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Non-Energy Benefits: Status, Findings, Next Steps, and Implications for Low Income Program Analyses in California

REVISED REPORT

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ORGANIZATION OF REPORT

1. BACKGROUND AND EXECUTIVE SUMMARY

This paper provides a comprehensive analysis of the “state of the art” in Non-Energy Benefit (NEBs), or traditionally-omitted positive and negative impacts from energy efficiency programs. This paper also reports on the status and recommendations on estimation approaches for low income programs in California. The authors reviewed more than 100 conference papers and consultant reports, and interviewed scores of state and utility professionals to identify progress, measurement approaches, policy issues, and regulatory treatments related to quantifying non-energy benefits associated with energy efficiency interventions–with a focus on low income programs.

Executive Summary

NEBs are an array of positive and negative effects of energy efficiency programs, beyond energy and associated bill savings. Over the last 20 years, a wide range of NEBs have been identified in studies.[1] Starting with work in the mid-1990s, the literature began to explore more consistent measurement methods, and sort these benefits into three “perspectives” based on the beneficiary of the effect–the utility or agency; society at-large, and the participant.[2]

Utility-Perspective NEBs: These are indirect costs or savings to the utility and its ratepayers. They include bill payment improvements, infrastructure savings. The vast majority of initial work on NEBs in the 1990s focused on utility perspective NEBs, particularly addressing topics related to arrearage changes from low income programs. Significant impacts were attributed to the programs (an average of about 20-25% reduction in arrearages); however, when valued for the utility at carrying charges, these arrearage effects were small for each participant. Further, when compared to the values associated with other benefit categories from the societal and participant perspective, the arrearage and debt/financial benefits from programs represented a small fraction of overall NEBs. There is a fair number of utility-perspective NEBs that are not addressed in the literature. These include:

- Line loss reductions. These may be addressed within some cost-effectiveness computations, but not universally, and the values are not clearly called out as an impact of the programs.
- Time of day/capacity impacts/avoided infrastructure. This is very important. However, it may be that the estimates associated with demand response programs may currently be considered direct impacts, rather than NEBs. There are effects associated with a wide array of programs, and these indirect benefits are valuable, however, it can be debated whether they fall into NEB or energy effect categories.
- Insurance impacts. These impacts cover the utility’s costs for deductibles or for self-insurance from avoided emergency incidents that may be avoided through pro-active program retrofits and other program actions.

[1] See TecMarket Works, Skumatz, and Megdal, 2001 for a review of the early literature.
[2] These perspectives might be re-ordered from the large to the small (society, utilty, participant), but order does not affect the results or discussion.

Societal-Perspective Impacts: These impacts are indirect program effects beyond those realized by utilities, their ratepayers, or program participants, but accrue to society at large. The literature focuses on several potential societal effects:

- **Emissions**: Consistent, defensible, and more readily-implemented modeling approaches have been developed to estimate these effects. This is a significant improvement over work available for the 2002 Low Income Public Purpose Test (LIPPT) analysis. (Note that for California (moving forward), the emissions computations are addressed through avoided cost adders, and are not a focus for on-going work.)
- **Job creation / economic development**: The literature shows significant impacts associated with efficiency programs which vary depending on the type of program (weatherization and education programs are more labor intensive than appliance replacement programs), region, and local industry mix. Most researchers rely on third party macroeconomic input-output models to develop these estimates, with considerable reliability.[3]
- **Hardship benefits**: A few studies on low income programs have extended the estimation of hardship values, measuring indicators of employment scores, family stability, mobility, and reduced dependence on state benefits.
- **Other**: The health and safety impacts have been very sparsely studied, even though the impacts on the health care system – including incidence of chronic illnesses, etc. - may in fact be quite large. Infrastructure (water and power) and national security impacts are gaining some attention. Few other societal impacts have been seriously measured.

Participant-Perspective NEBs: The most controversial types of NEBs are those that accrue to the program participants. This is where factors like operations and maintenance, comfort, productivity, "doing good for the environment" and others arise. Some lists include more than a score individual benefit categories. Evaluators have tested more than eight main methods of measuring these NEBs, with the literature focusing on a relatively small subset. Each method has pros and cons, and a few studies have compared performance of different measurement methods. The results show participant NEBs often exceed the value of the energy savings from the program measures and researchers argue they merit continued analysis.

Policy Implications: The literature has examined the role of NEBs as important underlying motivators improving program participation, or "uptake", and demonstrated that NEB analysis along the "delivery chain" for programs can identify weak links and barriers to program implementation. In program design and evaluation, NEBs have been identified as useful in marketing and targeting; messaging; program design and refinement; incentives development, and benefit cost work. While most utilities and regulators do not treat NEBs formally, some examine them for marketing purposes. A few include "easily computed" NEBs in formal analyses (e.g., soap and water savings for washing machine programs).One utility includes percentages of NEBs in various scenarios they present to the regulators. Although NEBs have a wide array of potential applications, they have been used only sparingly by utilities and regulators around the country because of concerns about measurement uncertainty. Considerable debate has also arisen over the use–or lack of use–of NEBs in regulatory tests, and whether improved tests would lead to better program selection. NEBs may reflect some of the most important effects from energy efficiency measures and programs, and may especially represent some of the most important outcomes for low-income strategies.

Analysis:

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[3] It may be argued taht these "net" jobs are a cost rather than a benefit associated with the program, depending on the context..

The report examines advances and patterns in NEB estimation and results since the 2001 Low Income Public Purpose Test (LIPPT) model was developed. This includes review of the results from other low income programs, degree to which formal analysis of NEBs has been incorporated into the program regulatory framework, and progress in specific NEB estimation work.

Implications for Low Income Program NEBs Assessment in California: Early steps of the project examined weaknesses in the current NEB modeling approach for low income programs in California, and examined the literature for possible insight and solutions. Weak areas in the current procedures include:

- A focus on participants and program-wide NEBs, rather than a measure basis;
- Complex and opaque procedures (and tracking / recordkeeping) for running scenarios, especially when multiple alternatives for measures and climate zones are involved;
- Weak communication between the existing tool and other workarounds, models, and spreadsheets that currently constitute part of the program planning / approval procedures;
- A need to update the tool to incorporate some needed measures, new research (and new NEBs), updated participant NEB research, and other enhancements;
- Holes in the tool, omitting some measures, omitting kW impacts, and
- Development of better summaries of the results.

The analysis supported development of recommendations for relatively low-level efforts, and more extensive research.

Basic / Low Level Efforts: These efforts focus on using existing research to either upgrade the existing model or provide the underpinnings for a new tool to support enhanced estimates and easier operation for required programmatic computations. These efforts include:

- Translating / associating NEB values to program measures;
- Assembling data entry and model "choice" work onto one sheet for each perspective, plus an overall data entry sheet to facilitate scenarios, and to better track settings.
- Incorporating methods for switching measures "in" and "out" of the scenario
- Providing more straightforward summaries of the NEB results and their size relative to other benefits;
- Upgrading several NEB categories to reflect progress in the literature (economics, participant NEBs; emissions might be included except that California addresses emissions estimates through the avoided cost)
- Exploring more direct communication between the DEER database and the NEB computations to reduce data entry work; and
- Incorporating financial-based calculation approaches for several participant NEB categories including measure lifetime and operations / maintenance, and compare the results to survey-based results obtained in other studies.

Detailed Research: This research focuses on improving (and better proving) relationships between NEBs and measures, identifying reliable estimation methods for key omitted NEBs, and developing the simplest possible tool for estimating NEBs for California's low income programs. These efforts include:

- Conducting a participant / non-participant survey to estimate missing NEBs, identify the most reliable method of measuring participant NEBs, exploring variations in NEBs in relation to climate zones and demographics, and reliably demonstrating relationships between measures and NEBs.

- Conducting estimation / analysis work on potentially high value missing NEBs including health impacts and safety effects, and peak / off-peak / kW effects.
- Conducting research on peak / off-peak and kW-related NEBs
- Work with the utilities to identify a uniformly agreed method for measuring improvements in "quality of life" or "household stability" –type metrics related to program goals, and developing methods to estimate these impacts that can generate "buy in" from the relevant stakeholders.
- Develop a revised, more user-friendly, but credible / flexible, multi-year estimating tool for computing NEBs for Low Income Program measures, considering possibly a "Deemed" NEB tool, an "adder", a hybrid, or other (possibly DEER value), and a convenient way to link E3, DEER, and other tools.

2. NEB BACKGROUND AND ESTIMATION METHODS

Most projects that result in energy savings also have an associated array of non-energy costs and benefits. These costs and benefits generally include a financial impact (e.g., the project's capital cost or its energy and maintenance savings), or have a non-financial or intangible impact (e.g., decrease in aesthetics or an improvement in comfort). Non-energy benefits are generally defined as any real or perceived, financial or intangible benefit accrued by a project and not reflected in energy savings (BC Hydro 2008). They are effects that are omitted from traditional energy program evaluation work, which focuses on impacts on energy savings.

Non-energy benefits (NEBs)[4] or non-energy impacts (NEIs), given their more indirect nature, are relatively hard to measure (HTM)[5] effects. As a consequence, they may also tend to be prone to more uncertainty than some other measurements associated with energy efficiency programs. The level of effort spent on estimating these effects should be somewhat proportionate with their potential impact on decisions about programs or energy efficiency interventions. This paper addresses several key topics:

- Types of NEBs
- Methods and progress in NEB measurement / analysis,
- Status of NEB estimation in Low Income programs,
- Current and potential applications of NEBs in program, policy, and regulatory arena.

2.1 Background

A significant body of work has developed around recognizing and measuring non-energy benefits[6] (NEBs). Over the last 20 years, a wide range of NEBs have been identified in studies.[7] Early publications focused on enumerating potential categories of benefits or theoretical discussions (Mills and Rosenfeld 1994, Flanagan 1995 and many others), but quantitative work was scarce. The early work in NEBs was applied to low income programs– perhaps because effects beyond energy savings were commonly included as part of the list of goals for these types of programs. The best early quantitative work was conducted in association with two programs, the nationwide Weatherization Assistance Project (Brown et.al. 1993) and a Colorado homes program (Magouirk 1995). Brown examined several NEBs related to property values, reduced fires, reduced arrearages, tax and economic benefits and environmental externalities. Magouirk included estimates of a broader list of impacts from

[4] Non-energy benefits (NEB) have been called non-energy benefits, non-energy effects, non-energy impacts, indirect effects, and other terms. The first major term applied to the research was "non-energy benefits" (NEBs). As long as we understand the definition – largely that both positive and negative effects are implied -- the term NEBs will be used in this paper because it assures that the historical literature is not lost. We argue that those researchers that initially identified the concept retain naming rights. None of the new research rebranding the name has changed the meaning of the concept. It also retains credit where credit is due for developing the concept.

[5] Megdal associated this "hard to measure" language with NEBs in several works.

[6] Literature review adapted from Skumatz, " Zero and Low Energy Homes in New Zealand: The Value of Non-Energy Benefits and Their Use in Attracting Homeowners ", ECEEE 2007

[7] A detailed literature review covering more than 300 studies is included in TecMarket Works, Skumatz, and Megdal, 2001. Versions are included in earlier studies including the following (Skumatz 1997, Skumatz and Dickerson1998, Weitzel and Skumatz 2001, and other subsequent studies).

emergency gas service calls, payment-related effects, and other effects, and did so in a fairly systematic manner. These studies provided useful early estimates of NEBs, but suffered from several problems.

- Each study estimated benefits in only a scattering of topics, mixed benefits that accrued to different beneficiaries, and used different "units," with some benefits expressed in net present value and others in cash-flow terms (although Magouirk provided measurements in more consistent units).
- All the benefits were computed using data from secondary sources, which severely limited the array of benefit categories that could be estimated or attributed to a particular program.

Categorization, Causes, and Uses of NEBs

Starting with work in the mid-1990s, the literature began to explore more consistent measurement methods, and sort these benefits into three "perspectives" based on the beneficiary of the effect –utility/agency; society, and participant.[8] Each is described in more detail in Table 2.1.

