value and are included in the MA TRM as an NEI for program year 2019. We provide both the range of values found, the study recommended value, and the specific TRM value. Additionally, because we are not focusing on low-income properties, we do not include NEIs specifically obtained from the low-income rental property owners/managers. However, the literature review covering NEIs typically used within low-income and survey findings from low-income participants are included where applicable (noted as low-income programs in the application of values for specific NEIs below). The report provides significantly more detail than what we include below, and we encourage interested parties to closely review this document.

Using this Information: When customers that have a discounted rate (typically low-income customers) consume less energy, the utility sells less energy at the discounted rate and then can reduce its rate subsidy. As such, this NEI is only available to participants on a discounted rate. While the values shown here are for MA, the method can be applied using utility-specific rates.

Utility – Safety-related Emergency Calls

Method Used to Determine Values: Literature Review. According to the authors, most studies assumed impact values from other sources (unnamed in this study).

Range of Values: $0.07-$15.58 per participant per year; the study recommended value of $8.43 per participant per year (median value found in literature) is applied in the TRM.

Values Applicable to: Natural gas programs that include activities to identify and repair equipment with gas leaks.

Application of Values: Multiply the NEI value by the number of participants in the relevant program and add to other monetized benefits. Can apply annually.

Using this Information: To use this NEI, a program would need to repair space or water heating appliances (thus leading to a potential reduction in emergency calls to the utility). The utility costs for rolling a truck to respond to emergency calls can vary significantly. Absent a close review of the utility cost, this NEI value may be too high or too low.

Participant – Comfort - Higher Comfort Levels

Method Used to Determine Values: Literature review found that it was not possible to come up with a reliable point estimate for this NEI and so study authors used a survey to obtain more reliable information for non-low income (NLI) participants and low-income (LI) participants. The survey applied a relative valuation method with self-reported savings as dollars or percentage of bill savings and scaled individual NEI responses to fit within an overall NEI value. That is, the respondent was given a typical bill savings value (in dollars) and asked to provide an NEI value relative to the bill savings value as dollar value per year or as a % of annual savings. The study authors scaled all responses to fit within the overall NEI value. The study authors used a previous study from the literature review for the residential new construction value.

Range of Values: $27.13-$279 per participant from the literature; the study recommended values of $125 per NLI participant, $101 for LI participants, and $77 for residential new construction (RNC) participants. Study authors disaggregated these participant level values into a measure-specific NEI for the NLI and LI participants, and the current TRM is applying a range of values depending on the program and measure. For example, residential air sealing has a thermal comfort value of $10.13 per measure per year while low-income single-family air sealing has a value of $35.89 per measure per year. The TRM applies the recommended value for RNC (a value that was estimated to be 19% of overall NEI benefits).

Values Applicable to: Residential and low-income programs in the state.

Application of Values: Multiply the NEI value by the number of participants or number of measures in the relevant program and add to other monetized benefits. Can apply annually.

Using this Information: The dollar values in this NEI are based on the expected reduction in energy bills using the rates found in MA, and therefore give a sense of the magnitude of the NEI only as rates at other utilities would provide a different dollar reduction. However, Table 9-5 in the study shows a range from 29% to 45% of the expected saving for NLI, and Table 9-6 shows a range from 13% to 27% for LI — values which most likely could be used by any utility. Tables 9-10 and 9-11 provide the disaggregated values.

Using this Information: This specific study does not provide information on the derivation of common area lighting, as that must have been determined after 2011 and before 2018. Given that these values are based on previous agreements and appear to be focused more on CFLs than on LEDs, we are uncertain if the O&M continues to provide the same level of benefits. Most likely, these values are good approximations for the magnitude of potential benefits and could be transferred, but more research is needed.

Participant - Asset Value - Increased Housing Property Value

Method Used to Determine Values: Survey (see description in comfort level NEI).

Range of Values: $2.57-$22 per participant; study recommended one-time values of $1,998 for NLI participants, $949 for LI participants, and $72 for RNC. Study authors disaggregated these participant level values into a measure-specific NEI for the NLI and LI participants. The current TRM applies one-time values of: $0.03 per residential showerhead, $1.44 per residential refrigerator. $1.72 per low-income showerhead, and $26.61 per low-income single-family replacement freezer or refrigerator.

