Non-Energy Benefits:

Values and treatment in cost-effectiveness testing--single and multifamily whole-home energy efficiency programs

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TESTIMONY OF LISA A. SKUMATZ

ON BEHALF OF E4TheFuture

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Q: Please state your name, title, and business address.

A: Dr. Lisa A. Skumatz, Principal, Skumatz Economic Research Associates, 762 Eldorado Drive, Superior, CO 80027.

Q: What is the purpose of your testimony?

A: I was asked to provide testimony on non-energy benefits values and treatment in cost-effectiveness testing in residential single and multifamily whole-home programs.

Q: On whose behalf are you testifying?

A: I am testifying on behalf of the E4TheFuture.

Q: What are your Qualifications?

A: I have 35 years of experience in energy efficiency program evaluation, 21 years of experience in non-energy benefits and cost-effectiveness tests, have conducted more than 200 energy efficiency projects, and have published more than 125 much-cited articles in peer-reviewed, conferences, or trade journals (more than 50 in non-energy benefits). Methods I developed in non-energy benefits (NEBs) and in measure lifetimes analyses have been adopted as state of the art and the estimated useful lifetime (EUL) approaches have been incorporated into protocols around the country. My previous work experience includes DOE National Laboratory (5 years); PG&E Utility (3 years); Consultant, in increasing levels of responsibility (25 years), and non-profit work.

Q: Which case-related documents have you read?

A: I have not reviewed any case documents. The bulk of my testimony relates to Non-energy benefits, and benefit-cost and cost-effectiveness tests and methods work I have conducted over the years in energy efficiency.

Q: What are current practices in cost-effectiveness tests and in applying NEBs and their elements to cost-effectiveness tests and earnings computations for programs?

Non-energy benefits (NEBs) are the wide variety of positive and negative effects beyond energy savings that are delivered to utilities, participants, and society as a consequence of delivering

energy efficiency programs and measures. The historical approach to program, measure, and portfolio benefit-cost screening omitted these effects – even though economic theory would tend to include them -- because they were harder to measure than energy savings, and they were not generally the primary program goal. However, omitting impacts (positive or negative) biases decision-making, and runs the risk of misallocating public funds. There is now 20-plus years of literature estimating NEBs, and more than a dozen states around North America incorporate some subsets of NEBs as adders, direct estimates, or hybridized approaches in their screening processes.

There are a number of factors that enter into traditional computations for cost-effectiveness tests. These include various categories of costs and benefits (usually valued energy savings; see Figure 1 below), and these are modified by factors related to measure lifetimes and discount rates.[1] Savings estimates are traditionally derived from billing analyses or M&V approaches; costs come from a variety of sources. Measure lifetimes come from adopted tables. Savings benefits are often modified by net-to-gross (NTG) ratios, so the savings can be considered "attributable" to the program. The values for NTG that are used sometimes include free ridership alone, sometimes include spillover, and occasionally include market effects. In some cases, the values are "deemed", rather than measured using evaluation techniques for each individual program or program year, with a value usually set within the range of 0.9 to 1. One place in which low income programs are sometimes treated differently is that their NTG ratio is almost always assumed to be "1"; it is usually assumed that there are no free riders in the low income sector, as the customers are assumed to be relatively less likely than other customers to invest in efficient equipment and upgrades without the program's assistance.

I have also conducted work on the status of, and proposed refinements to, major cost-effectiveness tests. The most commonly-used tests are outlined in Figure 1 (rows 1-5). From an economic and evaluation perspective, benefit-cost tests would be expected to include best estimates of the attributable costs and benefits, in order to provide an unbiased basis for decision-making. The

[1] The discount rate used should reflect the risk associated with the investment. WACC reflects investment in power plants and utility; the appropriate discount rate for energy efficiency programs should be closer to the social discount rate or toward treasury returns, depending on the conditions. See Skumatz IEPEC 2015 and forthcoming Skumatz, *Electricity Journal*, 2015.

most commonly-used benefit-cost tests, with a few exceptions (e.g. the UCT), tend to include all costs but not all the (net) benefits related to the perspective the test is meant to reflect. The presumption is that when protocols were established, the formulae provided space for consideration of costs and benefits that were known and measurable at the time. However, the better and more adaptable approach would have been to explicitly include the missing elements in the formulae in order not to specify a test that "locked in" bias in the metric. Omitted from the equations, the formulae have been interpreted to incorporate the assumption of a value of zero for these omitted (and unspecified) impacts and additional benefits.