Table 2.1 Summary of NEBs Accruing from Three Perspectives

	Overall Description	Key "Drivers"	Specific Examples	Uses / Applications
Utility / Agency / Ratepayer Effects	These are incremental positive or negative impacts from initiatives that affect ratepayers and utilities and reduce revenue requirements. These effects are generally valued at utility (marginal) costs. They vary by type of participant (residential, low income, commercial) by overall energy savings and peak/non-peak timing and other factors.	• Financial burden • Debt collection efforts • Emergencies and/or insurance • T&D, power quality and reliability • Subsidies and transfers	Changes in bad debt written off; changes in carrying costs on balances; labor and other changes from changes in bill- and collection-related calls / activities; changes in shut-offs / reconnects; changes in line losses from power through lines; outage frequency / duration; many others	Current: Few. Some used to suggest targeting of bill-payment problem customers. Potential: Regulatory tests.
Societal Effects	Incremental non-energy impacts from initiatives that affect the greater society or that cannot be attributed directly to utility/ratepayers or participants. These effects are valued as appropriate to the benefit category. They vary significantly based on local economy, generation mix, peak/non-peak program effects, and other factors.	• Economic development/job creation multiplier effects • Environmental, including emissions • Health • Tax impacts • Water and other resource use • National security	Economic output changes; job creation; changes in greenhouse gas (GHG) emissions; infrastructure savings for energy, water, waste water, etc.; fish and other environmental effects; assessment of energy vulnerability, other.	Current: A few utilities and agencies use deemed multipliers for GHG emissions or avoided environmental effects. At least one presents fraction of environmental and economic benefits as part of "scenarios" for B/C tests and portfolio analysis. Potential: TRC
Participant	Incremental non-energy	• Payments and	Change in ability to understand / control energy usage; changes in	Current: Program

[8] Initiated in Skumatz 1997 and described in detail in subsequent research,and repeated in Amann, 2006.

	Overall Description	Key "Drivers"	Specific Examples	Uses / Applications
/ "User" Effects	effects from initiatives that affect those using the energy efficient equipment, beyond energy or bill savings. These effects are valued in terms relevant to the participant. They vary by user and by program and initiative (specific measures installed, education/outreach, weather, etc.).	collection • Education • Building stock • Health • Equipment service/productivity (comfort, maintenance, etc.) • Other utilities / resources (water, etc.) •	ability to pay; changes in time spent on bill payment/collections issues; changes in interruptions in service (shutoff, etc.); changes in other bills (water, etc.); changes in property value; changes in health effects; direct/indirect changes in energy "service" and stream of associated income/utility/satisfaction (productivity, comfort, light quality/quantity, noise, maintenance, lifetime, reliability, etc.), and other ("green", etc. and other.	marketing (limited), project screen (limited), scenario analysis (limited); [9] some in modified TRCs when NEBs readily measurable. Potential: Portfolio development, program refinement, marketing, customer B/C, B/C tests.[10] Specifics

Considerations for Appropriate Attribution of NEB Impacts

The following is a list of basic issues to be considered in assessing and attributing NEB effects to EE interventions.

- **Redundancy in sources or categories**: Similarly-named benefits can arise in multiple perspectives without being redundant. For example, fewer billing-related calls to a utility save money and time for both the utility and the household making the call. These are distinct impacts. Of course, each needs to be valued in terms appropriate to that beneficiary, and the number of subsets of different perspectives and benefit categories that are included in a computation depends on what is appropriate for that specific application (e.g. particular benefit-cost tests, etc.).

- **"Net" Effects**: NEBS may be positive or negative, and the "net" effects may also be positive or negative. Negative benefits can be interpreted as barriers in some applications.

- **"Net" of standard equipment choices**: When NEBs are applied to energy efficiency programs, it is critical that the impact be measured above and beyond the base of what would happen without the program–specifically, the (presumably, standard efficiency) equipment that would be selected without the program.

- **"Net" of free riders**: To the extent that the interest is in NEBs that are attributable to the program above and beyond what would have happened without the intervention, the NEBs would have a free ridership (and potentially spillover) factor applied.

- **Minimizing Overlap/Double Counting**: The drivers for NEB effects tend to emanate from a limited number of key impacts associated with energy efficient equipment. Multiple, closely related benefits and impacts could be measured, but it is likely the individual benefits might be difficult for participants to separately measure or assign value to each effect. Too many categories of impacts exacerbate the problem of overlap and double-counting.

[9] Some information on current usage of NEBs from a preliminary paper provided Jillian Mallory, "Discussion Paper on Counting Participant Non-Energy Benefits in the Total Resource Cost Test", 4/15/08, BCHydro.
[10] Some information on current usage of NEBs from a preliminary paper provided Jillian Mallory, "Discussion Paper on Counting Participant Non-Energy Benefits in the Total Resource Cost Test", 4/15/08, BCHydro.

3. NEB PRACTICES AND MEASUREMENT METHODS

The following sections provide a review of the work to-date on the practices and measurement of non-energy benefits for each category

3.1 Utility Perspective NEBs – Measurement Methods

The vast majority of initial work in the 1990's focused on utility-perspective NEBs, especially arrearage changes from low income programs. Significant impacts were attributed to the programs. The estimated impacts ranged from no reduction to 90 percent reduction in arrearage balances. The average value among these early studies was a 26 percent reduction, and the median for programs not targeted at customers with bill payment difficulties was 18 percent. Valued for the utility at carrying charges[11], these arrearage effects were small for each participant.

However, when compared to the values associated with other benefit categories from the societal and participant perspective, the arrearage and other debtor financial benefits from programs represent a tiny fraction of overall NEBs. Therefore, they have not been the focus of a great deal of current research in conference proceedings. However, limited work continues on these impacts on a program-by-program basis, especially for low-income programs because, arrearage reductions are often a goal of low income programs.[12] The financial / arrearage work is generally fairly program specific, uses historically demonstrated measurement approaches, range within limited bounds, and generally are not being included in conference literature.

There are a fair number of utility-perspective NEBs that are not being addressed in the literature–probably because they can be difficult to estimate–and some of these may have significant weight and value. Additional research would be beneficial. These include:

- **Line loss reductions**. These may be very important and valuable and are relatively easy to measure.[13] Some utilities have, in the past, used rules of thumb for this loss that are fairly high. If these rules of thumb are correct, then they represent an additional benefit to EE programs of significant value. One set of figures provided to the author in 2001 suggested transmission line losses of 2 percent and distribution losses of 4.5 percent for a total of 6.5 percent. However, these factors may vary by time of day and season, etc. Additional research on this point may be valuable in computing a total savings associated with specific EE programs or portfolios.

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[11] Until and unless it becomes a bad debt, the cost for arrearages to a utiltiy is the carrying cost, (similar to avoided interest income) they would incur until the payment is received.

[12] A notable series of studies from Quantec / Cadmus Group (largely several studies by Khawaja et. al. and Drakos et. al) has ventured beyond simple arrearage analyses into indicators of household stability. These are discussed in the societal and participant sections of the summary.

[13] In a most simple format, it might be computed as system-wide generated kWh less kWh billed as a share of generated kWh. Certainly there are engineering factors available, and factors like average utility line length per customer or similar numbers can be used. The next level of sophistication could be peak vs. non-peak, and ultimately hourly dispatch estimates. See the parallel discussion in the section on societal impacts from GHG emissions that is in the next section of this report. Again, the degree of sophistication (and related cost) needed depends on the use to which the figures will be put.

- **Time of day/capacity impacts/avoided infrastructure**. These are potentially quite large and very important, and are relatively easily measured.[14] These indirect benefits are potentially associated with a wide variety of programs (including low income programs) and are valuable in reducing costs associated with building capacity that can be avoided from well-designed or specifically-targeted EE programs. However, it can be debated whether they fall into NEB or energy effect categories.
- **Safety and Health-related impacts**. Utilities may save significant insurance and liability costs from safety-related effects. These liabilities may be reduced by the audits and inspections associated with many EE programs.
- **Other**: To the extent that the utility can avoid other future risks or liability claims due to the efforts of EE programs or to the avoidance of generation, the programs are beneficial to the utility and its ratepayers at-large in terms of reduced revenue requirements. These effects have not been studied.[15]

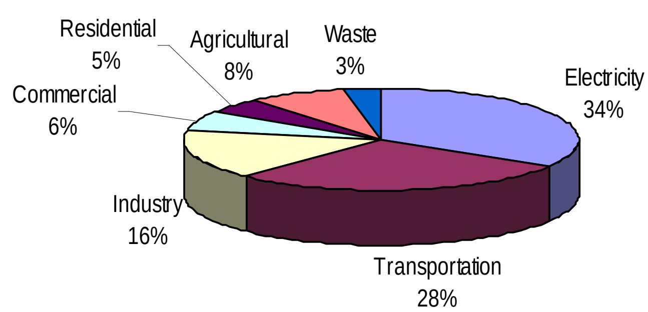
3.2 Societal Perspective NEBs – Measurement Methods

The literature on societal NEBs has grown recently with the increased attention on "green" goals and acknowledgement of the strong relationship between energy–particularly building energy–and climate change (See Figure 3.1).

In this section, we discuss three primary categories of societal NEBs:

- Climate change/emissions;
- Economic development / jobs creation, and
- Other societal NEBs.

Figure 3.1: Greenhouse Gas Emission Sources (USEPA 2005)



Much of the latest literature focuses on societal NEBs. There has been real progress in this area of NEBs research, the impacts appear to be significant, and measurement of some of these impacts (from both measure-based and behavioral programs) has interest outside the traditional evaluation literature and applications (e.g., climate change, stimulus remedies).

[14] However, it may be that the estimates associated with demand response programs may currently be considered direct impacts, rather than NEBs. However, given most programs state goals in kWh, the kW benefits would usually be considered NEBs.

[15] Many of these effects may be parallel or related to the effects listed under societal perspective. To the extent public health suffers from generation or EE programs or other activities, the utility may end up paying a judgement some day. That would represent a utility NEB (positive or negative) and benefit (or harm) the ratepayers. It is nearly impossible to judge the sources of those risks *a priori*, but as standards of business eithcis and practices change, liabilities change. Could printers know their inks would later contaminate sites and cause Superfund cleanups and their astronomical costs? Careful study of possible sources of these kinds of risks may have merit.

3.2.1 Climate Change

Energy efficiency strategies can provide environmental benefits to the region and to society because of their impact on pollution. Early studies estimated programs' impacts on meeting Clean Air Act goals, reducing acid rain, and a variety of other environmental benefits and their associated health effects. More recent work focuses on quantifying the impacts in terms of metric tons of carbon equivalent (MTCE) or metric tons of carbon dioxide equivalent (MTCO2E). These stand in for the array of emissions chemicals, and, depending on the monetization factor selected, can represent the value of the associated harmful effects from the emissions.

In the "Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases…" by the US EPA on April 24th 2009, EPA officially stated that "the case for finding that greenhouse gases in the atmosphere endanger public health and welfare is compelling and, indeed overwhelming." The ruling proposes that the six major greenhouse gasses be covered under the Clean Air Act, giving the federal government the authority to regulate the emissions of these gasses due to their imminent threat to human health, the environment, and the US national security and well-being.[16] This is a strong basis for a case to consider at least some non-energy benefits in program design and planning, and measurement of at least some non-energy benefits in regulatory arenas. The potential for cap-and-trade credits, the environmental and energy efficiency funds provided by the American Recovery and Reinvestment Act of 2009, and new attitudes in Capitol Hill bolsters the need for measurement of key societal non-energy benefits in association with energy efficiency programs.

Alternative Approaches for Estimating Emission Factors

More and more programs are looking at the benefits and costs of avoided greenhouse gas emissions.[17] Emissions are a growing consideration around the nation; we summarize progress in the literature for estimation of NEBs in this report; however, California addresses emissions impacts through adders embedded in the avoided cost figures.

