Non-Energy Benefits / NEBs – Winning at Cost-Effectiveness Dominos: State Progress and TRMs

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ABSTRACT

Domino-style, more and more states are incorporating NEBs into benefit-cost (B/C) tests in various subsets and formats. NEBs can reduce bias in the cost-effectiveness tests, improving program and portfolio investment decisions. In this paper we summarize the specific approaches states are taking to incorporate NEBs in tests including: 1) adders (and what they do/don't include); 2) "easy to measure" NEBs; 3) all NEBs; and 4) a hybrid adder/estimation approach.

We examine collaborative procedures in states, and states that are incorporating NEBs[1] through changes to the Technical Reference Manual (TRM) – a process that involves identifying and/or developing measure-based NEBs.

In the paper we identify those NEBs that are appropriate for inclusion, and the common ranges for values. We provide case studies, and identify patterns in the approaches and values being used in different states. We update states that have taken basic adder approaches vs. more aggressive approaches in NEBs. We identify values of measure-independent NEBs and measure-based NEBs – and particularly identify the priority gaps that are being identified – in values and measure-specific NEBs – as part of the deliberations.

Finally, we discuss treatments and values in B/C work and implications related to bias, risk, and cost, and address directions and recommendations for the future.

INTRODUCTION

This paper provides information on five main topics related to NEBs (or CEEs) and their adoption / integration into Cost-Effectiveness Tests:

- Background – We discuss the range of NEB values for the most studied program types, research on measure-based vs. program-based NEBs, and remaining gaps.
- Review of approaches – We focus on the four main approaches used for incorporating NEBs into B/C tests; the ranges of values adopted (and where), and the relationship to estimated NEBs.
- Sources and size of risk in B/C computations, for context relative to NEB variability.
- The variety of strategies being used to introduce NEBs into deliberations on updates to B/C tests around the country – the next generation of dominos.
- Finally, we provide directions and recommendations for the future.

NEB Values, Measure Research, and Gaps

NEBs have been measured in hundreds of studies over the last 22 years, including estimates derived from:

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[1] Known as Non-energy benefits, non-energy impacts, omitted program effects, multiple benefits, and other terms. We use the traditional NEB terminology, recognizing it is the ***net*** of positive and negative effects. We prefer NEB or to coin new term, ***co-energy effects (CEE)***, which has the benefit of staying neutral (positive and negative), does not say "omitted" as we hope they won't continue to be, and links to "energy", which is a fatal flaw of some of the terms.

- direct measurement of impacts (e.g. arrearages, sales, test scores, etc.);
- secondary data combined with impact estimates (e.g. operations and maintenance, lifetimes, illnesses, insurance risk, water savings);
- detailed models (e.g. emissions, jobs / economic impacts); and
- surveys (e.g. comfort, control, etc.).

NEBs have been estimated and accumulated for the traditional residential and commercial sector programs, as well as solar, real time pricing, commissioning, and many other programs (See BeMent and Skumatz 2007, Skumatz and Khawaja 2009, and others). The value of NEBs is substantial, as it is not uncommon for NEBs to exceed the value of the direct energy savings. Participant NEBs make up the bulk of the overall NEBs value. Using residential weatherization and/or Energy Star / Home performance / retrofit programs as an example (among the most studied programs), Figure 1 presents a summary of ranges and typical values for key categories of NEBs for these programs. Typical values, based on a literature review for of retrofit and weatherization programs, are presented in Figure 1. The percentage and dollar columns are not quite comparable; some studies were presented in a way that precluded translation to the other format, so the study lists are not identical between the columns.

Figure 1: Summary of Ranges and "Typical" Values for NEBs for Weatherization / Retrofit Programs (Source: Skumatz 2014)

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 Multipliers - relative to bill savings	56% -	698%	300%	111% -	782%	224%		
NOTE: Ltd variation for emissions are for peak / off-peak focused programs.								

The total of the multiplier values for NEBs (applied to the energy savings estimate) for each of the three main classes of NEBs are summarized below.

- Utility NEBs: In Figure 1, the total of these factors are valued at about 24% of the program's energy savings; excluding benefits associated specifically with low income factors, the remainder is about 8%.
- Societal NEBs: Figure 1 shows that societal NEBs total about 55% of the value of energy savings, with the largest shares represented by economics (31%) and emissions (about 7%, conservatively)
- Participant NEBs: Figure 1 shows that participant NEBs, including those associated with low income program elements, total to about 144% of the value of household bill savings; excluding low income effects (payments, home improvements, hardship), the NEBs total about 111%.