The focus of my research for more than 20 years has been to: 1) develop best estimation techniques for these omitted effects –positive and negative omitted non-energy benefits (NEBs), 2) conduct research work to estimate values for the range of NEBs, and 3) research approaches to cost-benefit tests that reduce bias. My work particularly relates to the potential inclusion of various elements of non-energy benefits as a way of reducing bias in existing tests that currently include all costs, but not all benefits.

The first three columns of Figure 1 review the major categories of costs and benefits included in the tests. The next column is a summary (from a few years ago) of the states that use the test in a screening or cost-effectiveness role. The traditional tests are numbered 1-5.

Figure 1: Summary of Benefit-Cost Tests and Potential NEB-Based Updates[2]

Test	Benefits	Costs	States Using Traditionally	Improved treat-ment with NEBs
1. Utility Cost (or Program Administrator Test) (UCT or PAC)	• Avoided supply costs for transmission, distribution, and generation (TD&G) • Avoided gas and water supply costs	• Program administration • Participant incentives • Increased supply cost	CA, CT, HI, IA, IL, IN, MI, MN, MO, NY, OR, RI, TX, VA, WA, BPA	Use cost only paid by the utility
2.Ratepayer Impact Measure	Same as above plus • increased revenue	Same as above plus • Decreased	AR, CO, FL, GA, HI, IA, IN, MI,	

[2] Source: Skumatz, "Non-Energy Benefits / Non-Energy Impacts (NEBs/NEIs): Status and Recommendations on Measurement, Values, and Treatment in Cost-Effectiveness Testing for the State of Maryland", Prepared for NRDC, March 2014; table research mostly conducted 2009-2012.

Test	Benefits	Costs	States Using Traditionally	Improved treat-ment with NEBs
(RIM) (or No Loser's Test, or non-participants test)		revenue	MN, NC, ND, NV, SC, VA, WI	
3.Participant cost	• Utility bill reductions • Participant incentives	• Participant direct costs	AR, CA, FL, HI, IA, IN, MI, MN, NY, VA	Participant NEBs
4.Total Resource Cost (TRC)	• Avoided supply costs for TD&G • Avoided gas and water supply costs • Utility bill reductions	• Program administration • Participant incentives • Participant direct costs • Increases supply costs • Decreased revenue	AR, CA, CT, CO, GA, HI, IA, ID, IN, MA, ME, MI, MO, MT, NH, NJ, NV, NY, RI, SC, UT, VA, WA	Include all participant and utility NEBs; (costs are already included);[3]
5.Societal / Societal Cost Test (SCT)	Same as above plus • Externality benefits (reduced pollution, improved reliability, etc.)	Same as above	AZ, IA, ME, MN, MO, MT, NJ, OR, VT, WI	Include all NEBs – utility, societal, and participant NEBs valued (already generally includes all costs)

Q: Are any states including NEBs in their benefit cost or cost-effectiveness calculations?

A: Yes. The number and method continues to change, as more states incorporate NEBs into their assessment processes.[4] A list from a few years ago follows in Table 2. The status is, of course, constantly changing; note that several others, including Maryland recently began to consider NEBs in its process. Regulators prefer simple rules, and states that are examining this issue are taking one of several tacks:

- Incorporating a simple, conservative "adder" to the benefits. Most of these adders are serving as proxies to incorporate factors related to omitted environmental or emissions effects, or as a placeholder for a broader set of NEBs. Some include separate values for gas vs. electric measures, and for low income programs. Most of the current values adopted by states range from 7.5% to 30%

[3] consistent alternative is to exclude all NEBs and costs associated with achieving them are excluded; former is easier

[4] Skumatz, Lisa A., Ph.D., "NEB Values for Single and Multi-family Whole Building Retrofit Programs and The Issue of Measure-Based NEBs", Skumatz Economic Research Associates, Inc., prepared for E4TheFuture, September 2015.

- Incorporating "easy to measure" NEBs to the benefits. Several states are adopting this flexible approach – with the "easy to measure" benefits varying depending on the program (e.g. water bill savings from clothes washer programs, etc.).
- Trying to measure / include all NEBs, or the leading from among several dozen NEBs, or
- A hybrid approach, using an adder plus measuring either easy-to-measure benefits, or as many benefits as possible outside of what is included in the adder.