Typically, evaluators will use accepted M&V protocols to measure the energy impacts related to installed measures, and then translate the energy savings to avoided emissions. There is no consensus on the amount of GHG emissions attributed to the reductions in energy use. There are currently three approaches for calculating the associated reductions:

- **System Average:** The least expensive method, and as with many other least expensive methods, the least reliable. Under this approach a system wide grid average is used for the local, regional, or national grid, and emissions per MWh are estimated. This may be the lowest cost approach; however it has the greatest level of uncertainty in emission impacts. It also masks potentially important differences between peak and off-peak programs.

- **Margin Operations:** This method looks at potentially displaced emissions for on- and off-peak hours, different seasons, and shoulder months.[18] This method takes into

[16] The original Supreme Court case overturning a lower court ruling stating that the EPA could not regulate GHGs (*Massachusetts v. EPA*) was based on vehicle emissions; however, the EPA proposal is expected to have large reaching implications going well beyond vehicle emissions.
[17] This section uses information from Sumi and Bryan 2008; Dickerson and McCormick 2005; Sumi, Block and Erickson, 2005; and Schiller, Vine, and Prindle, 2005.
[18] The State of Wisconsin's Focus on Energy "middle ground" is a good, and well documented, example of this approach.

account that the emissions for off- and on- peak hours may vary, and considers that EE impacts will most significantly affect the marginal energy producers, or the plants that come on last to compensate for high demand periods. These plants may vary depending on the season. Unlike energy impacts, on-peak hour reductions may result in a lower benefit/cost ratio than off-peak hours when considering GHG emissions. For example, in Wisconsin, Focus on Energy found that the off peak producers were emitting higher amounts of GHG than the on-peak plants. This runs opposite to EE evaluation where cost savings per MWh on-peak are typically significantly higher than cost savings per MWh off-peak.

- **Hourly Dispatch:** This approach can produce the most detailed and most certain results. But it is the most expensive analysis to complete. Evaluators look at the individual plants and calculate emissions for each hour. Determining the displaced emissions requires complex modeling of energy reduction over the entire grid and may include such calculations as the displaced emissions of building a new plant now, compared to in the future, when the plants may be more efficient.

We believe that there is general agreement by evaluators that the second two methods are preferred to the first. The first is too simplistic for most uses, and the second requires only marginally more information for a far more robust and refined outcome. This should be the minimum required analysis, and the third method may be justified for some applications.

Issues Complicating Use of GHG Emissions Avoided from EE/RE in Cap and Trade and Other Applications

Typically in energy it is not necessary to consider the locality or the specific source of the energy savings reductions within a utility territory. Evaluators are able to report the net impacts overall, regardless of where the specified energy savings originate. On the other hand, the exact source of the associated reductions is integral to the analysis of GHG reductions. If the reductions occur in a non-attainment area it could influence the evaluation of the displaced emissions.[19]

In preparation for a trading arrangement like cap-and-trade or for verifying credits for GHG emissions, three key problems must be solved to improve the credibility of energy savings computations and associated emissions.[20]

- **Additionality**: Additionality refers to emission reductions that are attributed to a program beyond those that would have occurred without the program's presence. This issue is one of the main potential stumbling blocks in attributing GHG emission reductions. This issue may become prevalent as regulators consider cap-and-trade programs and start to set limits on emissions. If a utility is mandated to reduce emissions below a given level, and an EE program reduces emissions to that level, the question of double counting and who gets to count the displaced emissions becomes important.

- **Program vs. project**: The issue of whether to measure a *program* or a *project* has also been cited in much of the literature on GHG attribution. Generally, a single *project* such

[19] On a health basis, the local air shed is critical. However, the industry currently seems to be treating a MTCE as a MTCE rather than associating specific values. As the market matures, or as auctions arise, this may or may not change.
[20] The problems associated with three topics are addresssed in many papers. Solutions have rarely been discussed in the papers.

as an office audit and retrofit will not result in large avoided emissions and the evaluation may be costly. Looking at an entire group of similar projects, or completing a *program* evaluation using a sample of projects, may be more cost effective and result in a higher quantifiable emissions reductions, but there are currently no standardized protocols to complete *program* evaluations.

- **Error, Uncertainty, and Risk**: Estimates of energy savings associated with energy efficiency and renewables strategies will have a component of error. While these errors may be lower with renewables, as the comparison is "no plant", energy efficiency represents a more complicated situation as the savings estimates are affected by baseline estimates, potential behavioral influences, etc. Uncertainty estimates might be discussed in terms of confidence intervals around savings estimates, or as a subjective assessment based on the risk to the trading program associated with over- or under-estimated savings. Others recommend that "… uncertainty levels be defined to be within certain confidence limits at the program or portfolio level. The confidence limits can be used to discount, if applicable, the allowances from an energy efficiency project. The optimum level of M&V (measurement and verification) varies by project and program and is that which finds the proper balance between uncertainty and cost – too much of either can result in an unsuccessful trading program." (Schiller, Vine, Prindle 2005, page 554)

While nearly a dozen papers in the field list and define these issues,[21] none have been in a position to resolve the issues described. This will largely have to await international discussion.

In the meantime, for the purposes of estimation of NEBs for program and planning uses (but not for carbon trading) the peak/non-peak and hourly dispatch models provide suitable methods, and there are reasonably reliable models for use in developing the estimates.

In most cases, periodically updated "deemed" factors (potentially ranges) for each generation fuel, and potential categories of vintage of plant or, where available, actual emissions, will provide a suitable method to estimate emissions. Applying these deemed values to programs would require assigning the program shares of "peak" vs. "non-peak" generation fuel mixes by utility or territory. For most program evaluation decision-making and uses, this level of detail will suffice, and it is not clear the payback from more enhanced modeling is needed and that it would balance the time and effort spent debating derivations, factors, and models. Based on preliminary research, in which variations in emission impacts on the order of 7 or 14 percent or less[22] do not affect the direction of the findings, the enhanced modeling is not needed. For high value applications, more enhanced (hourly dispatch) modeling may be justified.

Based on a review of 25 conference papers published since 2001 on the topic of assessing GHG impacts from EE programs, we found the following additional results.

- **Estimation Methods, Factors, and Impact Results**: More than a dozen papers have developed estimates of program- or portfolio-level GHG emission reductions using simple and refined emission factors. Significant impacts have been noted by the papers that went beyond a description of methods to conducting estimate work. Notably, one study (Sumi, Weisbrod, Ward, and Goldberg 2003) found that for a portfolio of Wisconsin programs, the benefit-cost ratio increased from 3.0 to 5.7 when economic and

[21] For example, Price et.al 2004, Dickerson and McCormick 2005; Schiller, Vine, and Prindle 2005; Sumi, Bloch, and Erickson 2005; Sumi, Ward, and Hall 2007; Nemtzow and Siddiqui 2008; Sumi and Ward 2008 and others.
[22] Sumi et.al 2009.

environmental impacts were incorporated (even using partial lists and conservative assumptions). In a New York study, (Hill et al., 2004) they found that even the least-cost greenhouse gas solution would be cost-effective for New York's long-term GHG reduction. These achievable contributions "… could be realized at net costs below three cents/kWh. Biomass, hydropower, municipal solid waste (MSW) , and solar thermal would be the renewable energy resource contributions, with wind added in later. The net economic benefits to New York from pursuing this least-cost approach to meeting GHG reductions for 2012 are estimated at $4.5 billion." They note they used conservative assumptions (possibly understating the true economic value of EE/RE).

- **Recommendations for Uses**: All of the studies note that GHG and societal emissions analysis work is valuable, and the authors' assessment of the progress in the literature seems to indicate that generally reliable results can be derived with sufficient convergence in basic methods and approaches. To ignore these impacts (as well as economic impacts) is to bias resource choices away from EE and shortchange the assessment of their impacts. The literature tends to suggest the main uses for these computations include:
  - cap and trade, once methods are refined;
  - cost-benefit, providing an avenue to balance short and long-term goals, and there is support for including the values in programmatic and portfolio regulatory tests, and possible development of a revised regulatory strategy that recognizes environmental benefits ,
  - marketing EE projects, and
  - reflections of measure performance.

3.2.2 Economic Development

Economic development benefits include increased employment, earnings, generated tax revenues, increased economic output, and decreased unemployment payments. We summarize these effects as "job creation/economic development". A host of other public assistance and social insurance programs depend on income, not just unemployment insurance. Most of these are transfer payments and would not necessarily be considered a net gain. Of course, taxpayers would spend less as a result, so it is a transfer to taxpayers.

Energy efficiency is a key job creation engine, and short- and long-term driver for the economy. Its importance is reflected nationally through the Administration's American Recovery and Reinvestment Act (ARRA, or commonly "stimulus package"[23]) and at the local level by states and cities that have included job creation from energy efficiency in their list of goals for climate change or demand-side management (DSM) plans.

A flurry of early work on this topic in the mid-1990s showed strong economic impacts associated with energy efficiency programs.[24] Later work (Skumatz 2001) noted that some of the early

[23] The language for the $3.2 billion for the Energy Efficiency and Conservation Block Grant (EECBG) Program, authorized in Ttile V, Subtitle E of the Energy Independence and Security (EISA) Act of 2007, and signed into Public Law (PL 110-140) on December 19, 2007 specifically states that the Act works to reduce reliance on petroleum through increases in energy efficiency.
[24] A summary of early work (pre-2001) in this field was included in Skumatz 2001, reproduced in TecMarket Works, Skumatz Economic Research Associates, and Megdal and Associates, 2001. It summarized work by Pigg and Dalhoff (1994) , Dalhoff (1996) Brown et.al. (1993) (Harris (1996)) and others. The results found high variation between the results; the literature at the time was not very mature..

estimates were overstated because they did not provide “net” estimates – netting out the job and economic effects associated with the activities upon which the money would otherwise have been spent (e.g., electricity generation, consumer price index (CPI) or other bundles). This oversight has been corrected in nearly all later work.

Recent work in the field relies largely on available input-output models–most commonly, and cost-effectively using credible, vetted models available from third-party vendors that support estimation at the county, state, or national level.[25] The estimation work requires running a “base” and “scenario” case, using the following steps:

- Select the area of coverage for the effects – county, multiple counties (that might make up a utility territory), state, or national;
- Identify the dollars spent in each of the appropriate NAICS (North American Industry Classification System) industry sectors under the scenario case incorporating the energy efficiency program, and comparing the results to the base case. For the base case, there are two schools of thought.
    - One school argues the program investments might be assumed to have transferred from the alternative expenditures of electricity generation.
    - The other school argues that because the funds are derived from public goods charges, industries associated with production of the consumer price index market basket should be used as the alternative to the energy efficiency program industry mix.
    - Credible cases can be made for both these alternatives, and selection of either one, or showing differential impacts from both alternatives would be valuable in future work. There may also be other justifiable alternatives.
- Estimate job creation and economic impacts – indirect and induced – that are “net” of the base case represents the estimate of the impacts associated with the program.

These estimated economic effects may be positive or negative, although energy efficiency programs are generally more labor intensive than electricity generation. Exceptions to the case of a positive economic impact might include:

- Cases in which the program’s measures are manufactured outside the territory being considered, but electricity generation happens locally
- Behavioral programs like load shifting programs, where the same energy and equipment is generated and used, but used at different times.
- Programs encouraging lower usage, without changing measures.

This measurement approach has become fairly common and can be applied fairly easily to a wide variety of programs in energy efficiency and renewables. Furthermore, a limited number of widely available credible models are available for analyzing economic impacts. Assuming underlying modeling assumptions are documented and defensible (industries affected, etc.) the results are relatively easily replicated and compared. Thus, estimation of these results is fairly reliable and consistent, and they should perhaps be included as a decision factor in selecting and evaluating energy efficiency alternatives.