The way in which these values are used in cost-effectiveness tests is described later in the paper.

Although both residential and commercial values have been studied since 1994, gaps remain, especially in the area of measure-specific NEBs[2], presumably because many programs deliver packages of measures, and the evaluations are program-wide. The following paragraphs summarize progress and remaining research gaps.

NEB Value Consistency and Transferability: Analysis indicates that the transferability of NEB values varies based on their primary driver (Skumatz 2015c). Some NEB values may be quite transferable for similar programs / similar participants across geographics (e.g. some patterns in arrearages); others are transferable between programs and measures within the same utility (e.g. emissions for peak vs. baseload programs, as a multiple of energy saved). Some are very location, program, and measure-dependent (e.g. economic multipliers depend on local industry / jobs mix and program measures, health and safety). Many participant NEBs (e.g. comfort) depend on installation of specific types of measures (e.g. shell or heating / cooling) but also climate.[3] Others primarily depend on measures installed (e.g. home improvements, water savings, adjusted by local water rates). There is some indication that the NEB values may be less climate-dependent if the NEBs are expressed as a percent of energy savings rather than dollar values.

Measure-based NEBs: One approach that has been raised to try to make NEBs more transferable is to estimate NEBs associated with specific measures (measure-based NEBs). Then, presumably, specific NEB values could be added and subtracted as measures are added and subtracted. One complexity arises; much as there are interactive effects for impact evaluations, there are almost certainly interactive effects in NEBs (Gardner and Skumatz 2006). While there are some single-measure programs, and NEB studies have been conducted on a number of these programs (e.g. work on air conditioners, commercial motors, refrigerators, etc.), the second complexity is that most programs – and most NEB studies – have concerned multi-measure programs. Virtually no studies have collected NEB data both program-wide and for specific contributing measures[4] (one

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[2] This is because NEB study budgets have been small (with a few state exceptions), so separate sampling to provide measure-based data within program-wide NEB studies have remained unfunded. Also, low income programs were most interested in program-wide NEB effects (policy and goal-related).

[3] Participant NEBs can also vary based on low income vs. not, and have also been found to vary based on higher vs. lower percentages of infirm, etc.

[4] For one thing, it costs more, and NEB studies have historically suffered from low budgets.

study is currently underway in the Northeast). This (measure stratification) is probably the best approach. However, there are several *ex post* options:

1) Across the board / no disaggregation, and assign all program measures the same program-level multiplier. While expedient, it is not correct (since comfort is commonly the largest NEB, it doesn't make sense to assign its contribution to water measures), but it may be a short-term option.
2) Savings Share: The NEB value could be allocated based on share of savings the individual measures produce. This was explored successfully in the Northeast (NMR, 2011).
3) Regression: Given NEB values, and the presence / absence of specific measures, regression analysis can be used to tease out the share of NEB value attributable to each measure (and even household / demographic characteristics). This has been successful (Gardner and Skumatz 2006). This last regression approach has the greatest appeal for defensibility, if data are available.

Gas vs. Electric NEBs: In our review, we found only a few studies that explicitly identified the NEBs for gas vs. electric participants (Skumatz 2010a)[5]. Most studies seem to study program-wide savings, perhaps because NEB studies are combined with broader process evaluations that sample for other goals. In several reviews (Skumatz 2015c Weinsziehr and Skumatz 2016, Skumatz 2016 and others) we analyzed apparent (preliminary) patterns between gas and electric NEBs. In the study we found preliminary evidence that participant-perspective NEB results are fairly similar in order of magnitude (multiplier) terms, for gas and electric programs. Additional work on gas and electric measures was conducted in Tetratech 2012. However, the literature on this topic is thin and is a gap.

Multi-family: The literature on NEBs for single family (low income and standard) programs is fairly robust and has been recently summarized (Skumatz 2014), while information on the multifamily sector is more scarce. In a recent pair of studies ((Skumatz 2015c, Skumatz2016) we identified fewer than half a dozen studies, and few had hard estimates of NEBs overall or by category. We focused on three studies[6] (Skumatz 2010a; NMR 2011, and Cluett and Amann 2015) to draw inferences to the sector. Note that the multifamily programs that have been analyzed are often low income programs; however, we also calculated ratios or deleted benefit categories specifically associated with low income to improve comparability. A detailed analysis of this work is included in Skumatz, 2016, omitted here for space considerations. This multifamily sector is also complicated because decision-makers and beneficiaries are not always the same (depending on program design, measures, etc.).