Figure 2: Comparison of NEBs Treatment in Regulatory Environment, for a Sample of States *(Source: Skumatz et. al., 2009, updated)*[5], [6]

Regulatory / Screening Application	Examples of Utilities / regions
Program Marketing	Fairly widespread use in utilities / states across the country
Test / Program Screen – adder	IA, CO, OR, WA, VT, DC, NY, NW,
Test / Program Screen - readily measured	MA, CA, VT, CO, NH, BCHydro, DC, RI
Test / Hybrid (potential adder & measured)	CO, OR, DC, VT
Test / Program screen – Broader	With quantification: MA, RI.

Q: Have you researched NEBs for Whole Building or Weatherization / Retrofit Programs for the residential Sector? Do the results have relevance for New York?

A: Yes. In work for several clients, (Skumatz 2014[7], and 2014b[8] and other studies), we identified the ranges for NEBs for single family weatherization programs. These analyses are summarized in Figure 3. The review of the various categories of NEBs indicates:

- **Utility NEBs** are a minority of the estimated NEBs values (perhaps 3-4% of total NEB values estimated). Although very important, not all categories have been estimated (there

[5] Skumatz, Lisa A., "Non-Energy Benefits / Non-Energy Impacts (NEBs/NEIs) and their Role & Values in Cost-Effectiveness Tests: State of Colorado", Skumatz Economic Research Associates, prepared for Energy Outreach, April 2014.

[6] Malmgren and Skumatz, "Lessons from the Field: Practical Applications for Incorporating Non-Energy Benefits into Cost-Effectiveness Screening, *Proceedings of the 2014 ACEEE Summer Study on Buildings, Asilomar CA, August 2014.*

[7] Skumatz, Lisa A., Ph.D., "Non-Energy Benefits / Non-Energy Impacts (NEBs/NEIs) and their Role & Values in Cost-Effectiveness Tests: State of Maryland", March 2014.

[8] Skumatz, Lisa A., "Non-Energy Benefits / Non-Energy Impacts (NEBs/NEIs) and their Role & Values in Cost-Effectiveness Tests: State of Colorado", Skumatz Economic Research Associates, prepared for Energy Outreach, April 2014.

is only limited work on power quality / reliability / security, etc.). I do not further address these NEBs in this testimony because they are relatively small.

- **Societal perspective NEBs**: These NEBs are dominated (in estimates to date) by economic and emissions impacts. Emissions impacts are addressed elsewhere in New York' TRM.[9] Economic impacts are the major category remaining, and the estimates are highly dependent on the measures included in the program, and the industries located within the utility's territory – they are location and program measure dependent. This limits: 1) transferability from other studies conducted in other communities, and 2) limits transferability between programs, because measures drive the savings.[10]
- **Participant NEBs**: Participant NEBs are substantial. For building-wide programs, it is not uncommon for participant NEBs to be valued as equal to or greater than the bill savings, leading to a potentially significant change in the B/C ratio when included.

A review of Figure 3 shows that the "typical value" column for percentages (fifth column heading) shows the following approximate NEB multipliers[11]:

- Utility NEBs: About 24%, but excluding low income factors, the remainder is about 8%,
- Societal NEBs: about 55%, with the largest share economics (31%) and emissions about 7% (treated elsewhere for New York).
- Participant NEBs: About 144% of the value of household bill savings.

[9] Note that New York TRM actually addresses the carbon impacts. There are other emission impacts, and these presumably also have value, but few of the published studies (including the author's) have been able to identify strong market values to use for some of the additional emissions. Therefore, for this document, we omit further consideration of these impacts. For further discussion of the state of the literature on this issues, see Skumatz 2014 (Skumatz, Lisa A., Ph.D., "Non-Energy Benefits / Non-Energy Impacts (NEBs/NEIs) and their Role & Values in Cost-Effectiveness Tests: State of Maryland", Skumatz Economic Research Associates, prepared for NRDC, March 2014). and Skumatz et. al. 2009, "Lessons Learned and Next Steps in Energy Efficiency Measurement and Attribution: Energy Savings, Net to Gross, Non-Energy Benefits, and Persistence of Energy Efficiency Behavior", Skumatz Economic Research Associates, Prepared for CIEE, November.