A review of recent literature finds seven studies published since 2000 that focus on estimating economic development impacts. The quantitative results vary fairly dramatically, and are

[25] Some projects with higher funding levels are developing more locally-tailored models that may address specific sub-areas or provide more granularity at the industry level. Examples may include NYSERDA, although the author cannot tell from publications what models were used for this work. Author interview iwth Megdal (November 2009) indicates the MBECS model was used.

presented in different units. One study ((Mulholland, Laitner, and Dietsch 2004) estimates each dollar of federal spending drives $3.54 of non-federal investment (e.g., matching state spending dollars plus private sector investment). An Oregon study (Josephson, et. al., 2004) estimates that one average megawatt saved increases annual economic output in Oregon by $2.2 million. The only studies that examined differences by program type and region (Imbierowicz and Skumatz 2004, Imbierowicz, Skumatz and Gardner 2006) found that economic output multipliers associated with weatherization program expenditures are considerably higher locally (more labor intensive) than those associated with appliance replacement programs (46 percent vs. 25 percent for Wisconsin, 49 percent vs. 34 percent for California, and 106 percent vs. 25 percent for the US). Comparing state impacts, the study found slightly larger multipliers for California programs (likely due to broader industry mix), In addition, the study finds that appliance replacement programs do not provide much multiplier effect even when national scope is considered, largely because appliances are mostly manufactured overseas. The study illustrates several key points:

- All energy savings and all programs are definitely not equal when economic impacts are taken into account.
- Economic impacts need to be estimated separately for each program (type) and locality. Economic impacts are local, and "deemed" values are unlikely to be well suited to estimating program impacts.[26]

The range of results is troubling; however, given that the impacts vary by program and territory, some variation is to be expected. More work is needed to compare and verify results, and identify and confirm logical patterns in results.

Theoretically, modeling procedures are fairly simple, and credible models are available. This is an area in which impacts could be measured, included, and analyzed fairly readily and with a fair degree of confidence, and the metrics could be used to:

- Select (or craft) measures, programs, or portfolios with greatest impact on the local or larger economy;[27]
- Provide credible estimates of auxiliary benefits associated with programs, that may (or may not, from a policy point of view) be included in benefit-cost tests for program planning and selection.

3.2.3 Other Societal Benefits

- **Health and Safety (H&S)**: Little work was published on health-related NEBs since 2001. Risks from weatherization and other "building tightening" programs include risk from carbon monoxide exposure. Brown (1996) provides some early assumptions and computations of the associated risk. The only work measuring incidences related to safety impacts is Blasnik (1997). Health and other risks associated with other indoor air constituents have not been well researched, but none of the individual components involved in demonstrating the value of these impacts is inherently difficult to estimate. One of the most interesting studies on this topic is Fisk (2000 and others). His study contains results that have implications for the societal and the household / participant perspectives. He specifically estimates the effects from indoor air quality (IAQ) and the indoor

[26] However, it is possible that regulatory agencies may want to designate acceptable third party models in order to reduce arguments about modeling.
[27] And in the short run, identify progarms that may be best suited to "stimulus package funds".

environment on the prevalence of common health effects,[28] This shortage of studies does not mean this is not an important topic–quite the opposite. The research is expensive, generally requiring detailed data on program measures or interventions with health-related effects, detailed data on pre-post or test/control groups. However, even with these data, it is difficult to make generalizations about health effects associated with programs because of the variety of measures, behaviors, and the strong potential for interrelated and compounding effects. These effects make energy savings estimation and modeling work difficult; the challenge of taking impacts from individual measures and trying to sum them to provide credible estimates of health effects is daunting unless it is conducted on a program-by-program, test/control basis, or the impacts are provided as a "bounding value" rather than an estimate. Taking the leap from these (personal) impacts to the societal impacts of these illnesses on hospital infrastructure needs and insurance rates (the societal reflection of these impacts) is important, but even more problematic and complex. Some effects are reflected in insurance tables – like fire deaths and property damage – and to the extent these effects can be traced to program measures, credible (partial) H&S estimates can be developed. But asthma and other chronic diseases may be exacerbated (or improved) by EE design and measures, and these effects may well be very important. At this time the estimation work needed to monetize these effects does not exist. Given concerns from builders, architects and engineers, and occupants about sick buildings, asthma, and other issues, it is likely valuable to conduct research to estimate the level of these risks sooner rather than later. If large, it should be addressed and mitigated; if small, that fact can be widely disseminated in marketing materials to alleviate fears about EE measures.

- **Low Income Hardship:** Programs can have an impact on resident illnesses and job retention, on disposable income and bill payments, and ultimately household relocations. Work in Oregon and elsewhere (Quantec 2008a, b, Khawaja et.al., 2007) has used combinations of arrearage- and survey-based data related to improved utility payment behavior and illnesses to estimate impacts on employment status, mobility, reduced dependence on state benefits, and family stability.

- **Water**: Impacts on water savings have been analyzed at a household or business participant level (especially in association with clothes washer programs), and estimates of water saved per measures installed is reliably well-known. Behavioral impacts will have an effect on these estimates and provide interesting programmatic opportunities, and some studies indicate that changes include longer showers and other effects. The infrastructure impacts related to deferral of new plant or treatment facilities or other societal impacts have <u>not</u> been studied. In many areas of the country, especially California, water is a precious resource, and development of new supply is costly. To the extent that energy efficiency programs include measures that save energy for hot water and secondarily save water, society benefits. The volume of avoided water and wastewater use (which are easily estimated from program records) can be valued at the

[28] He examines impacts on costs of the illness directly, as well as on employee leave and productivity issues. He develops dollar values for the national productivity gains from improved IAQ. Potential annual savings and productivity gains of $6-14 billon from reduced respiratory disease, $1-4 billion from reduced allergies and asthma; $10-30 billion from reduced sick building syndrome symptoms, and $20-$160 billion from direct improvements in worker performance that are unrelated to health. He also considers impacts from communicable illnesses, sick building syndrome, and direct impacts on human performance (including impacts from thermal environment, lighting, and IAQ), He suggests that key measures that might trigger these improvements include: lighting, air economizers, heat recovery, nighttime pre-cooling, operable windows (vs. fixed), insulation, and thermal windows. (Fisk, 2000).

avoided water cost or cost of the next water supply source where that information is available. Deferring development of a dam or next water source has potentially very significant societal benefits to communities in investment, access to capital, and helping keeping rates low.

- **Infrastructure, National Security, and Other Societal Benefits**: Little work has been conducted on other societal benefits. Recalling the discussion of GHG impacts above, one study notes infrastructure benefits associated with deferring construction of power plants until the plants are "cleaner"–or we might morph that argument into deferral of plants until they can be replaced with plants with cheaper fuel types or fuel types preferable for other reasons. For example, fuels with US-based sources, rather than international sources that may face import restrictions or be subject to political winds. Work in this area is nearly completely lacking, at least in the available public literature, and thus, the importance is difficult to assess; a preliminary scoping should be conducted to identify at least the bounds for this valuation.

3.3 Participant Perspective NEBs – Measurement Methods

More than 45 studies on NEBs have been included in the major energy journals since 2001.[29] The studies address one or several of the following topics:

- methods for estimating specific (or groups of) participant NEBs,
- participant NEB estimation results for specific programs,
- recommendations for additional research participant NEBs, and
- recommendations for appropriate uses for participant NEBs.

Well-researched measurement work on NEBs, based on detailed literature research and work in contingent valuation, scaling techniques, revealed and stated preference and other methods were pioneered in the late 1990s. Granted, NEBs are, almost by definition, hard to measure (HTM); however, not measuring the effects means that decisions about programs are likely to be suboptimal because they ignore key effects. Running scenario analysis around ranges or order of magnitude values would be preferable to excluding the impacts altogether. Thus, approximate estimates provide value; the improving sophistication of measurement methods implies that these approximations are getting better and better.

By far, the greatest controversies related to participant NEBs arise from two issues:

- Measurement/computation approach, and associated confidence in the results, and
- Appropriate uses of the estimated NEBs.

The major approaches to measuring participant NEBs that have been used or proposed at the individual household or business level are briefly outlined below.

There are two main categories of NEB estimation approaches.

- Computational approaches, using primary or secondary data assembled from program records or literature-based sources; and

[29] Our starting point for the new literature review. The author conducted a thorough review of more than 350 studies related to NEBs for a project in 2000/2001. This research was the basis for Skumatz 2000 and for TecMarket Works, Skumatz, and Megdal, 2001. The findings and conclusions that are still relevant from that previous work are embedded in this research paper.

- Survey-based approaches: Most commonly used are several types of survey-based data gathering and estimation approaches, including stated preference surveys, and revealed preference approaches. The latter include willingness to pay (WTP) and willingness to accept (WTA) contingent valuation (CV) studies; comparative or relative valuations; and other revealed preference and stated preference approaches.

Direct computation approaches have obvious benefits. Unfortunately, an extensive array of less tangible but potentially important benefits that have been repeatedly listed as important in the literature cannot generally be estimated directly by a computational approach, including comfort, aesthetics, and other factors. Thus, relying on computational methods is not sufficient in deriving overall estimates of participant-perspective NEBs. A variety of survey-based valuation methods have been used by economists, social scientists, and researchers in the environmental and advertising fields to develop estimates of the monetary value of externalities and intangible goods. Each method has been derived from a review and application of well researched academic literature. Methods with particular applicability to energy are discussed below (Skumatz and Gardner 2006), including direct computation, stated preference survey, [30] and other approaches. We categorize them into 7 different types and 11 methods that have been applied to NEBs to some degree.

[30] Since 1994, the standard prelimiary steps in conducting these sureys has been to first ask an open-ended question about what NEBs may have been recognized by the respondent, then whether or not individual NEBs are positive or negative, before proceedings with more complex questions about valuations. Skumatz 1997 and succeeding literature.

Table 3.1 Participant NEB Computation Approaches Proposed and Used to Date[31]

Category	Description	Specific estimation approaches	Strengths	Weaknesses
A. Computational approach / Primary Estimation:	Some categories of NEBs can be estimated fairly directly. For example, lost work time can be calculated using pre-post office records and wage rates[32] or other monetary values for time.[33] Summarily, water/sewer savings can be calculated using data on actual water and sewer rates.	1. Primary computation	• Strong, reliable, defensible results well executed	• Expensive • Lacks large sample sizes, so applicability and statistical properties are weak • Generally only used for limited number of NEB categories
B. Computation using Secondary Data Estimates:	In this case, secondary data from various sources are combined to develop a credible estimate of program impacts. For instance if secondary data are available noting risk of fires from particular measures, and the value of each average fire in terms of loss of property and life is available from, for instance, insurance companies, then these values can be multiplied times the number of measures installed to develop a total estimated value of risk from fires (or health and safety).	2. Computation from secondary sources	• Strong, reliable, defensible results • Adaptable to scenario analysis	• As strong as the secondary sources • May only be applicable to a subset of very quantitative NEB categories
C. Computation / estimation using Regression Approaches:	In some cases, statistical and regression approaches have been used to develop estimates of productivity or other effects that can be affected by confounding factors (Okura, et.al. 2000). These have been applied to several very important NEBs related to daylighting, specifically sales benefits in retail outlets, and test performance improvements in schools.	3. Regression approach	• Strong performance, with statistical reliability associated with results • Can be used with important quantitative NEBs	• Expensive, labor and skill-intensive • Data collection difficult • Can only be used to estimate limited set of NEBs
D. Survey methods – Contingent Valuation and Willingness to Pay (WTP) / Willingness to Accept (WTA) surveys.	Contingent valuation surveys are widely used in the environment and natural resources fields to estimate the value of intangible or hard-to-measure impacts including recreation, environmental and other effects. The contingent valuation (CV) method of non-energy benefits valuation, in its most basic form, entails simply asking respondents to estimate the value of the benefits that they experienced in dollar terms (willingness to pay WTP/ willingness to accept WTA are common approaches). An advantage of WTP surveys is that they provide specific dollar values for benefits that can be compared to each other and to the value given for the comprehensive set of program benefits. Disadvantages include the difficulty that many respondents have in answering the questions, the	Methods include: 4. Open-ended contingent valuation WTP / WTA questions,[36] 5. Discrete contingent valuation questions,[37] 6. Double-bounded and one-and-one-half bounded question formats,[38] 7. Ranking and	• Common in literature • Clear in application • Relatively inexpensive*	• Difficult for respondents to understand and answer* • Volatile responses* • Literature cites weaknesses with open-ended responses relative to bounded options

[31] Skumatz and Gardner, "NEBs...", Western Economics Association International Paper, NV, 200X, adapted.
[32] As noted in Skumatz and Gardner, 2006, there are weaknesses from some of the direct computation methods as well. Direct computations are only available for an almost certainly non-random list of participants, and would likely be biased upward becuase only those businesses expecting large impacts would be likely to measure them..
[33] Some businesses may have conducted research of this type. However, estimates tend to be limited in nature, covering only the odd business or covering only one measure or a key benefit, limiting the size of the sample (and thus the error band estimation), as well as the coverage of NEBs.