Values Applicable to: Residential programs in the state.

Application of Values: Benefit applied one time by multiplying the NEI value by the number of units.

Using this Information: The dollar values in this NEI are based on the expected reduction in energy bills (a value provided to the respondent based on their installed measures) using the rates found in MA, and therefore give a sense of the magnitude of the NEI only as rates at other utilities would provide a different dollar reduction. However, tables 9-10 and 9-11 provide the disaggregated values as a percent, which are values that most likely could be used by any utility.

Participant – Productivity - More Durable Home and Less Maintenance

Method Used to Determine Values: Survey (see description in comfort NEI)

Range of Values: $90-$202 per participant; the study recommended home durability values of $49 per NLI participant and $35 for LI participant (who install shell and weathering measures or HVAC equipment) and maintenance values of $124 for NLI and $54 for LI participants (who install HVAC equipment). However, the current TRM applies a range of values based on program and measure.

Values Applicable to: Residential retrofit programs in the state.

Application of Values: Multiply the NEI value by the number of participants or number of measures in the relevant program and add to other monetized benefits. Can apply annually.

Using this Information: The dollar values in this NEI are based on the expected reduction in energy bills (a value provided to the respondent based on their installed measures) using the rates found in MA, and therefore give a sense of the magnitude of the NEI only as rates at other utilities would provide a different dollar reduction. However, tables 9-10 and 9-11 provide the disaggregated values as a percent, which are values that most likely could be used by any utility.

Participant – Health & Safety - Improved Safety

Method Used to Determine Values: Algorithm and PA data (for heating system ventilation, carbon monoxide, and fires only). Each area (avoided fire deaths, avoided fire-related injuries, avoided fire-related property damage, and avoided deaths attributable to CO poisoning) has a different algorithm, shown on page 5-38 of the document.

Range of Values: $0-$105 per measure; the study recommended values from the algorithm applied to heating systems for avoided fire deaths ($37.40), avoided fire-related injuries ($0.03), avoided fire-related property damage ($1.24), and avoided deaths attributable to CO poisoning ($6.38). However, the current TRM applies a range of values based on the measure. For example, weatherization has a value of $19.64 per participant per year, while air sealing has a value of $2.24 per participant per year.

Values Applicable to: Low-income program participants.

Application of Values: Multiply the NEI value by the number of participants or number of measures in the relevant program and add to other monetized benefits. Can apply annually.

Using this Information: There is a wide disparity between the study recommended values and what is currently being applied, which we assume is due to ongoing discussions between the utility and the commission or inclusion of a newer study.

Societal – Energy Security

Method Used to Determine Values: Literature review and documents

Range of Values: $1.83/MMBtu; study authors recommended this value and the Rhode Island TRM applies this value.

Values Applicable to: Programs where participants use fuel oil or kerosene and the measures installed cause a reduction in the consumption of that fuel oil or kerosene.

Application of Values: Multiply the NEI value by the estimate fuel oil or kerosene savings in MMBtu per measure from installed measures and the number of homes using fuel oil or kerosene as the primary heating fuel. (Note that this is the exact algorithm presented in this report, but it is likely that the actual way to apply the information is to obtain an average MMBtu savings per home and then multiply by the number of homes.) Can apply annually.

Using this Information: The study authors determined the cost/MMBtu by multiplying 10% by the cost the forecasted 2012-2016 levelized cost per MMBtu of imported low-sulfur oil provided in the 2011 Avoided Energy Supply Costs in New England study by Hornby et al. (Synapse Energy).

R. NMR Group Inc. 2013. HVAC NEIs of Early Replacement or Burnout (Memo). July 15, 2013

This 13-page memo describes the analysis used to adjust NEI values for residential heating, cooling and water heating equipment based on whether the equipment is an early replacement compared to a replace on burnout. The values in this memo supersede those found in the August 15, 2011, study report (described above). The memo authors introduced the concept of an NEI being different for measures being replaced on failure (ROF) if the NEI was because of the energy efficiency of the equipment or simply because the equipment was new. We include this memo in our list of studies to demonstrate the ongoing nature of discussion regarding certain NEIs.