- The analysis found that the "average" NEBs for MF occupants (non-low income) was estimated to be about 112% of energy bill savings from the program – a little greater than bill savings in benefits from the program.

[5] Early work for the California utilities separately sampled for SoCalGas customers as well. Additional studies could not be reviewed thoroughly to identify variations for gas vs. electric.

[6] 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.

- The figure for multi-family owners was estimated to be about 71% of bill savings (as might be expected- they don't personally experience the comfort benefits, for example).
- Participant NEBs for similar non-low-income single-family programs cluster in the range of about 90% (Figure 1, lowest range, excluding the low income elements like financial and home improvement elements) to about 120-145% (depending on which NEBs are included), based on studies conducted around the nation.

In summary, for the short term, there may be options to use to adapt existing literature beyond the direct programs (and utilities) studied. Participant-perspective NEB results seem to be fairly similar in order of magnitude terms, for gas and electric programs, and for single family and multi-family occupants. They appear to be a little lower for owners / managers of the multifamily buildings.

Four Methods for Incorporating NEBs into B/C Tests –

The early utility integration of NEBs into the regulatory and screening environment has taken four forms (See Figure 2 for State approaches):

- Adders: Deliberative processes (committees, advisory panels, with research input) have selected percentage or dollar "adders" to be applied to the savings value. The values selected are not necessarily meant to reflect all NEB values, but are deliberately selected to be conservative, and meant to reflect a step in the right direction. Higher or extra adders are common for low income programs, reflecting the NEB values associated with the policy goals linked to these programs.
- "Easy to measure" NEBs: Some agencies have opted to allow program- or measure-specific NEBs that are "easy to measure" or "readily measured". The list of categories varies by utility (see Figure 2)
- All NEBs: Another approach agencies have considered is broader application of NEBs by program or measure. Given the plethora of programs, measures, and NEB values, no states have adopted this approach "whole hog". A few states take the approach of considering the estimated values and assign amounts based on those estimations.
- A hybrid adder/estimation approach. A number of states have adopted what might be called a "hybrid" approach, using an adder to represent some baseline NEBs (carbon, low income, etc.) and then allow the addition of easily measured NEBs as well.

Relative Risk Sources in B/C Tests

The process for calculating B/C tests is important, conservative, scrutinized from many sides – and slow to change; it is the basis for decisions allocating hundreds of millions of public or ratepayer dollars in investments every year and change is risky for utilities, programs, implementers, and customers. Considering the addition of NEBs – regardless of their theoretical appropriateness – is properly undertaken only with caution. However, delays that are occurring because of concerns that (some) NEBs are based on surveys and are thus too risky for inclusion in the B/C test may be unjustified for at least four reasons:

- A large body of research has been conducted, employing a combination of academically-based survey approaches (like NTG), third party models (not unlike energy simulation models or engineering approaches for impact evaluation), direct computations (not unlike deemed values), and other methods. Inclusion of well-researched non-zero values of NEBs reduces bias in the B/C test.

- Other inputs to the B/C test are based on surveys – and surveys that may be more hypothetical than NEBs in some aspects;
- Other inputs to the B/C test are outdated, and/or are not based on vetted research;
- Assumptions underlying other inputs vary widely around the country, and the assumptions made dramatically affect results.

Figure 2: Comparison of NEBs Treatment in Regulatory Environment, by State *(Source: Malmgren and Skumatz 2014, updated)*