[10] Skumatz, Lisa A., Ph.D., 2006. "Net NEB Multipliers for NEB Impacts – Do Multipliers Vary Significantly by State and Program Type?", Proceedings of the ACEEE Summer Study on Buildings, Asilomar, CA, August. And Imbierowicz, Karen, and Lisa A. Skumatz, Ph.D., "The Most Volatile Benefits (NEBs) – New Research 'Homing in; on Values for Environmental and Economic Impacts", Proceedings of the 2004 ACEEE Summer Study on Buildings, Asilomar, CA, August. The study used input output modeling to demonstrate the highly differential multiplier impacts of two different efficient programs in three different job-mix states. The study showed how much the local economic / job mix matters, and how varying the NEBs from different programs can be.

[11] Multipliers for utility and societal NEBs may be calculated relative to either retail or other savings-based values, depending on the study's method; participant NEBs are usually calculated as a multiple of customer bill savings (retail).

For New York, generally, if we applied these "typical" values, the total NEBs would be about 183% (8%+31%+144%), excluding factors related to water and emissions. About 76% of the multiplier comes from participant NEBs.

Figure 3: Summary of Ranges and "Typical" Values for NEBs for Weatherization / Retrofit Programs [12]

Note: Relative consistency indicator: ** low variation / relative consistency across programs; * low variation / relative consistency within program types; ~somewhat consistent; Variations by program, target audience, or limited variation by program are noted in the last column.

Subtotals by major categories Weatherization Programs	Dollar NEB Values Range Low-High	Typical Value	Percentage NEB Values Range Low-High	Typical Value	Consis- tency	Varies with Pgm Target Audience, et
UTILITY PERSPECTIVE						
Payment-related	$2.55 - $14.50	$6.40	1% - 14.5%	4.7%	*	Pgm
Added if Low Income subsidies avoided	$3.00 - $25.00	$13.00	4% - 29.0%	16.4%	*	Pgm & target
Service Related	$0.10 - $8.50	$3.25	0.1% - 2.7%	0.8%	*	Pgm
Other Primary Utility	$0.13 - $2.60	$1.40	2.1% - 3.3%	2.4%		
TOTAL UTILITY NEBs	$5.78 - $50.60	$24.05	7.4% - 49.5%	24.4%		
UTILITY NEBs MULTIPLIER	3% - 25%	12%				
SOCIETAL PERSPECTIVE						
Economic	$8.00 - $340.00	$115.00	3.0% - 237.6%	31.1%	*	Pgm
Environmental / Emissions	$3.00 - $180.00	$60.00	0.7% - 57.9%	7.1%	**	Ltd variation
H&S equipment / fires	$0.00 - $0.30	$0.00	0.3% - 0.3%	0.0%		Pgm
Health Care	$0.00 - $0.00	$0.00	0.0% - 0.0%	0.0%		Pgm
Water / Wastewater infrastructure	$1.00 - $28.00	$15.00	0.9% - 33.1%	17.0%		Pgm
TOTAL SOCIETAL NEBs	$12.00 - $548.30	$190.00	5.0% - 329.0%	55.3%		
SOCIETAL NEBs MULTIPLIER	6% - 274%	95%				
PARTICIPANT PERSPECTIVE						
Water and Other bills	$2.85 - $54.00	$15.00	4.5% - 63.4%	20.0%	*	Pgm
Financial / customer service	$0.27 - $36.70	$3.60	8.7% - 16.4%	3.4%	*	Pgm & target
Economic Dev'p / Hardship	$0.00 - $115.00	$75.00	26.3% - 55.3%	8.0%		Pgm & target
Equipment Operations	$26.00 - $127.00	$82.00	17.1% - 42.7%	28.4%		Pgm
Comfort, Noise, Related	$26.00 - $105.00	$69.00	12.2% - 51.3%	26.6%	*	Pgm
Health / Safety	$3.02 - $100.50	$16.50	1.5% - 59.5%	12.8%	*	Pgm
Control / Education and Contributions	$26.25 - $177.00	$89.75	19.8% - 72.0%	26.2%	*	Pgm
Home Improvements	$10.50 - $77.00	$36.00	8.3% - 38.4%	18.8%	~	Pgm
Special / reliability / other	$0.00 - $4.05	$0.00	0.0% - 4.8%	0.0%		Ltd, target
TOTAL PARTICIPANT NEBs	$94.89 - $796.25	$386.85	98.5% - 403.8%	144.1%		
PARTICIPANT NEBs MULTIPLIER	47% - 398%	193%				
All NEBs Multipliers: **Relative to Bill Savings**						
Utillity	3% - 25%	12%	7% - 49%	24%		
Societal	6% - 274%	95%	5% - 329%	55%		
Participant	47% - 398%	193%	99% - 404%	144%		
ALL Multiplers - relative to bill savings	56% - 698%	300%	111% - 782%	224%		
NOTE: Ltd variation for emissions are for peak / off-peak focused programs.						