Participant – Thermal comfort, health benefits, property value increase, home durability

Method Used to Determine Values: Literature review and analysis of past program tracking database to derive credible reasons to keep the NEI as previously found or to adjust it using the algorithm O*verall NEI Value = [(Energy Efficiency Portion of the NEI * Full NEI Value)*ROF%]+[Full NEI Value * (1-ROF%)]*

Range of Values: The memo recommended reductions in all previous values, although the reductions were on the order of about 10%, depending on the measure (shown in Table 5 of the memo). A 2018 study closely reviewed which NEI values the utilities were applying and found discrepancies between what this memo recommended and the values in use.

Values Applicable to: Past NEI values for thermal comfort, health benefits, property value increase and home durability for specific residential heating, cooling and water heating equipment.

Application of Values: Multiply the adjusted NEI value by the number of participants or number of measures in the relevant program and add to other monetized benefits. Can apply annually.

Using this Information: These values may move closer to being MA-specific and unable to be applied elsewhere because study authors applied a specific percentage of measures within the MA programs that were known to be ROF. We expect that the percent of ROF would be different across the various programs and that the percent that were ROF versus early replacement may be difficult to determine.

S. NMR Group Inc. 2016. CT PAs Program Savings Documentation and NMR, 2016, Project R4 HES/HES-IE Process Evaluation and R31 Real-time Research. April 13, 2016.

Participant – Multiple NEIs, but comfort was the largest component

Method Used to Determine Values: The study authors used multiple sources of data to assess NEIs deriving from two specific programs: Home Energy Solutions (HES, assessment, a few core services such as faucet aerators and air sealing for a nominal fee and recommendations for add-on measures to achieve deeper savings) and Home Energy Solutions-Income Eligible (HES-IE, same program, but no co-pay and different add-on measures). They deployed surveys of participants and nonparticipants as well as vendor and multifamily landlord interviews. They reviewed program documents and performed benchmarking of the values.

Range of Values: $0.87/dollar saved on energy costs for HES, $0.90/dollar saved on energy costs for HES-IE, and $0.73/dollar saved on energy costs for HES-IE landlords and property manager participants. This value covers multiple NEIs.

Values Applicable to: Participants in these two programs.

Application of Values: Multiply the value by the household energy savings.

Using this Information: The values are specific to the two underlying programs and should not be transferred directly. However, the study provides the magnitude of additional benefits (e.g., $155.6 million for the HES program) and is a method that could be transferred.

T. Ohio. 2009. Finding and Order in the Matter of Protocols for the Measurement and Verification of Energy Efficiency and Peak Demand Reduction Measures. Case No. 09-512-GE-UNC

Utility – Avoided Ancillary Services

Method Used to Determine Values: Algorithm using available costs for ancillary services and energy market purchases found in the annual market report for PJM (see Rutgers 2018 for link to this current report).

Range of Values: 2%-4% of energy costs

Values Applicable to: PJM and MISO participants, although this value is old and others may have superseded the specific values.

Application of Values: Applicable to all ancillary services that could be displaced or reduced in volume by energy efficiency measures. Compute the ratio of ancillary service (sum of all revenues of ancillary services) to energy market purchases (sum of all energy revenues).

Using this Information: Before using this as an NEI, a jurisdiction needs to check that the values are not already embedded within the energy costs. The method is easy to use, but it is specific to jurisdictions in PJM or MISO.

U. Peregrine Energy Group. 2016. Analysis of Job Creation from 2015 Energy Efficiency in Rhode Island by National Grid. Also see http://www.ripuc.org/eventsactions/docket/4600A-DIV-DraftRept-FrameworkMethodology(10-3-18).pdf.