Category	Description	Specific estimation approaches	Strengths	Weaknesses
	volatility of the responses, and significant variations in responses based on socioeconomic, demographic and attitudinal variables.[34 35] Enhancements over open-ended WTP or WTA options have been used in multiple NEB studies with varied levels of success.	ordered logit approaches[39 40]		
E. Survey methods – Relative scaling methods	In this approach, respondents are asked to state how much more valuable (specific or total) NEBs are relative to a base. That base may be a dollar amount, or another factor known to the respondents. Initial work focused on asking percentages higher / lower for valuations. After an extensive review of the	In summary, the categories of these methods include: 8. Relative scaling in percentage terms; 9. Relative scaling in	• Well demonstrated in academic literature • Easy for respondents to answer / understandable* • Less volatility than WTP	• Requires good choice of enumerative / comparison factor. • LMS requires quantitative translation from several responses

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[34] Responses to open-ended contingent valuation questions are more prone to bias (Arrow et al. 1993), and the experience of the authors has been that such responses vary more than those provided by any of the other valuation techniques discussed in this paper (Skumatz 2002, Skumatz and Gardner 2006).34 Arrow et al. (1993) list the following criticisms of the contingent valuation (CV) method for environmental valuation: 1) CV can produce results that appear to be inconsistent with assumptions of rational choice; 2) responses can seem implausibly large when considering multiple programs; 3) relatively few previous applications of the CV method have reminded respondents of relevant budget constraints; 4) it can be difficult to provide adequate background information on the programs and assume it is absorbed by respondents; 5) it can be difficult to determine "extent of market" in generating aggregate CV estimates , and 6) CV respondents may be expressing the "warm glow" of giving, rather than actual willingness to pay for the program in question

[35] Skumatz and Gardner 2006 discuss these aprpoaches in great detail as they apply to NEBs; a summary of key issues follows. Despite the well-known limitations of direct or open-ended contingent valuation questions, there are certain situations in which they can be of use in measurement of NEBs. However, while open-ended WTP can sometimes be useful in generating a baseline, to provide more consistent and credible survey information, several variations on WTP/CV approaches can be used. 1) Discrete contingent valuation questions, in which respondents are asked to give a binary "yes/no" response regarding whether they would be willing to pay a given amount for a specified good (e.g., the non-energy benefits that they experienced). This is the CV question format recommended by the 1993 NOAA panel on contingent valuation (Arrow et al. 1993). 2) Double-bounded or one-and-one-half bounded question formats, in which respondents are asked (a) to give a yes/no response to a first value, then give a follow up response to a second value, which is higher or lower depending on the response to the first question, or (b) told that the true value of the goods in question are thought to exist within a certain range, and asked to give a yes/no response to a random value, then asked to give a second response to a lower or higher value depending on the first response, unless the first response was a no to the lowest value or a yes to the highest value. These variations may increase the quality of the willingness to pay estimates obtained from referendum-type contingent valuation questions. See Cooper, Hanemann and Signorello (2002) for a discussion. 3) Ranking cards to estimate willingness to pay (also called ordered logit). The survey instrument used in this approach differs and asks respondents to rank several hypothetical scenarios in which the amount of non-energy benefits, other characteristics of the program, and a numeraire are varied at random. A rank-order logit model is then used to estimate the parameters on the utility function. The advantage to the rank-order approach is that it neither asks respondents to provide percentage or dollar estimates of the value of the non-energy benefits that they experienced nor does it ask them, hypothetically, whether predetermined values would be acceptable in exchange for those benefits. An additional advantage of this approach is that the information obtained is very robust, and the models can often be estimated with relatively small sample sizes (Weitzel and Skumatz, 2001)

[36] Used by multiple researchers

[37] Used by multiple researchers

[38] Used in Skumatz and Gardner 2006 and other work by the authors.

[39] Linked with statistical modeling approaches.

[40] See Skumatz and Gardner 2004 WI and Summit Blue / Nyserda 2007.

Category	Description	Specific estimation approaches	Strengths	Weaknesses
	academic literature, the use of simpler word-based comparisons (much more, etc.) could be justified and adapted, and was tested extensively.[41] The nomenclature in the academic literature for this approach is "labeled magnitude scaling" (LMS).[42]	verbal terms (LMS)	/ WTA / CV approaches* • Inexpensive* • Can gain responses from large sample of customers, improving statistical properties	
F. Ranking-based survey approaches	These surveys ask respondents to rank NEBs or measures with alternative sets of NEBs on a two-way comparison basis (for example Analytic Hierarchy Process, AHP) or more numerous options in rank order (usually ordered logit or similar approaches). To make the estimates most robust with the least cards or questions, careful statistical design is needed (for example orthogonal models like latin squares). These approaches use information from the rankings to compute values and preferences. (Skumatz and Gardner 2004, Khawaja 2009, Wobus et.al. 2007)	9. AHP 10. Ranking and ordered logit approaches[43] [44]	• Robust estimates with good statistical properties are derived using this method • Requires less "monetizing" of NEBs by respondents • Strong academic grounding	• Complex question and experimental design • Can require complicated comparisons by respondents • Slower than other responses. • More difficult than some other approaches for analyzing multiple NEBs, measures.
G. Other survey-based approaches - Hedonic regression:	Most of the other methods presented have been the stated preference variety used for non-market (including environmental) goods; they require program participants to directly disclose, in one way or another, their preferences for non-energy benefits. Many non-energy benefits, however, are market goods. They are purchased by consumers, bundled with the energy-efficiency appliances that	10. Hedonic decomposition	• Well demonstrated in academic literature • Provides strong statistical and explanatory power / causal factors	• Expensive, labor and skill-intensive • Data collection complicated • Can only be used to estimate limited set of

[41] The LMS was applied in Skumatz 1999. Multipliers to allow transtiion between words and values are presented in the literature; however, Skumatz used surveys from more than 500 respondents to confirm and refine these values for use in NEBs. The values from the academic literature were generally confirmed.

[42] The relative scaling method of non-energy benefits valuation is a stated preferences approach in which survey respondents are asked to express the value of the non-energy benefits that they experienced relative to a well-understood numeraire, such as the energy savings due to the energy-efficiency measures installed through the program, program costs, or potentially any of a host of outside / non-program factors (The use of this technique and this numeraire for application to energy efficiency programs was pioneered in Skumatz and Dickerson 1997) There are several variations on the basic approach. In the direct scaling variant, respondents are asked to estimate their non-energy benefits (both positive and negative) as a percentage of their cost savings on energy. In the Labeled Magnitude Scaling (LMS) variant, respondents are asked to rate their non-energy benefits as being more valuable, less valuable or as valuable as the numeraire (e.g., their energy savings). Responses are then scaled using multipliers derived from academic sources modified by extensive empirical work from energy surveys. The relative scaling method has several advantages for use in survey research. First, program participants often find it difficult to express non-energy benefits, which are intertwined with more directly energy-related aspects of the efficiency measures that they receive, in absolute levels. However, as participants in energy efficiency programs, they are often well-attuned to changes in household or business energy costs, and therefore fully cognizant of the value of reduced energy use. Expressing the value of non-energy benefits relative to more obvious energy savings is a natural comparison that most respondents can easily make (Skumatz and Gardner 2006). As noted in Amann (2006), Skumatz pioneered this approach for NEB use and aplied it in studies of residential appliance and low-income weatherization programs (Skumatz and Dickerson 1998; Skumatz, Dickerson and Coates 2000) and has since applied it in studies of ENERGY STAR home performance, new homes, and appliance programs (Fuchs, Skumatz and Ellefsen 2004). In these studies, respondents found the relative scaling questions much easier to answer than WTP questions and the responses were more consistent than those from WTP surveys.

[43] Linked with statistical modeling approaches.

[44] See Skumatz and Gardner 2004, Khawaja (2009) and Wobus, et.al. 2007.

Category	Description	Specific estimation approaches	Strengths	Weaknesses
	produce them, and hedonic regression approaches are suitable for these applications, decomposing price of a good as a function of its characteristics (Griliches 1961, Shelper 2001). With some variations, hedonic methods have been applied to NEBs.[45] [46]			(quantitative) NEBs
H. Other survey approaches - Reported Motivations and Factor-Importance Judgments.	Customer-reported motivations for pursuing home performance projects and the relative weighting of those motivations can also be used to determine the value of the energy and non-energy benefits resulting from the project. Lutzenhiser asked customers in a California project about their motivations for buying comprehensive home performance retrofits. The reported multiple motivations among six categories (in order of frequency): specific system/building concern; environmental health and energy costs (tied); comfort; resource conservation; and other (Lutzenhiser Associates 2004).	11. Reported Motivations	• Strong performance analytically, statistically • Easy for respondents to answer • Handles quantitative and qualitative, hard and "soft" NEBs	• Expensive, labor and skill-intensive • Data collection complicated
Key: Asterisks represent results illustrated in the performance comparisons from Skumatz 2002.				

[45] Because many of the characteristics of goods that give rise to non-energy benefits are abstract and subjective (e.g., light quality), the traditional hedonic regression approach may be difficult to apply. However, using the more restrictive definition of non-energy benefits, a hedonic approach to the estimation of the non-energy benefits that arise due to increased levels of energy-efficiency technology is possible and has been used. Caroll (2005) discusses a similar approach, suggesting statistical analysis of revealed preferences. Revealed preference models using a combination of program data and survey results can be used to derive estimates of NEB value. The models are used to determine how reported intent translates into action, incorporating information on, for example, the cost of the installed measures, the NEBs reported by participants, and the value of those NEBs as determined through a CV survey to derive estimates of the actual costs participants paid for the energy and NEBs associated with common projects or measures (Carroll 2005). One drawback of this approach is the time and expense associated with data collection and analysis. Skumatz and Gardner 2005 used the hedonic regressions approach to associate NEBs with specific meaures in a bundled measures program.

[46] This technique may not be as robust as the stated preference approaches discussed above in that it is not capable of estimating subjective types of non-energy benefits because the more subjective characteristics of energy-using measures (aesthetics, contribution to household comfort and aesthetics, impact on health, etc.) are not available on a product-by-product basis, and are difficult to distill into readily interpretable units. This limitation notwithstanding, the hedonic regression approach non-energy benefits valuation uses data that are (a) readily available for most energy-consuming measures and (b) less susceptible to bias than direct estimates obtained from surveys. Of course, the hedonic regression approach also assumes that the characteristics of a good are the only significant determinants of its price – an assumption which may or may not be reasonable depending on the goods under investigation. (Skumatz and Gardner 2006).

Data Collection: Studies have used a variety of methods for collecting data to support estimation of participant NEBs, including phone, mail, web, on-site interview and email approaches, as well as detailed on-site data collection using program and business records, etc. Of course, each of these data collection methods has the usual pros and cons (relative cost, speed, length / complexity tradeoffs, etc.). However, when it comes to survey-based NEBs, phone and web approaches provide additional advantages;[47] interview and on-site data collection work best for ranking and regression-based options.

Comparison of Performance of Participant NEB Approaches

Advantages and disadvantages of these various approaches have been addressed in the literature and are summarized in the Table above. To date, only a few studies have directly compared NEB results arising from multiple measurement methods, and these findings are incorporated into the advantages and disadvantages described in the table above. These studies used two or more computational approaches to develop estimates for one program and data collection effort. Various combinations of the studies allowed comparisons between "labeled magnitude scaling" (LMS), comparative percentage, Willingness to Accept (WTA), Willingness to Pay (WTP) results, and ranking methods. The main factors used to compare the performance included:

- credible methods/demonstrated in literature;
- ease of response by respondent /comprehension of the question by respondents;[48]
- reliability of the results;[49]
- volatility of results within studies and in comparison to others;
- conservative /consistent results;
- cost; and
- computation clarity.