Regulatory / Screening Application	Utilities / regions	
Program Marketing	Fairly widespread use in utilities / states across the country	MORE AGGRESSIVE ==>
Test / Pgm Screen – adder	IA (10% elec, 7.5% gas, 1999); CO (10% adder, 25% Low Inc, 2008); OR (Carbon $15/ton; 10% adder, 2008); WA (10% adder, 2008); IL (emissions adder); VT (15%+15% LI); DC (10%); NY($15 adder for carbon); NW (15%); for low income (LI) or <1 (CA, ID, OR, WA, UT, WY, NH, NY, CT)	
Test / Pgm Screen - readily measured	MA (NEBs must be "reliable & with real economic value"; utility, prop, H&S, comfort; LI; eqpt, util, all costs of complying with foreseeable environmental regulations); CA (low income); IL (easily measured water plus easy others); VT (maint, eqpt replacement, LI, comfort, H&S, prop, util, societal); CO (measureable with current mkt values); NH (as adder; LI); BCHydro (maint, GHG, lifetime, product loss, productivity, floorspace); DC (eqpt, comfort, H&S, prop, societal); OR (esp. C&I; carbon value on societal test, PV deferred plant extension, water / sewer savings, laundry soap); CT (LI); RI (LI; quantify util, societal; H&S, eqpt, prop, comfort); NY (LI, eqpt)	
Test / Hybrid (potential adder & measured)	CO (measureable with current mkt values); OR (esp. C&I; carbon value on societal test, PV deferred plant extension, water / sewer savings, laundry soap); DC, VT.	
Test / Pgm screen - Broad	With quantification: MA, RI. MA order / decision - becoming broader - count in res & ICI / demonstratable including survey-based (not yet econ); Broad-based inclusions of all NEBs as an official screen: not yet found.	

We address four key sources of bias in the existing B/C computations, and compare their relative reliability and risk to those associated with NEBs. The basic B/C equation takes the form:

$$B/C=f\ [PV[NTG\&(Sav+NET\ NEB)*Lifetime]\ /\ PV(Cost)\ldots]$$

Where B/C=benefit-cost; f='function of'; PV=present value; NTG=net-to-gross; Sav=estimated savings; NET NEB=net result of positive and negative NEBs; Lifetime=EUL or estimated useful lifetime of measure, and cost is incremental measure or program cost.

Savings is repeatedly measured, but there are at least four other inputs that have reliability issues, with consequent potential impacts on B/C results: NTG, EUL, discount rate for present value, and costs.

Net to Gross (NTG): The estimate of the percent of gross savings that should be attributed to the program above and beyond what would have happened without the program is reflected in the estimated net-to-gross rate. Measurement of the two constituents – free ridership and spillover[7] –

[7] In simple terms, "free riders" are customers who take the program incentive, but would have purchased the efficient measure without the program. "Spillover" (there are three different types) reflects customers who are induced to purchase energy efficient measures because of program influences, but do not participate or get rebates

are traditionally based on self-report surveys about decision-making influence factors, and complicated to measure accurately. NTG consists of two factors: free ridership (FR) or those persons that would have purchased EE even without the incentive, but took the incentive (should be counted in costs, but no benefits); and spillover, which represent the people influenced to purchase EE by the program's presence and effects, but who did not participate in (and cost) the program.[8] The FR decreases the gross estimates of energy savings; the latter three counteract that effect, adding to the savings attributable to the program. However, many states omit the spillover effect (harder to measure), introducing inaccuracies in the calculation. Spillover levels depend on the program type; market transformation and education programs may have a great deal of spillover. Including spillover (perhaps 2-20% depending on programs, based on our research) could affect the B/CT results and favor some kinds of programs more than others.

Discount Rate: Meant to reflect risks associated with investment, three main discount rates have been used in B/C equations (Skumatz 2015a, Skumatz 2015b): the Utility's Weighted Average Cost of Capital (WACC; often 3-8% or more); a societal discount rate (~3% in Vermont, for example); and the 10 year treasury or prime rate return (~0.5% to 2%). The WACC reflects the risk associated with the utility's investments, mostly in generation, transmission, and distribution assets. The relative risk for investment in energy efficiency programs (at least mature "widget" programs), would potentially be expected to be less than a utility's investment in generation plants, which can have substantial risks of delays, cost overruns in labor, materials, or unknown technology (and potentially, the risk of disallowance). Energy efficiency programs generally can be funded from expenses, and tend to occur in very controllable ways (programs can be halted midstream, delete measures, etc.). Thus, efficiency programs should have lower discount rates than generation resources (which usually use WACC). Social discount rates have been argued; the lower threshold for this investment might be the treasury returns, which could be considered an appropriate return for an investment of little to no risk. In regulatory environments where utilities are rate-basing and not rate-basing the costs, the conclusions remain the same. In rate-basing, the risk of recovery is lower for energy efficiency programs than generation, and without rate-basing, the risk from investments from working capital do not need to reflect the capital-based risk embedded in the WACC. For low income program, the most suitable discount rate may in fact be very low, if programs are approved – or required – by regulators. As a result, discount rates in different locales have varied from 1% to about 8%. This has a dramatic effect on the present value computation for benefits. Program measures with 20-year EULs would lose 70% of their value on the basis of the difference between a 3% vs. 8% discount rate. This choice matters and affects B/CT results significantly.[9]