Societal – Economic Development and Job Creation

Method Used to Determine Values: Estimation of the direct job impacts of National Grid's energy efficiency programs and services delivered to RI electricity and natural gas customers in 2015. Methodology included (1) Interviews with managers at energy services companies, equipment vendors, and contractors or identified as sub-contractors. These companies voluntarily shared information on how they staff their contracts and services and even researched payroll records to provide FTE counts; (2) Detailed reviews of National Grid's records of all energy efficiency measures installed in homes, apartment buildings, businesses and industrial facilities throughout RI in 2015; and (3) Calculations of typical labor hours required for each installed energy savings measure, based on industry standards and discussions with the contractors themselves and other experts, and extrapolations of total FTE employment using total counts of measures installed in 2015.

Range of Values: Vary with program, ranging from 0.2 FTEs for a residential ENERGY STAR HVAC program to 147 FTEs for a C&I retrofit program. Including National Grid energy efficiency staff, total for 2015 is 695.8 FTEs.

Values Applicable to: The energy efficiency programs implemented by National Grid in RI for 2015.

Application of Values: A subsequent study using REMI modeling produced multipliers to monetize net job creation for inclusion as a benefit (see National Grid 2014).

Using this Information: Job creation impacts vary with the nature of the programs (labor intensive vs. capital intensive) and the nature of the baseline employment mix in the territory. This study gives a sense of possible impacts.

Using this Information: Users can compare the effective useful lifetimes of the efficient and standard/baseline measures and multiply the costs of replacement bulbs and labor for the avoided replacements over the difference.

V. RTF Staff. 2014. Preliminary Report: Quantifying the Health Benefits of Reduced Wood Smoke from Energy Efficiency Programs in the Pacific Northwest.

This study drew on a screening level assessment that provided estimated public health benefits from reducing wood smoke emissions ($PM_{2.5}$) across different scenarios where the emissions were reduced by 25%, 50%, 75% and 100%. Using this information, staff narrowed the scope to describe "the RTF Staff investigation into the feasibility of capturing, attributing, and monetizing health effects associated with a ductless heat pump (DHP) program. The primary objective is to better understand whether human health benefits (or costs) resulting from an energy efficiency measure can be isolated and quantified given the current state of the science. Using a DHP program as an example, this report investigates the technical underpinnings the quantification method used by air regulators, identifies the data requirements needed to perform an analysis, and describes the uncertainties around the data, analysis, and results."

Societal – Public Health

Method Used to Determine Values: Study authors drew on multiple sources through a four-step process to model savings. Specifically, they (1) quantified emission changes due to an initiative on ductless heat pumps, (2) performed dispersion modeling to determine geographic area where smoke would be reduced, (3) estimated the health effects, and (4) monetized those health effects.

Range of Values: Table 22 shows the monetary health benefits per kWh for a low ($0.02/kWh) and high ($0.24/kWh) estimate of health benefits.

Values Applicable to: A hypothetical situation of installing ductless heat pumps within the Pacific Northwest.

Application of Values: The low and high values show a possible order of magnitude for a program that saves 1,255 GWh.

Using this Information: For the purpose of informing potential health effects, reduction in wood use cannot be generalized across efficiency programs. Dedicated studies for different groups of measures or programs are required to estimate measure-specific or program-specific wood smoke reductions. This study provides a detailed example of critical steps in the Co-Benefits Risk Assessment (COBRA) mortality calculations for a hypothetical policy objective to help others understand what the COBRA outputs mean and how to interpret the epidemiological results.

W. Rutgers. 2018. Energy Efficiency Cost-Benefit Analysis Avoided Cost Assumptions.

Utility – Avoided RPS Compliance Costs

Method Used to Determine Values: Memo authors used different documents to project the additional cost that solar renewable energy credits (SRECs) and renewable energy credits (RECs) add to the wholesale cost of energy based upon current REC and SREC prices, projections of the levelized cost of electricity, and the wholesale energy and capacity revenue that wind and solar earn.

Range of Values: Varies by year (e.g., 2019 is $14.56/MWh while 2021 is $9.04/MWh).

Values Applicable to: The energy efficiency programs implemented by utilities in New Jersey.

Application of Values: Not specifically stated but assume that the renewable energy adder ($/MWh) is multiplied by the energy efficiency program electric savings and considered as a reduction in the adder cost.