Generally, the comparative research which examined quantitative and qualitative features associated with the NEB measurement methods, found that:

- WTP and WTA results (from Group D in the Table above) were weak and volatile, and confusing to respondents (and consequently had significant no response and missing observations). Respondents were slow to answer because of the confusion, and thus, data collection was relatively expensive, especially given the quality of the data in the responses. The values were generally larger (less conservative) than responses estimated using other methods (particularly Group E).
- Comparative responses (Group E) were generally consistent across programs, and very quick for respondents to answer, supporting reasonable data collection from hundreds of respondents, which improves statistical properties. The verbal comparisons (LMS) (method 9) were quicker for respondents (than Method 8), and the factors derived from the comparison of percentage vs. LMS categories were reported to be very consistent with the values reported in the academic literature.

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[47] These include easy skip patterns (to help shorten potentially lengthy and confusing batteries of questions) and the ability to provide greater explanations if the concepts are unclear to respondents. As costs decrease, larger samples can be accommodated, supporting better statistical properties, so this is also an advantage.

[48] Assumed to be at least somewhat related to or reflecting reliability of individual responses – less "guessing" involved (Skumatz 2002)

[49] Given the types of categories of benefits being measured, "accuracy" is difficult to assess or verify. The literature that has addressed this issue tends to relate it to the next criteria, consistency of results (across similar programs, or for the same program at different times, etc.)

- All methods involving WTP, WTA, and comparative valuation approaches (within Groups D and E) supported practical computation of NEBs for more than one NEB category.
- Ranking methods (Method D, number 7) provided for slower data collection than other methods, with more missing data. The questions were more difficult to construct, and only limited comparisons could be asked in the phone format, limiting the number of NEBs that could be estimated. The results were more conservative (lower) than those derived using the comparative (LMS and percentage) methods.
- The hedonic method (group G, number 10) was flexible and the results were consistent in direction and size with *a priori* theory.

These preliminary results are useful as others explore these and other analytical methods. To date, the LMS is a strong performer, balancing consistency, speed/efficiency/cost, and flexibility. If only one important NEB is necessary to measure, the regression-based techniques may be well-suited to the purpose. However, more work needs to be done to cross-reference and cross-check the performance and especially consistency of the results from the various methods. Only when considerable cross-checking is provided, along with demonstrated statistical properties, will confidence build for the computation of participant NEBs – especially the "softer," but still important benefits like comfort, and other NEBs. It is recommended that additional estimation work proceeds, employing multiple measures within one study to allow cross-checking and verification. Given that the literature has touted the importance of these benefits for two decades, developing credible measurement methods is important.

4. NEB VALUES / PATTERNS FOR LOW INCOME PROGRAMS

A detailed review of the quantitative literature on low income program NEB results is summarized in the table below, sorted by perspective and NEB category.[50] Table A.1 in the Appendix provides detailed quantitative results from several dozen low income studies; these results were used to draw the summary provided in Table 4.1. Patterns in these results are summarized in the following section.

Table 4.1 Values for NEBs for Low Income Programs for Utilities around the Country
(color groupings indicate "perspective"; LIPPT values summarize values prior to 2000; remainder updates that literature)

ID	Perspective or NEB Category	Summary of Values (per participant / yr); Implications
#	*UTILITY PERSPECTIVE*	
1	Carrying cost on arrearages	Impact values are higher for programs targeting high arrearage customers; Most standard programs in the 20-30% impact range. Dollar values clustering around $2/participant, and $32 (several in range of $60). High estimates values are reduced into this general range when translated into annual carrying cost terms.
2	Bad debt written off	Impact values usually in the 20-35% range; not many studies specifically on this feature. Values $60+ for those affected, $2 when averages across all participants.
3	Shutoffs	Values on order of $2 or less for many utilities; several found very high values ($100+)
4	Reconnects	Net values from pennies to $50+ reconnect charge (many did not multiply times incidence)
5	Notices	Few study these separately
6	Customer calls / bill or emergency-related	Values on order of $0.50.
7	Other bill collection cost	Few study these separately.
8	Emergency gas service calls (for gas flex connector and other programs)	Based on 2 main studies – Magouirk and Blasnik. Needs more work.
9	Insurance savings	Very rarely examined
10	Transmission and distribution savings (usually distribution)	Not often separately studied; embedded in utility avoided costs for some. Rules of thumb estimated percentages for some.
11	Fewer substations, etc.	Not studied to date
12	Power quality / reliability	Not studied to date
13	Reduced subsidy payments (low income)	Very directly related to the energy savings and utility's discount rate
14	Other	Tbd
	Total Perspective Utility	Lowest of the 3 perspectives. Totals range from $4-$31/HH.
15		
16	*SOCIETAL PERSPECTIVE*	
17	Economic development benefits – direct and indirect multipliers	Very dependent on measures and program type.
18	Tax effects - (2 possible effects: related to unemployment and income taxes from job creation / economic development; another effect possibly related to tax	Directly related to above plus local tax schedules. Can be calculated relatively easily. Not volatile in an unpredictable way.

[50] A table summarizing the specific estimation methods used in the 2000 Low Income Public Purpose Test is presented in Appendix A.

ID	Perspective or NEB Category	Summary of Values (per participant / yr); Implications
	credits for investment in certain measures / PV / solar, etc.)	
19	Emissions / environmental (trading values and/or health / hazard benefits)	Dependent on fuel mix, time of day (peak / off-peak) or can use more complex algorithms. Varies by utility. For California, the values are embedded in avoided cost adders.
20	Health and safety equipment	Very few studies; presumably very dependent on measures
21	Water and waste water treatment or supply plants	Rarely or never studied
22	Fish / wildlife mitigation	Never studied
23	National security	Rarely studied
24	Health care	Rarely studied
25	Reduced dependency / Improved social indicators of family stability and employment / reduced dependence on state assistance	Rarely studied, important
26	Other	
	Total Perspective Societal	Potentially valuable when economic development and emissions effects included.
27	***HOUSEHOLD PARTICIPANT PERSPECTIVE***	
28	Water / wastewater bill savings	Somewhat valuable, especially in California with high water and sewer rates. Easily computed from secondary data; depends on measures installed. $5-12/HH/yr
29	Operating costs (non-energy)	Rarely studied.
30	Equipment maintenance	Survey-based; $17-22 estimates.
31	Equipment performance (push air better, etc.)	Many studies; important, especially with comfort; extant values $14-18
32	Equipment lifetime	Few quantitative results separate from surveys.
33	Shutoffs	Survey based or based on computations of time value. Seems to indicate small values because of low incidence. Current values vary from a few cents to $12. Varies based on procedures at utility and charges.
34	Reconnects	Same as above.
35	Property value benefits / selling	Potentially very important, but also very local and program-specific (what measures, etc.). Needs more study, but likely very hard (costly) to compute because of data collection (not because it is complex). Varies from a few dollars to more than $20.
36	(Bill-related) calls to utility	Time value of data from arrearage study. Generally around $0.30; one study finds up to $8.
37	Comfort	Valuable in almost all studies; see line 31. Up to $50+ per year in one study. Commonly one of the top benefits from low income programs.
38	Aesthetics / appearance	Survey-based; should be related to line 35
39	Fires / insurance damage (gas)	Rarely studied; indirect; incidence data very thin.
40	Lighting / quality of light	Survey-based; depends on measures installed. One study showed $25.
41	Noise (internal / equipment)	Survey-based; depends on measures installed; extant values $15-20.
42	Noise (external)	Same as above; extant values $13-17
43	Safety	Few incidence studies – needs more work.; extant values about $20.
44	Control over bill	Survey-based historically. Values ~$30.
45	Understanding / knowledge	Needs more study. Potentially important.
46	"Care" or "hardship" (low income) - and/ or see row 53 - related	Important for further exploration.
47	Indoor air quality	Not strongly recognized as separate impact in most studies.
48	Health / lost days at work or school	Important; high value for some programs, but most between $4 and $12 / HH / yr.
49	Fewer moves	The mobility value is potentially high, but incidence studies are few. One study found value of more than $60; most use more conservative numbers and derive lower

ID	Perspective or NEB Category	Summary of Values (per participant / yr); Implications
		estimates (under $1 because of small incidence)
50	Doing good for environment	Highly valued by participants; not clear value to programs
51	Savings in other fuels or services (as relevant)	Direct when measuring gas and electric; not many other services studied.
52	GHG and environmental effects	Measured under societal.
53	Employment and family stability, reduced dependence on state assistance	Important; see line 46
	Other	Depends.
55	NEGATIVES include: Installation hassles / mess, negative values from items above	Not usually found to be important / valuable.
	Total Perspective Participant	Majority of value for some programs

4.1 Results, Patterns, and Conclusions from Low Income Program NEB Results

A review of these findings, along with the results included in the 2001 LIPPT summary report, allows us to examine some patterns by region and program type. Table 4.2, 4.3, and 4.4 summarize patterns in the results for each of the three perspectives, respectively utility, societal, and participant. Note that, in almost all cases, the values are based on an analysis of program-wide NEBs – not based on measure-specific impacts.

Table 4.2 Patterns in Utility NEBs by Program Type and Region

	Utility NEBs
General results	Small – less than 10% of total NEBs in most cases.
Variations by Program type	The effects have historically been larger for low income programs because the potential impact from arrearages and the impact of rate subsidy reductions are larger. Some have found that programs that target high arrearage customers have particularly larger impacts from utility NEBs. Few other impacts have been examined in great detail. If capacity impacts are examined and valued, it is likely peak programs will begin to have much more influential effects on Utility NEBs. To the extent line losses are higher or lower proportionally in peak vs. non-peak times; similar patterns will emerge if these values are incorporated.
Variations for Low Income or other sectors	Low income programs bring more Utility NEBs for arrearage reduction and reduced rate subsidies.
Variations by region of the country	Climate zones could affect these NEBs because of the effect of harsh winter climates (and high summer conditioning) on bills and arrearages, including for low income households. No specific patterns have been uncovered. In addition, gas utilities may see higher effects from potential emergency situations avoided.

Table 4.3. Patterns in Emissions and Job Impact NEBs by Type of Program and Region[51]

	GHG Emissions	Economic Impacts
General results	Emissions impacts have improved a great deal over the last 5 years, and have shown significant impacts.	Range from multiplier of 3.54 for national expenditures on EE (Mulholland, Laitner, and Dietsch 2004) to multipliers of 0.25 for appliance replacement programs (Imbierowicz et. al. 2006). In OR one MW saved

[51] Again, note that California embeds emissions and T&D effects into the computations of avoided cost; no separate work on these NEBs is required. However, this summarizes the broader literature, for the interest of the reader, and the results may provide a value that can be compared to the values incorporated into the avoided cost.

	GHG Emissions	Economic Impacts
		increases output by $2.2 million.
Variations by Program type	The effects vary significantly with program type to the extent that different programs deliver savings at different types of day / days of week / months of year. Emissions vary with the generation profile for the time the savings are delivered. Work by multiple authors finds these variations. Emissions reduction during peak hours is often smaller than for baseload reductions (baseload plants are less expensive but put off more GHG). However, see notes regarding region of country below. Thus air conditioner programs will have different profiles than lighting retrofits.	Dramatic impacts depending on program type because it affects different underlying industries affected by the program's specific measures and make-up (e.g. labor intensity). One study found multipliers from 30% more to more than doubled for weatherization compared to. Appliance replacement programs.[52] (Imbierowicz et. al 2006). The study finds that appliance replacement programs do not provide much multiplier effect even when national scope is considered, largely because appliances are mostly manufactured overseas
Variations by sector	No additional variations than by program type or region as listed elsewhere.	No additional variations than by program type or region as listed elsewhere.
Variations by region of the country	Significant variations by region of the country because the driver is electricity generation mix (at peak and off-peak). Where there is more hydro, emissions are lower, etc.	Variations are significant because the industry mix varies across the nation. The one study examining this impact[53] found that multiplier impacts for both weatherization and appliance replacement programs were always lower in Wisconsin than in California or nationwide (about 10% to 50% lower depending on program type). The study found slightly larger multipliers for California programs (likely due to broader industry mix), and largest when nationwide scope is considered.