Measure Lifetimes: The estimated useful life (EUL) of the installed equipment is multiplied times the first year savings of the measure to estimate the total lifetime savings. A review of measure lifetimes (Skumatz et. al. 2009) finds that: 1) lifetime values for individual measures can vary widely between states (a factor of two or more for some measures), and 2) the values that are

from the program. The first factor decreases the savings attributable to the program and the spillover factors increase the savings that can be counted as program-attributable.

[8] Officially, there are multiple types of spillover – participant in-program (participants purchase measures promoted by the program, but do not get their incentive), participant outside-program (participants seek out other EE equipment), and non-participant spillover (the remainder of the market that undertakes EE behaviors.

[9] It would affect the denominator as well (costs) but costs are generally one-year program cost, and not discounted or valued into the future.

used are rarely based on statistical underpinnings. An additional note is 3) the values are based on the values have been in place for more than 20 years in many cases, and even if they were accurate, they may no longer be appropriate for the newer mechanics and efficiency / operations decay behavior associated with new technologies being installed. In updated work, we assembled data on EULs adopted in more than 30 agencies around North America, and compared the high and low values for each of more than 67 pieces of equipment. Our analysis showed that although there is little variation for some measures, others vary by double or more. Of the 67 measures examined, the average variation from high to low was 66%, and the median was 40%, implying for half the observations had EULs varying for same measures by more than 40% high to low. The difference in actual years of median lifetime exceeds 15 years, with the median and average at 5 and 6.4 years, respectively. Of course the impact matters more for measures with shorter lifetimes, but the point remains the same: not only are the values not well researched, they vary widely and this directly affects the computed savings valued in the B/CT. In other research, we have prioritized some of the most critical measures for follow-up analysis.

Savings are not all the Benefits: The one input that probably does not have substantial reliability issues is the estimated savings[10], usually derived from an impact evaluation or approved M&V or deemed savings process. However, Benefit-Cost assessment should be based on all attributable benefits and the associated costs (incremental on both sides). NEB shows participant NEBs are often equal to energy savings, utility NEBs may be on the order of 10% of savings, and societal benefits (largely jobs and emissions) can be very substantial. Precise estimates of savings omit these values that may more than double the total program or measure benefits. The relative variation from these B/C elements are shown in Figure 3, and the cumulative effect on the numerator is substantial. In summary, many elements in the B/C equations have uncertainties, and NEBs are not necessarily the weakest link in the equation. The introduction of an estimated value for NEBs automatically serves to decrease bias in the B/C test, because to omit a value effectively introduces a value of zero. The literature clearly indicates the value is positive and substantial – and definitely non-zero.

Figure 3: Summary of B/C Equation Numerator Inputs and Risk / Variations

	NTG	EUL	Discount Rate	Savings Estimate	Costs /Incre-mental Cost	NEBs	Numerator – order of magnitude
Varia-tion	Add Spillover, depends; perhaps 20% range	0-4x EUL variation; Median 40% diff; assign ½ or 20%.	1-8% (800% range); >30% effect	Small;	Varies; not in numerator	May exceed Savings	Adds to 70% without NEB effect (+>100%)

NEB estimates include uncertainty, with different errors associated with estimates from modeling sources, impact sources, surveys, etc. NEBs have been measured repeatedly, consistently, and with good rigor. Most importantly, NEBs should not be held to an artificially higher standard than the other elements of the benefit-cost test, which are also necessarily imperfect. Including NEBs estimates reduces the bias in B/C-based decision-making.

Further, it has been argued that introducing NEBs would cause more programs to pass the B/C test, exceeding budgets. However, that will not be the only effect. The revised B/C tests will

[10] Note that we only address the energy efficiency B/C test computation. However, if the B/C test results for EE are compared to the B/C results for energy supply, there are, of course, errors in those projections as well, including cost of future power, etc. Engineering estates are just that, estimates, and presenting results in spreadsheets does not make an estimate more accurate.

affect which programs pass by most – given that those with more or higher valued benefits will see the largest effect on B/C test results. The change should better allocate funds across programs, no matter what budget level is selected.