Source: Skumatz, 2014.

[12] From Skumatz, Lisa A., Ph.D., "Non-Energy Benefits / Non-Energy Impacts (NEBs/NEIs) and their Role & Values in Cost-Effectiveness Tests: State of Maryland", March 2014. Minor edits included here.

To provide additional information on the size of participant NEBs for single-family weatherization programs, we provide the distribution of participant NEBs for two specific states in the following figure – for single family weatherization programs in Oregon and New York.

Figure 4: Participant NEB Values from SF Programs in Oregon and New York

Oregon[13]	New York[14]
Participant NEB shares – Share of the Total energy savings bill multiplier of 1.02.	Participant NEB shares – Total energy savings bill multiplier = 1.20
Comfort, lifetime & performance of equipment = 39%	Comfort, Lifetime of equipment = 32% of NEB multiplier
Improved housing value / ease of sale / aesthetics / equipment performance = 18%	Improved housing value / ease of sale = 32% of NEB multiplier
Health-related NEBs = 2%	Health-related NEBs = 20% of the NEB multiplier
Education / Control of energy-use / ability to avoid moving NEBs =24%	Education / Control of energy-use NEBs = 26% of NEB multiplier
Other = 16%	
1.02 total participant NEBs multiplier	1.20 total participant NEBs multiplier

These two examples are generally consistent with Figure 3, but also show that participant NEBs can often have a value about equal to the value of the energy savings. This means that benefit cost analyses excluding these NEBs are about half of what they should be. The NEBs approximately double the "benefits" and the value of the associated benefit-cost ratio.

Q: Are there NEB results in the literature for Multifamily programs, for gas vs. electric programs, or for specific measures?

A targeted literature review was conducted to identify the state of the art on these topics. We found the following.

Single- and multi-family NEBs Quantification: The literature on NEBs for single family (low income and standard) is fairly robust and has been recently summarized[15]; information on the

[13] Skumatz Lisa A., Ph.D., and David Freeman, "2010-2011 Energy Trust of Oregon Existing Homes Program – Process Evaluation", December 2012.
[14] Skumatz, Lisa A, "Non-Energy Benefits (NEBs) Valuation for Home Performance with Energy Star ™ Program", prepared for ACEEE EPA, and NYSERDA, February 2007.

multifamily sector is scarcer. We identified fewer than half a dozen studies, and few had hard estimates of NEBs overall or by category. We focused on three studies[16] (Skumatz 2010 for Xcel Energy; NMR 2011 for Massachusetts, and Cluett and Amann for ACEEE, 2015) and drew inferences to the sector based on comparisons. Note that the multifamily programs that have been analyzed are mostly low income programs; however, we have calculated ratios or deleted benefit categories specifically associated with low income in our analysis underlying this testimony.

MultiFamily owners / managers vs. occupants: We were able to readily identify and analyze one study that included benefits to multifamily owners (Skumatz 2010, low income). This study allowed us to cross-compare NEB results for MF renters, MF owners, and single family households for similar programs to determine the extent to which results were similar and potentially transferable.

Gas vs. Electric NEBs: In a recent review, we found only a few studies that explicitly identified the NEBs for gas vs. electric participants[17]. Most studies seem to study program-wide savings across gas and electricity, perhaps because NEB studies are combined with broader process evaluations that sample for other goals.

NEBs for Individual Measures: There is minimal information on NEBs for individual measures in the residential sector, because most programs "bundle" measures within programs. The exception is the occasional air conditioning program, programs measuring NEBs for EnergyStar™ appliances or some work in lighting. We found two studies attempting decomposition or assignment of program-wide NEBs to individual measures (Smith-McClain,

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[15] Skumatz, Lisa A., Ph.D., "Non-Energy Benefits / Non-Energy Impacts (NEBs/NEIs) and their Role & Values in Cost-Effectiveness Tests: State of Maryland", March 2014.