Table 4.4. Variations in Participant NEBs by Program Type and Region

	Participant NEBs
General results	Large – often equal to the value of the energy savings, depending on program (see below). There are patterns in leading NEBs as listed above.
Variations by Program type	Participant NEBs are higher for whole building programs than individual measure programs. This seems largely related to the inclusion of measures that affect comfort (HVAC, windows, design features).
Variations by sector	High value residential side NEBs tend to be: comfort, doing good for the environment, operations and maintenance / lifetime, and aesthetic effects. On the non-residential side, the most valued NEBs tend to relate to: comfort, operations and maintenance / lifetime, equipment performance, doing good for the environment, and labor / productivity issues. Low income programs tend to have higher NEB values associated with feature like "improved understanding of equipment energy use", control over bills, and similar. Negative NEBs – reflecting barriers – have also been measured. On the non-residential side, maintenance issues are the most common concern; on the residential side maintenance and aesthetic issues arise.
Variations by region of the country	Climate zones are influential in the value of NEBs because much of the high-value benefits come from comfort (affected by harsh winter climates and high summer conditioning). This single factor is often 15% or more of all participant NEBs. One study found that the highest valued source of NEBs was the insulation work (related to comfort).[54] In addition, on bills and arrearages, including for low income households. No specific patterns have been uncovered.

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[52] The study found economic output multipliers assocated with weatherization program expenditures are considerably higher locally (more labor intensive) than those associated with appliance replacement programs (46% vs. 25% for WI, 49% vs. 34% for CA, and 106% vs. 25% US). (Imbierowicz, Skumatz, and Gardner 2006).

[53] Imbierowicz, Skumatz, and Gardner (2006)

[54] Skumatz and Gardner 2004 decomposition study.

We can also examine the patterns by size and and variability of NEB. Based on this analysis, the results show that – if a utility wanted to estimate the minimum of NEBs to minimize costs – the NEBs in the yellow cell (or potentially the pink cell) could be aggregated into a multiplier. The NEBs in the salmon or purple cells (high variation) either need further investigation to identify the source of variability (and thus, potentially turn them into multipliers or adders based on those causal factors), or require estimation into the future because they are 1) important / highly valued, and/or 2) very program-specific. Not otherwise classified NEBs have not shown a clear pattern in value or variability.

Table 4.5 Variability and Patterns in Low Income NEBs

	Large size NEB	Not elsewhere classified	Small size NEB
Low variation	None identified with this pattern		Arrearage and coll'n NEBs (but easily measured by program; also varies depending on whether target is "high arrearage" customers)
Not elsewhere classified		Insurance Substation / infrastructure Power quality Tax effects Health & Safety Wastewater / water infrastructure Social indicators T&D losses	
High variation	Emissions (predictable models) Economic impact (predictable models; depends on measures) Participant NEBs (depends on measures, household characteristics) Emergency gas service call (needs more analysis)		None identified with this pattern

5. CURRENT AND POTENTIAL APPLICATIONS OF NEBs

There seems to be no shortage of informal uses or potential applications of NEBs, or reluctance for application of NEBs to formal uses like regulatory benefit-cost and regulatory test applications. Introduction into more formal applications will depend on developing estimates that withstand scrutiny from the range of audiences.

The most commonly-suggested current and potential uses of NEBs–which vary for utility, participant, and societal perspectives – are categorized in the Table below. Enhancements on these uses are described below.

Table 5.1. Summary of Current Uses for NEB Values
(Updated from BC Hydro 2008)

	Utility NEBs	Participant NEBs	Societal NEBs
Marketing & targeting		Yes	Suitable
Program refinement	Yes	Yes	Yes
B/C internal customer		Yes	Suitable
Portfolio development	Yes	Yes	Yes
B/C tests	Potential	Potential	Potential (high)

NEBs provide useful information for program marketing and targeting, program refinement, and many other applications. The benefits from these qualitative and informal/informational applications have been fairly non-controversial. A discussion of the more controversial topic of how NEBs may (or may not) be adopted into program level screening and related applications is included in the next section. NEB values have been used in the following ways:

- **Program marketing / targeting**: Participant NEBs perform a function parallel to market research in product sales. NEB research uncovers those non-energy aspects of EE programs and measures that appeal to businesses and households that may be the target of the programs, and in particular to those potential participants that are not already "sold" on energy efficiency features alone. NEBs can also be used to identify high impact measures and high impact target participants for programs, optimizing impact vs. cost.
- **Program refinement**: NEBs provide feedback akin to that provided by process evaluations. Negative NEBs reflect important program barriers that can be addressed. Differences in perception of NEBs by different actors in the supply chain[55] identify information, training, or other needs at various intervention points. A detailed NEB analysis can provide information for refining the level or design of the rebate or intervention level.
- **Benefits and Costs internal customer**: Businesses and households select equipment (and behaviors) based on an internal assessment of the benefits and costs of an array of financial and non-financial considerations and features associated with that measure or behavior. NEBs provide a mechanism for identifying and providing a financial proxy for many of these "other" features. This is a key component to understanding the participant's B/C analysis and their underlying program and participation decision-making. It provides information to

[55] Termed "disconnects" (Skumatz 2004). In research for Focus on Energy (Skumatz and Schare 2002) the authors point out that A&E firms may be specifying and recommending fewer EE measures than owenrs would be willing to invest in, and that it may be leading to under-investment in EE in new construction.

refine the program and supports refinement of incentives to make the B/C ratio favorable to program objectives.[56]

- **Portfolio development**: NEB analysis allows design of portfolios that maximize societal, utility, and/or participant benefits (or targeted NEB elements) given a fixed budget. Tradeoffs can be made between programs and measures to optimize a portfolio toward an array of financial and non-financial objectives, and provides a fuller assessment of portfolio impacts.

It is the area of B/C tests and program-level (and portfolio-level) screening that leads to the greatest controversy in NEBs. This topic is discussed in more detail below.

Alternatives for NEBs in Program-level Screening

Including NEBs in applications with significant financial applications like program screening is hampered by concerns about the reliability of estimates of NEBs. There have always been concerns about valuations of indirect benefits like comfort, aesthetics, and other "soft" benefits, or complex benefits like productivity, etc. For that reason, some agencies have defined subsets of NEBs that they consider "readily measured,"[57] and subsets of these are sometimes included in program screening or other applications. Examples of some of these "readily measured" benefits follow:

- BC Hydro: Maintenance, GHG, equipment life, reduced waste generation or product losses, improvements in equipment productivity, increased floor space[58]
- Energy Trust of Oregon: Carbon value on societal test, Present value of deferred plant extension, water/sewer savings as examples. Other specific measures benefits (e.g., lower soap use for laundry, etc.).[59]
- Others defined them in less specific terms, like: reliable and with real economic value (MA); maintenance and equipment replacement (VT); measurable with current market values (CO). (Source BC Hydro 2008).

As an early approach, some other utilities incorporated percentage "adders" meant to reflect the presence of NEBs, but remaining non-specific about their sources and variations in values that may accrue to different types of programs.

Utilities have proposed and used a number of alternatives for including NEBs in program-level screening.

1. **Adder**: Use an adder to reflect all NEBs. An adder is included in cost-effectiveness analysis to represent range of non-energy benefits. In the absence of a transparent link between the adder and specific NEBs, and to be conservative, the adder could be in the range of 10-15% of participant's energy bill savings. (Examples: BC Hydro (currently), New Hampshire, Northwest conservation "advantage")

[56] An example from a boiler program analyzed by the author illustrates this concept. Rebate levels were establisehd to provide a customer B/C ratio that would favor the highest efficiency model. However, customers were purchasing a somewhat lower efficiency model more frequently than desired. The NEB analysis demonstrated that one of the highest value features of the other model was its small footprint, and the footprint value outweighed the difference in incentive levels. To modify behaviors, the incentives needed to be adjusted. The utility made the simplying error of assessing customer B/C in terms of energy costs vs. purchase cost alone, rather than the greater bundle of features. NEBs provide proxies for those underlying values.
[57] This section relies heavily on a very nice and concise analysis of NEBs prepared by BC Hydro 2008.
[58] BC Hydro 2008. BC Hydro considers the following not readily measurable: Sales, property value, satisfaction, worker / student productivity, H&S, comfort, noise, aesthetics, convenience, pride / prestige, sense of environmental responsibility
[59] Author interview with Fred Gordon, Oregon Trust, 2009.

2. **Readily measurable NEBs only**: Options are described above, including water or soap savings for clothes washers, water savings from restrictors, etc. Examples (VT, MA, CO, OR)
3. **All NEBs** – Develop estimates of all readily measurable and selection of the most important (largest) hard to measure NEBs (including subjective NEBs), relevant to the cost test or application. Ensure that double counting does not occur. (No current examples)[60].
4. **Hybrid** – Include readily measurable NEBs and an adder for hard to measure NEBs: Include readily measurable NEBs and a conservative adder for hard to measure NEBs. Ensure that double-counting does not occur. (no current examples[61])

In a recent analysis, BC Hydro examined the alternatives based on how they met three objectives: maximize DSM opportunities, minimize regulatory risk, and minimize evaluation resources. The summary of this evaluation is provided in Table 5.2.

Table 5.2 NEB Alternatives in Evaluation and Cost Tests (from BC Hydro 2008)

		Alternatives			
Objective	Criteria	Adder	Readily Measurable	All NEBs	Hybrid
Maximize DSM Opportunities	Range of NEBs included	Small range of NEBs included	Moderate range	Wide range	Wide range
Minimize Regulatory Risk	Robustness of NEB valuation + Jurisdictional support	Low regulatory risk	Med regulatory risk	High regulatory risk	Med-high regulatory risk
Minimize Evaluation Resources	Evaluation simplicity	Minimal evaluation resources	Med evaluation resources)	High evaluation resources	Med evaluation resources

BC Hydro's analysis of the options probably represents the thoughts of many utilities considering next steps with NEBs. They note that

> *"…including HTM NEBs in the Total Resource Cost (TRC) test has the highest regulatory risk, due to concerns about the robustness in valuation methods and the fact that no other jurisdictions were found to include these NEBs in their program screening. And while the adder option has the lowest regulatory risk, it ranks the lowest in terms of maximizing DSM opportunities as it does not allow benefits over the "adder" amount to be considered in the TRC.*
>
> *Compared to the other alternatives evaluated, incorporating readily measurable NEBs in the TRC allows the most NEBs to be considered in the cost-benefit analysis while having moderate regulatory risk. Incorporating readily measurable NEBs can be done with relatively robust valuation methods and is an approach taken in a number other jurisdictions. Further, this alternative can be implemented in the near term and requires only moderate evaluation resources.*
>
> *However, including only readily measurable NEBs could limit the benefits for commercial and residential programs which are more likely to have "hard to measure" NEBs. The hybrid option would allow more NEBs to be included by using an adder to capture "hard*

[60] Considered in Caliornia as part of the LIPPT analysis, 2001; also a version of this has been used in New York. NYSERDA included percentages of all NEBs in various scenarios of the cost test that were presented to the regulator (e.g. 25% of NEBs, 50% of estimated NEBs, 100% of estimated NEBs, etc.).

[61] Interviews indicate the Northwest Power Planning Council may be working on a version of this option.

to measure" benefits, but suffers in terms of increased regulatory risk (no jurisdictions found to use this approach). … In any of these alternatives, the same methods and effort should be employed to establish any non-energy costs."

The crux of the issue is the confidence in the estimates of HTM NEBs.

BC Hydro summarizes the continuum of NEBs use in program screening options (conservative to more aggressive), with examples of utilities that employ the metric. This information is included in Table 5.3.