Using this Information: The method appears to be transferrable to other jurisdictions, but this memo does not clearly lay out exactly how the authors did their projections.

Utility – Avoided Ancillary Services

Method Used to Determine Values: Looked up value in a document on PJM State of the Market (available for free).

Range of Values: Varies by year – shown as $0.96/MWh for 2016 and a later document shows $1.04 for 2019.

Values Applicable to: Utilities in the PJM service territory.

Application of Values: Added to the wholesale electricity prices.

Using this Information: This is an easy to use and find value.

X. Schwartz, Peter, Brian Gerke, Jennifer Potter, Alastair Robinson, David Jagger, Kelly Sanders, Yao-Jung Wen, Jasmine Shepard, Teddy Kisch. 2019. Lawrence Berkeley National Laboratory. The Value Proposition for Cost-Effective, DR-Enabling, Nonresidential Lighting System Retrofits in California Buildings. California Energy Commission. Publication Number: CEC-500-2019-041.

Participant – Productivity – O&M

Method Used to Determine Values: Collected and analyzed multiple other studies that quantified specific savings, generally data from manufacturer case studies.

Range of Values: \$0.54-\$8.87 \$/ft^2 with a median value of \$5.61/ft^2 for office space

Values Applicable to: The savings are specific to use of networked lighting controls in offices. There is an accompanying Excel spreadsheet with values for offices, retail and warehouses.

Application of Values: Multiply the value by the square foot of space that has the demand response enabled networked lighting control (NLC) system. These values are stated to be from the increased building value through improved operating income from lowered energy and maintenance costs.

Using this Information: The values can be transferred as provided but with caution to ensure that the NLC that the NEI is applied to meet similar criteria as described in the document. Also, the study authors noted that "An important caveat is that while NLC systems certainly have the potential to yield cost savings beyond energy, it is uncertain what fraction of building owners or facility managers actually use the systems to their full potential to capture this value."

Y. Skumatz Economic Research Associates, Inc. (SERA). 2014. Non-energy Benefits / Non-energy Impacts (NEBs/NEIs) and their Role & Values in Cost-Effectiveness Tests: State of Maryland.

Various NEIs for Utility, Societal and Participant perspectives

Method Used to Determine Values: The study authors reviewed more than 20 studies on weatherization programs where the studies focused on programs that include low-income, non-low-income, and multifamily customers.

Range of Values: Figure 3.4 in the study is a large list of multiple NEIs across all three perspectives (utility, societal and participant). We do not recreate this list here, but others are encouraged to review the study to see all values. Examples are \$0.50-\$3.75/household for utility bad debt write-offs, \$8.00-\$34.00/household for societal economic benefits, and \$8.00-\$43.00 for participant maintenance benefits. The list includes percentage values as well for each NEI that a multiplier for the dollar value of kWh saved.

Values Applicable to: Weatherization programs.

Application of Values: A jurisdiction will need to review the NEIs and choose either a low, high or typical value to apply to the number of households in their weatherization programs.

Using this Information: Because the values derive from multiple studies with ranges available, the NEI values included in this study appear to be transferrable as provided, although a jurisdiction will need to review and choose specific magnitudes of those values.

Z. Synapse Energy Economics et al. 2018a. Avoided Energy Supply Components in New England: 2018 Report.

This study is completed annually, and six different New England states use the outputs (MA, RI, VT, NH, CT, ME). While the main outputs of the study cover avoided costs used outside of NEIs, there are a few utility system NEIs that we describe below. The study has significant detail regarding each of the energy supply components (i.e., avoided energy and natural gas costs, fuel oil and other fuel costs, avoided capacity costs, and transmission & distribution, in addition to the three components indicated below).

Utility – Avoided RPS Compliance Costs

Method Used to Determine Values: Analysis of Renewable Energy Credit (REC) prices and RPS target percentages specific to each state to derive the expected impact of avoiding each tier (or class) of the RPS.

Range of Values: $0.51-$4.94/MWh

Values Applicable to: The energy efficiency programs in MA, RI, VT, NH, CT and ME.