[16] Skumatz, Lisa A., Ph.D., 2010, "Non-Energy Benefits Analysis for Xcel Energy's Low Income Energy Efficiency Programs", May; NMR Group, 2011, "Massachusetts Special and Cross-Sector Studies Area, Residential, and Low Income Non-Energy Impacts (NEI) Evaluation (http://www.rieermc.ri.gov/documents/evaluationstudies/2011/Tetra_Tech_and_NMR_2011_MA_Res_and_LI_NEI_Evaluation%2876%29.pdf) and Cluett, Rachel, and Jennifer Amann, 2015, "Multiple Benefits of Multifamily Energy Efficiency for Cost-Effectiveness Screening, ACEEE Report A1502.

[17] Skumatz, Lisa A., Ph.D., 2010, "Non-Energy Benefits Analysis for Xcel Energy's Low Income Energy Efficiency Programs", May. Early work for the California utilities separately sampled for Southern California Gas customers as well. Additional studies could not be reviewed thoroughly to identify variations for gas vs. electric.

Skumatz, and Gardner 2006[18]) using regression methods, and the NMR Massachusetts work (NMR 2011), which allocates the percentages of NEBs to measures based on their percentages of the program's energy savings.

Based on this review of the evidence available, we found the following.

- The participant NEBs are valuable – whether they are valued from the perspective of the households that are participants, or the landlords / managers. In each case, we find the NEBs multipliers for these benefits– range from about 70% to more than 100% of the bill savings.
    - Participant NEB Values for landlords are similar in value to values estimated for households: between about 70% and 100+% of bill savings.
    - Participant NEB Values for gas are about the same as electric: The figures varied little between the two sets of participants.
    - Disaggregating to Measures: There are only very limited examples of three main methods that have been used to disaggregate NEBs to measures: regression techniques, stratified sampling to estimate disaggregated measure savings directly, and assignment by share of energy savings.

Q: Are there results or values from the literature that may provide guidance for ranges of NEBs for New York?

As a total value, we find For New York, generally, if we applied these "typical" values, the total NEBs would be about 183% (8%+31%+144%), excluding factors related to water and emissions. About 76% of the multiplier comes from participant NEBs (after these specific exclusions).

On a measure-by-measure basis, we provide the following two tables that provide some of the best available information or multipliers for NEBs.

[18] Smith-McClain, Lisa, Lisa A. Skumatz, Ph.D., and John Gardner, 2006, "Attributing NEB Values to Specific Measures: Decomposition Results from Programs with Multiple Measures", Proceedings of the ACEEE Summer Study on Buildings, Asilomar, CA, August.

Figure 5: Recommended NEB Values as Multipliers on Bill Savings

(Adapted from NMR Massachusetts Cross-cutting Study[19]; recognize the allocations on a savings basis are based on Massachusetts values for savings for the measures)

Measure	NEB Multiplier on Energy Savings	Measure	NEB Multiplier on bill savings
Air Sealing	47%	Insulation	116%
Appliance (refrigerators and freezers)[20]	See Figure 6	Lighting[21]	105% (See Figure 6 and footnote)
Cooling systems	27%	Service to heating or cooling system	4%
Duct Sealing	4%	Low Flow Showerhead	1%
Heating & Cooling system	24%	AC system sizing	4%
Heating & Hot water system	7%	Programmable Thermostats	12%
Heating system	231%	Window	6%
Hot Water System	8%	Weatherization	114%

Figure 6: Estimates of Appliance Participant NEBs as a Percent of Measure Savings – Bill Savings Multipliers

(derived from Skumatz, 2006)[22]

Household appliances	Refrig-erators	Dish-washers	Clothes Washer	Room Air Condit-ioner	CFL Bulbs[23]	Lighting Fixture[24]
NEB Multiplier as a percent of the measure's energy savings	29%	65%	54%	71%	90%	30%

Note that these multipliers are based on participant perspective NEBs and are multipliers applied to bill savings associated with the energy saved – the value of the retail bill savings. Given the similarity in values estimated in the literature for the various subgroups, we might recommend that the values may apply to both gas and electric programs, and single-and multi-family programs. The multipliers should apply as long as the savings from the measures last (measure lifetimes or EULs); they are annual savings multipliers.

[19] NMR Group, 2011, "Massachusetts Special and Cross-Sector Studies Area, Residential, and Low Income Non-Energy Impacts (NEI) Evaluation

[20] The value in the original table of this citation was 1%. Our preference is to replace this with NEB multipliers from specific studies of lighting. See next table.