Examples of How States are Deliberating NEBs

Over the last five years, but especially the last two or three, many agencies have been considering alternatives for introducing NEBs into B/C analyses. A selection, that shows the variations in how the topic is being introduced in different areas of the country, is shown below. The approaches being used may provide ideas for other states wondering how they might raise the issue.[11] We have provided original NEB research, responses to requests for information, and testimony in many of these past and future activities.

- New York[12]: In the mid-2000s, NYSERDA incorporated NEBs into their program evaluation work, and modeled economic and job impacts from EE programs. This increased the literature, as they had a broad portfolio. Although not incorporating NEBs formally into the decision-making, they presented performance results with portions of the NEBs reported (standard, standard plus, etc.). NEBs are not formally considered in the Department of Public Service (DPS) calculations of cost-effectiveness, with the exception of a carbon credit adder ($15) related to long run avoided cost. The State invested in substantial NEB research (important for quantification and validation for a wide range of programs), which was not directly incorporated into the cost-effectiveness analysis in New York, but has helped support decisions in Colorado and Vermont to incorporate NEB adders, as discussed below.

- Colorado: Key drivers in this state were: 1) intervenors that were persistent and were successful in introducing into the Plan a requirement for an NEB study for at least the low income programs; 2) research in 2008 and 2011 (Skumatz 2010a) that examined NEBs within the context of cost-effectiveness screening (referring to work elsewhere, and conducing primary research in the State), and 3) a large group of intervenors in the dockets that supported decisions to count NEBs as an electric and gas adder in the cost-effectiveness screening. The 2008 study and deliberations led to proxy values introduced in 2009/2010 (10% electric, 20% for low income, 5% for gas). A later proceeding and study led to adoption of values of 25% for the low income programs and for both gas and electric energy sources. Updates are being considered in the next round as well. Lessons include the importance of intervenors and support, quantitative research, and a recognition that such research is an ongoing process and not static.

- Vermont: Important contributors to getting this state to incorporate NEBs into B/C screening was the quantity and nature of the growing work in NEBs studies, the dominos from other states incorporating NEBs in their proceedings, and the support of a broad collaborative of stakeholders. An early adopter of the concept (1990), Vermont had incorporated a societal cost-effectiveness test with a 5% adder for the environmental externalities and a 10% adder to account for reduced risks from EE relative to generation. In 2009, a consensus of participants in the proceeding suggested NEBs should be incorporated in some way, but the best approach

[11] For those deliberations that have been completed, we name the state; for those still underway, we do not wish to affect the on-going work, so we only present the approach, which might assist other areas.
[12] These first four are described in more detail in Malmgren and Skumatz 2014.

(method and level) needed discussion. A Utilities Analyst for the Board was successful in getting an immediate 5% NEB adder incorporated as a stop-gap placeholder for EE measures for thermal and process fuels, ad suggested stakeholders create partnerships to seek out research to support a defensible NEB value. A large group of stakeholders was established and they began researching the NEBs literature. They ultimately used the literature to identify quantitative values for a range of key benefits associated with low income programs (especially related to financial and hardship benefits). Beyond values from the literature, the stakeholder group (collaborative) also promoted the research that was being conducted on the need to update C/E screening to incorporate NEBs. Combined with the Colorado and NYSERDA work, the case was ultimately made in VT to incorporate NEBs – specifically a 15% adder for conservative value, to be revisited and amended with new research.

- DC: DC was a special case. They only recently established enabling legislation for and EE utility (2008/9) and their legislation selected the Societal Test, and required that the screening include NEBs (including "comfort, noise reduction, health and safety, ease of selling / leading home or building, improved occupant productivity, reduced work absences due to reduced illness, ability to stay in home / avoided moves, and macroeconomic benefits). DC established a 10% NEB adder early on. They also added a 10% risk adder, and a 10% adder for the reduction of environmental externalities. Beyond the adders, DC incorporates traditional types of NEBs into their primary goals and measured benchmarks for their programs. This consideration of social equity with energy efficiency goals is an unusual and remarkable model.