Application of Values: The study authors multiplied the price of a REC ($/MWh) by the quantity of RECs (MWh) purchased.

Using this Information: Because the RPS costs (purchases through RECs) are based on customer usage, reduction in usage from energy efficiency programs mean that a utility can procure fewer RECs. While the description above is relatively straightforward, there are many details that the study authors took into account in their analysis. Interested parties should review the original document to better understand forecasting and other RPS details.

Societal – Non-embedded Environmental Costs

For this NEI, study authors estimated environmental impacts that impose damages on society that are not already embedded in energy prices specific to two categories: the non-embedded portion of GHG impacts and the costs of NOx emissions. For the Northeast states, costs associated with RGGI, SO_2 regulation programs, and the MA 310 CMR 7.74 regulation (that sets limits on CO_2 emissions by large power plants) are already included in the avoided costs.

Method Used to Determine Values: For the non-embedded GHG impacts, study authors analyzed the marginal cost of abatement where the marginal abatement technology was offshore wind displacing gas-fired generation. For NOx, study authors took the median value of the published cost per short ton of nitrogen from a nationwide study ($31,000/short ton), assumed a 50/50 mixture of NO and NO_2 in emissions, and used the emission rates for a new natural gas-fired combustion turbine power plant to derive the wholesale avoided cost for NOx.

Range of Values: $0.075/kWh-$0.076/kWh (a 15 year levelized cost using a cost of $174/short ton of CO_2) for non-embedded GHG impacts and $1.65 per MWh as the avoided cost of NOx. Table 156 includes the non-embedded CO_2 costs for non-electric fuels (in $/MMBtu that ranged from $10.18 for natural gas to $14.01 for distillate fuel oil).

Values Applicable to: The energy efficiency programs in MA, RI, VT, NH, CT and ME.

Application of Values: Multiply cost per kWh per year by the total program kWh savings for non-embedded GHG impacts and the NOx cost per MWh by the total program MWh savings.

Using this Information: Applying the non-embedded GHG impacts from this study is very specific to the Northeast and not transferable, although the study method (of choosing an abatement technology and comparing to the displaced technology) is very transferable. Likewise, the NOx value may not be applicable if a local jurisdiction does not use natural gas-fired combustion turbine power plants, but the median value of the cost per short ton of nitrogen appears transferable given the nationwide values (note that this study's authors brought the nitrogen costs up to 2018 dollars from the dollars provided in the nationwide study).

Utility – Energy and/or Capacity Price Suppression Effects (DRIPE)

Method Used to Determine Values: Regression analysis (natural gas and electric energy DRIPE), equilibrium analysis (electric capacity DRIPE), publicly available records, literature review

Range of Values: The study describes multiple DRIPE values and gives a few examples of specific values that we do not copy over. The multiple values are for Capacity DRIPE (cleared and uncleared capacity), electric energy DRIPE (for the four periods of winter and summer peak and off peak), natural gas DRIPE (from gas supply and for gas to electric cross DRIPE), and oil DRIPE. The executive summary shows illustrative examples of $0.91/kWh for capacity DRIPE and $1.91/kWh for energy DRIPE for summer peak periods.

Values Applicable to: Northeast states in the analysis.

Application of Values: Appendix J in the study provides the step-by-step instructions for calculating the benefits of uncleared capacity and uncleared capacity DRIPE; others are a more straightforward multiplication of the DRIPE value by energy saved.

Using this Information: The description above is limited, and there are many details that the study authors took into account in their analysis. Interested parties should review the original document to better understand assumptions made on hedging, decay, price elasticity, forecasting and other DRIPE details.

Utility – Reliability

Method Used to Determine Values: Literature review, publicly available records on T&D outages, and detailed analysis. The study based the reliability NEI on the Value of Lost Load, the New England Forward Capacity Auction values, and the marginal reliability index (change in loss of energy expectation in MWh, for each additional MW of available capacity or reserve margin).

Range of Values: A 15 year levelized benefit of $0.65/kW-year for "cleared resources" and $6.60/kW-year for "uncleared load reductions" where a cleared resource means that "the quantity supplied (offered) has been matched to the quantity demanded (bid), the amount to be bought and sold has been determined, and settlement between buyers and sellers is possible."[17]

Values Applicable to: New England states within the study.