[21] The value in the original table of this citation was 105%. Our preference is to replace this with NEB multipliers from specific studies of lighting. See next table.

[22] Skumatz, Lisa A., 2004, Non-Energy Benefits from ENERGY STAR®: Comprehensive Analysis of Appliance, Outreach, and Homes Programs, Proceedings of the 2004 ACEEE Summer Study, Asilomar, CA, August.

[23] The value in the original table for this factor is 90% for CFL. Note this is a similar order of magnitude as presented in the original data in Table 1, which was 105%.

[24] See previous footnote.

Q: What conclusions do you draw about NEBs and cost-effectiveness tests?

A cost-effectiveness approach that incorporates all costs and benefits, measured to the best reasonably-available science of the day, best guides investment. The appropriate subsets of non-energy benefits should be added to the benefits in benefit-cost tests in order to reduce bias and explicitly recognize their place in the equation.[25] There are some benefits that are easily measured, and are relatively program independent, and "adders" may be easily used to represent these omitted effects. There are other NEBs associated with programs or measures that are easily measured, and some utilities are including these NEB values – or subsets thereof - in their benefit cost work. Other states are incorporating a hybrid approach that incorporates both an "adder" representing program invariant benefits (e.g. a peak vs. off-peak adder for emissions), and easily measured NEBs that are program-(or measure-) specific. An additional "adder" representing some set of additional societal benefits associated with low income programs can be associated with these programs; values adopted in other states ranges around 15%.[26] A hybrid approach may represent a useful compromise to reduce some computational burden – identifying a suitable figure for program-invariant elements (in many states that may be emissions), and a separate value element that includes direct estimates of important NEBs associated with measures or programs.

The NEB values currently available –program-wide or by measure, as appropriate for the program – can provide near-term proxy values in the state's benefit-cost calculations. We recommend using them as it 1) reduces bias in the benefit cost analysis currently in use; and 2) opens the space in the equations for improved, local estimates in the future. Regular studies updating values can be incorporated into the State's evaluation plan; the estimation of participant NEBs can be accomplished by adding a NEBs question battery to existing program process evaluations at minimal cost. Ultimately it may be that after a few years of specific measurement, deemed values

[25] Work on these enhancements were conducted and recommended by Skumatz initially in 2001 (TecMarketWorks, Skumatz Economic Research Associates, Inc., and Megdal, "Low Income Public Purpose Test") and follow up work cited within in 2003, 2006, 2009, 2010, 2014, and 2015 and others. Other recent work by Wolfe on the Resource Value Framework also addresses similar topics.

[26] Malmgren and Skumatz, "Lessons from the Field: Practical Applications for Incorporating Non-Energy Benefits into Cost-Effectiveness Screening, *Proceedings of the 2014 ACEEE Summer Study on Buildings*, Asilomar CA, August 2014.

may be derived[27] (and updated periodically) if the values remain constant or predictable. In determining the amount to invest in the estimation of NEBs, and what is a "reasonable" amount to spend, economics would argue that the amount that should be spent is up to the cost related to the results of a wrong (program) decision. Theory does not argue for precise and unlimited / high cost NEB estimation work. In practice, this may argue that, at a first level, the test should be calculated using the high end and the low end of a range for the subset of NEBs that is appropriate for the specific program. If the same programmatic decision results for the low and high end of the NEB range, then the test values are sufficient for the purpose. If not, some reasonable additional effort should be expended to narrow the range for the most important or uncertain NEBs until a decision is clarified, or the cost to proceed further in estimating the NEBs would exceed the value of refining the decision.

The body of non-energy benefits research that has accumulated over the last 20 years demonstrates consistent methods for estimating NEBs, and provides values that can be used in the near term to update and reduce the bias in benefit-cost tests for efficiency programs.

[27] For most programs the baseline value for "replacement on burnout" is the standard efficiency for appliances or building code specifications, and for "early replacement" programs, the baseline for the delta savings would be a comparison to existing equipment for one period of time (until the equipment would have been replaced), and the comparison to the standard baseline thereafter. However, for low income programs, a strong argument can be made that the appropriate deemed values perhaps should be considered as a delta from a baseline of existing conditions, at least for a long time, because neither tenant nor landlord (depending on the decision-maker) tends to replace the equipment until it is completely inoperable.

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