- Ongoing, Midwest: In this state, some basic NEBs are already reflected in the tests. A non-profit intervenor led the charge to expand the options by raising concerns about ways in which the current C/E screening was conservative and/or biasing results against EE (including NEBs). The issue was raised again when decisions were made not to procure some EE resources / savings because of benefit-cost ratios less than 1.0. Legal briefs were filed challenging the order and a working committee was established to work outside the direct regulatory process to consider the issue of NEBs. It was agreed the TRM update process would be a suitable way to incorporate measure-specific NEBs in the B/C process. The process moved forward well for a time, but then it began to unravel. A near-consensus by the committee would be needed for commission adoption and that position is currently uncertain; the process is currently on hold to determine next steps.

- Ongoing, Mid-Atlantic: As part of a very broad regulatory change, NEBs and a review of the C/E process was a regulatory request for review and consideration by the commission. Many documents were submitted in response, and a recently-released order will lead to substantial informational proceedings. A great deal of work on establishing a revised benefit–cost framework is part of the next step.

- Ongoing, Midwest: A regulatory commission decided to conduct a revision of rules for benefit-cost treatment, gathered information and developed an approach and process for consideration of NEBs, but then reversed that section of the changes. The process will be picked up again next year.

- Ongoing, Midwest: Action in this area is the responsibility of a multi-organization steering committee, and NEBs is one project they are working on. The commission is pursuing a study to conduct research on the national and state front that will inform the potential inclusion of NEBs in their benefit-cost process.

- Ongoing, Northeast: They have included some level of NEBs in existing benefit-cost work and in the TRM. They are currently undertaking primary NEB research to address several NEB gaps that will let them further revise the TRM and provide measure-based estimates – and provide a framework for conducting NEB studies for the broader portfolio of programs going forward. Some progress, results, and TRM changes are expected in 2016.

Different recommendations were provided from different interviewees. Some saw intervenors play a key role in getting NEBs on the table; in others, a big utility's interest was key to serious consideration of a change. Some are deciding to work through the TRM review procedures to incorporate NEBs into the standard process. All of the on-going work implies that a quick-turnaround approach is more a wish than a reality; collaborative work is needed and it takes time. Work trying to generalize lessons has been attempted for years, but may be gaining traction again, thanks to work pioneered by NEEP, work on a broad and updated standard practice manual, work by non-profits and intervenors acting in multiple states, and other efforts.

Summary, Recommendations, and Remaining Gaps

A game of dominos is underway. Increasingly, utilities are recognizing the importance of adding NEBs into B/C proceedings, and are undertaking the work needed to introduce the work. As we have published in other work, more than a dozen states allow inclusion of some subsets of NEBs into the equation, and the list is growing.

Whether existing values are transferable, or whether work "from the ground up" is needed, is crucial – to limit estimation cost, reduce complexity, and reduce risk to implementers. The answer, logically, depends on which type of NEB it is, and whether it (or its underlying drivers) varies across regions or programs. Therefore, we have classified NEBs into those that vary with program and measures and location, versus those that do not (generally). But more importantly, the literature is extensive, and may, with some limited analysis, be transferable enough to address short term needs –recognizing funding to address key gaps should be allocated to allow the gaps to be addressed. The key gaps and priority research areas (Skumatz, et. al. 2009 and others) include,

- measure-based estimates – directly estimated, and additional exploration of regression approaches – or savings-based placeholders – to provide near-term proxies to use;
- Estimates of health effects (participant and societal), as early US work and recent international studies indicate these are high-value NEBs.
- numerous commercial NEBs (particularly process-related, cooking, and others; see Skumatz et. al. 2009)
- gas vs. electric NEB values;
- single- vs. multi-family NEBs, and possible demographic variations;

These gaps do not raise major uncertainties about the direct applicability of NEBs to some of the major programs in place (single-family weatherization, appliance programs, etc.) for which there are multiple reliable estimates – and for which, if there is some budget, local estimates can be readily developed from primary research.

However, there are options available now – and opening the door and identifying placeholders for improvement is better than waiting. Chicken and egg wastes time. We suggest that an "adder" approach for incorporation of NEBs into utility B/C tests is well-suited to those NEB categories that are *measure- and climate-invariant* (and derive almost exclusively off the energy savings, and can therefore be calculated as a multiple of the energy savings), vs. those that depend on the specific measures included in the program. An extra adder for low income programs appears justifiable. The values in Figure 1 and Figure 2 are strong starting points. Considerable work has also been conducted in the commercial sector, but the values are less consistent; more work is needed there.

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