Application of Values: The study includes lookup tables for specific values to apply (Table 98 for cleared load reductions and Table 99 for uncleared load reductions).

Using this Information: This study describes how the NEI is calculated and the method could be used within a different region, but the specific inputs are tied to New England generation and should not be applied elsewhere. The description above is limited, and there are many details that the study authors took into account in their analysis. Interested parties should review the original document for this NEI.

AA. Tetra Tech. 2012. Massachusetts Program Administrators Commercial and Industrial Non-Energy Impact Study. June 29, 2012.

This study grouped several possible NEIs into a single value that we label O&M and separated this NEI into measure-specific per-unit values. Specifically, the NEI included administration costs, material movement, other costs, other labor, O&M, product spoilage and waste disposal. The report provides significantly more detail than what we include below, and we encourage interested parties to closely review this document.

Participant – Productivity - O&M

Method Used to Determine Values: The study authors conducted semi-structured telephone interviews with participants who had previously responded to a free ridership / spillover survey, as well as supplementing their research with information from nonrespondents. The sample design targeted prescriptive and custom program participants and was measure specific by fuel type. The study report does not provide the exact number of customers that eventually answered the NEI questions but does provide responses based on measure type from 788 electric and gas measures installed by both prescriptive and customer program participants. Interviews included open-ended questions, and the study authors followed a detailed coding scheme to clearly categorize these responses and described how authors derived monetized results.

Range of Values: NEI values varied by program and measure type, so we do not list them all there, but Table 5-1 in the study shows a range of NEI values for electric measures from $0.0038/kWh (for custom "other" measures) to $0.0966/kWh (for prescriptive HVAC measures). Additionally, custom combined heat and power/cogen had a negative NEI of -$0.0147/kWh. Gas measure values ranged from $0.2291/therm (custom HVAC measures) to $3.6151/therm (prescriptive building envelope measures).

[17] Definition for "cleared" from https://www.iso-ne.com/participate/support/glossary-acronyms/#c.

Table 5-1 provides the confidence levels of the NEIs, and the study authors did not recommend use of any NEI that was not statistically significant. The study provided specific NEI values by building use (see tables 4-8, 4-13, 4-18 and 4-23). The most recent TRM for MA shows application of information from Table 5-1 only for the prescriptive and custom program measures of lighting (electric NEI) and building envelope and HVAC (gas NEIs).

Values Applicable to: Prescriptive and customer retrofit measures installed by commercial or industrial customers.

Application of Values: Multiply the NEI value by the measure category saving by fuel type.

Using this Information: The labor cost values that the study authors used to monetize the NEI were specific to MA and could be higher than in other states. Additionally, the NEI values in this study reflect the underlying mix of measures, so if that mix substantially changes, the NEI values may be less applicable.

Appendix B: Study Approach

This report is based on a literature review of existing information. Since the 1990s, consulting firms such as Cadmus, DNV GL, E3, Itron, NMR, Skumatz Economic Research Associates, Synapse Energy Economics, Tetra Tech, and others have completed numerous NEI studies. Berkeley Lab has published many studies on avoided costs and cost-effectiveness testing for utility energy efficiency programs, as well as NEIs.

This report includes a broad, but not exhaustive, sample of these studies. Specifically, our research relied on the NEI categories identified in the DSESP.

The database indicates which cost-effectiveness tests and discount rates each state uses and provides references for sources of impact values and related policies, as well as other relevant guidance documents. The 30 states included in the DSESP database as of March 2019 bounded our research. The DSESP references were the starting point for our data collection and analysis. We made no concerted effort to go beyond the NEIs listed in the DSESP, although we found a few additional impacts as we collected information (e.g., rate discounts, avoided safety-related emergency calls). We gathered over 100 documents, many that were PUC and legislative background documents supporting NEI inclusion for these 30 jurisdictions. Of these documents, we identified 27 documents that quantify impacts (see Appendix A) in a manner that could allow for transfer of their NEI calculation methods or values to other jurisdictions.