Table 5.3. Current Approaches / Treatment of NEBs (updated from BC Hydro 2008)

NEBs Approach (Conservative to Aggressive)	Program Screen	Examples
Program marketing only - conservative	TRC	Ontario, Manitoba, Quebec
Scenario Analysis	TRC	NY (variety of NEBs included for scenario; programs must pass without NEBs)
Project screen	TRC	WI (participant-valued NEBs only)
Program screen – readily measurable	Modified TRC PPT possibly	MA (NEBs must be "reliable and with real economic value"), CA (only for low-income); VT (maintenance, equipment replacement); CO (measurable with current market values), NH (adder of 15%); BC Hydro; OR (especially for C&I)
Program screen – broader NEBs	Modified TRC PPT	None found[62]

Additional detail and updated information is provided in Table 5.4 below.

Table 5.4 Status of State and Regulatory Uses of NEBs

State / Region	Are NEBs Examined / How	Are NEBs "Officially Used?
California	The State hired a consultant to construct a low income program NEB model a few years ago, which computed about 30 utility, societal, and participant NEBs. That model's inputs are outdated, and the model is being updated to 1) update / tailor assumptions and inputs, 2) add more NEBs and update measurement approaches, 3) transform the model to a measure, rather than program basis, and 4) better coordinate with the other processes and steps for submitting program benefit cost results for program screening and the needed scenarios, etc.	The State investigated formal inclusion of participant-side NEBs in tests of Low income programs several years ago, and is currently reinvestigating that issue to some degree. There have also been specific discussions with the regulators about indirect ways to incorporate NEBs into the current benefit-cost test model.
CA, ID, OR, UT, WA, WY – PacifiCorp	They do not quantify NEBs, except limited arrearage analyses. Some evaluation work – potentially including NEBs – are conducted if the program is performing poorly to see if NEBs can help improve the cost-effectiveness.	They use an environmental "adder" of 10% of the benefits for low income cost-effectiveness if the regulators allow (as they do – or did – in Washington, see below)
NY	Detailed evaluation of NEBs is conducted for many or all of the programs in their residential, commercial,	NEBs such as comfort, safety, air quality, productivity, etc are included in regulatory cost-

[62] Briefly considered / analyzed in 2001 for Low Income Public Purpose Test for California, but no progress was made. Currnently, the CPUC Is considering modifications to the TRC to incorporate some NEBs as a cost offset. The proposal is being pushed by Knight. In addition, the State is issuing an RFP for another round of research on whether NEBs belong in tests for low income programs.

State / Region	Are NEBs Examined / How	Are NEBs "Officially Used?
	industrial portfolio. They estimate a variety of utility, participant, and societal NEBs.[63] For participant NEBs, they generally use the survey method developed in the literature,[64] For societal figures (emissions and jobs) they use specialized regional models developed by a consulting firm. For utility benefits they generally rely on defaults and proxy values from the literature, adjusted for New York, and do not generally conduct arrearage or similar studies.	effectiveness evaluations for low income. For other programs, they have presented information to the regulators that include NEBs, and regulators are shown the benefit cost results including zero NEBs, 50% of NEBs, and 100% of NEBs (or similar) – a scenario approach. The NEB results are also used for analyzing marketing and outreach, but this is not a regulatory requirement.
Vermont	A calculation of NEBs associated with Vermont's weatherization program was conducted in 1999, (adapting numbers developed for a California program), and the numbers were updated for the 2007 report. This report used a combination of program, secondary, and literature-based inputs. Currently, this is the only efficiency program in Vermont that quantifies NEBs.	NEBs such as reduced air emissions, property value increases, tax benefits, health improvements and employment impacts are incorporated into formal cost-benefit analysis for the low income program, which is required by the state legislature. The analysis is also used for marketing and outreach.
Pacific Northwest; (from BPA, Energy Trust, and NEEA)	Calculations are measure specific (for BPA), not program specific, and in the residential sector cover lighting, appliances, HVAC, etc. The "Regional Technical Forum" has established a protocol to evaluate the air emissions associated with specific measures (CFLs, appliances, windows, HVAC, etc.), and BPA is developing a method to evaluate the jobs and emissions impacts of energy efficiency projects funded by the Recovery Act. BPA would like to do whole house or program level analyses, but the current model is not designed for this. Energy Trust / NEEA consider "readily measured" NEBs associated with programs (for example, water savings for washer programs, etc.) They are measured using "direct-type methods. "Speculative' or "soft" metrics like comfort, etc. are not measured.	The work is being used in regulatory cost-effectiveness analysis. TRC calculations include the value of air emissions reductions. BPA will only fund cost-effective measures with at BC ratio of 1 or greater. Energy Trust / NEEA report that they include the "readily measured" NEBs in the cost-effectiveness reporting.
Montana	The Montana Public Service Commission does not require non-energy benefits to be reported and none of the regulated utilities have done so. A possible exception is for the weatherization program where some non-energy benefits may have been reported for federal requirements. No NEBs are reported for the weatherization program. None of MO PSC's regulated utilities have reported NEBs for economic evaluations.	NEBs do not need to be reported for regulatory evaluations.
WA – Puget Sound Energy	PSE used to quantify some non energy benefits (environmental, comfort, and quality of life indicators), but doesn't currently do so. Usually relied on Regional Technical Forum values and on occasion used participant surveys and data to quantify benefits. No reports are available demonstrating past methodologies. Currently no NEBs are quantified, but since it is believed that significant NEBs are	NEBs were, but are no longer, used for internal and regulatory cost-effectiveness test. No NEBs are required to be reported for regulatory purposes, but lower B/C ratios are allowed for low-income weatherization programs because NEBs are assumed to be associated with those programs.

[63] The list of NEBs generally includes the entire list presented in Table 1 delivered to Xcel.
[64] They generally rely on the comparative measurement methods, and for some, they also incorporate conjoint methods. Each method was discussed in the seminar presented to Xcel at the beginning of this project. The measurement approach / process was initiated / set up by SERA.

State / Region	Are NEBs Examined / How	Are NEBs "Officially Used?
	associated with the low-income weatherization program, a B/C ratio of .67 is allowed (a TRC test ratio of 1 is usually required).	
MA	The current TRC model does include NEBs, but the methodology and source data used to quantify NEBs is unclear for some of the values. The inputs are derived from various reports and existing literature, but there are concerns about the accuracy, and updates are planned. NSTAR plans to update them, and part of NSTAR's recently filed 3-year plan includes an evaluation of NEBs.	The benefit cost model used for regulatory cost-effectiveness evaluations has NEBs build in for reduced costs to utility (arrearages, termination, collections), and participant benefits (mobility, comfort, etc.).
Arizona	The average air emission (SOx and NOx) per kWh produced by a given utility is used to generate values of emissions reductions. Some utilities are beginning to incorporate the value of carbon reductions as well. Broader NEBs are not currently considered or assessed.	The Arizona Corporation Commission does not require NEBs to be included in cost-effectiveness evaluations, but will allow utilities to report air emissions reductions if presented to them
Arkansas	The Arkansas Public Service Commission efficiency programs are just getting underway. The pilot projects have not required any cost-benefit analysis, but the comprehensive programs will need to demonstrate cost-effective energy and capacity savings. No NEBs will be required to be reported, but the PSC would consider them (if presented).	NEBs do not need to be reported for regulatory evaluations.
Georgia	The Georgia Public Service Commission does allow evaluation of externalities. None of the regulated utilities have reported any NEBs as part of regulatory cost-effectiveness evaluations.	NEBs do not need to be reported for regulatory evaluations
South Carolina	Neither the South Carolina Code of Laws nor the Public Service Commission of South Carolina requires utilities to consider the non-energy benefits of energy efficiency in the utilities' economic analyses. The Commission would consider such a proposal if presented by one of the regulated utilities.	NEBs do not need to be reported for regulatory evaluations.
Wisconsin	They have included NEB quantification in a number of program evaluations (including participant NEBs), particularly in the low income / weatherization side.	Broad NEBs are not officially incorporated into regulatory cost-effectiveness.

Opportunities for including NEBs in benefit costs tests are illustrated in the summary of benefit-cost tests used in various locations around North America. Note that the last several rows include the potential to include subsets of NEBs – should more confidence be gained in the estimates of HTM NEBs. However, in the near term, estimates of the societal NEBs that have achieved a higher degree of measurement confidence (economic, emissions) can be included in the program screening and benefit cost test analyses.

Table 5.5. Summary of Benefit-Cost Tests (adapted and updated from Amann, 2006)

Test	Benefits	Costs	States Using Currently for what purpose.. they all use all tests, the question is which use them is the final screen
Utility Cost (or Program Administrator Test)	• Avoided supply costs for transmission, distribution,	• Program administration • Participant incentives	CA, CT, HI, IA, IL, IN, MI, MN, MO, NY, OR, RI, TX, VA, WA, BPA

Test	Benefits	Costs	States Using Currently for what purpose.. they all use all tests, the question is which use them is the final screen
	and generation (TD&G) • Avoided gas and water supply costs	• Increased supply cost	
Ratepayer Impact Measure (RIM) (or No Loser's Test)	Same as above plus • increased revenue	Same as above plus • Decreased revenue	AR, CO, FL, GA, HI, IA, IN, MI, MN, NC, ND, NV, SC, VA, WI
Participant cost	• Utility bill reductions • Participant incentives	• Participant direct costs	AR, CA, FL, HI, IA, IN, MI, MN, NY, VA
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
Societal	Same as above plus • Externality benefits (reduced pollution, improved reliability, etc.)	Same as above	AZ, IA, ME, MN, MO, MT, NJ, OR, VT, WI
Public Purpose (includes NEBs)	Same as above plus • Participant incentives • Quantifiable participant NEBs	Same as above	CA, KY, WI (low income)
Total Market Effects (TMET) (includes NEBs)	Same as above plus • Additional participant NEBs (for program and spillover participants) plus • Broader macroeconomic effects	Same as above	For evaluation purposes only
Program Efficiency (PET) (includes NEBs)	Same as above	Same as above • Excluding participant direct costs	For evaluation purposes only
Initial BCA (Simple BC) (includes NEBs)	Same as Public Purpose Test plus • Participant direct costs (as negative benefit) [65]	Same as above	For evaluation purposes only

A TMET approach would provide the most complete feedback on program impacts, benefits, and costs, and the most comprehensive assessment of the expenditure of public goods dollars. However, to move to a full effects test (like the TMET) will take additional research on participant benefit measurement methods.

Cross-cutting Recommendations:

Prioritizing additional research is a bit of a chicken and egg issue. It may not be worth time to assess additional measurement methods unless they will be put to highly valued or important uses; however, they will not be put to these uses unless reliable and robust valuation approaches are identified ***and trusted***.

There are, however, strong arguments for considering NEBs in some regulatory tests, at least on a theoretical basis.

[65] Similar to the option proposed by Bob Knight, Bki in various publications, including BECC 2008, and elsewhere.

- Low income programs: many of the principal goals for the programs relate directly to NEBs.
- Incorporating direct and improved economic and GHG NEBs in screening and B/C metrics as appropriate.
- Incorporating readily measured NEBs into screening and B/C work
- Developing acceptable multipliers for the "other" HTM (not "readily measured" NEBs) as a start to get at least proxies for the values into the computations and the conversation – and the decision-making.
- Using these metrics to create "hybrid" NEB values to be included into the screening and B/C process and protocols.

Finally, the value of NEBs as input to process evaluation and NTG (Net-To-Gross) computations should be further explored and potentially made part of the standard procedure for these evaluation types.

5.6 What Has Been Learned: Emerging Approaches and Experience

A great deal has been learned about NEBs in the last decade.

- After years of just being listed and hypothesized about, the literature has focused on developing estimation methods, and has suggested that NEBs represent significant value – to society, participants, and to some degree, to utilities or agencies offering the programs.
- Utility NEBs are not substantial, but mainly because NEB categories with significant potential have not been investigated.
- Significant progress has been made in the area of estimating economic impact from EE initiatives. Widely vetted third party models seem to provide a good balance between ease and replicability. One issue that arises is that the models generally allow selection of impacts at the national, state, or county level. If a utility or agency's territory differs from these lines, some interpolation may be needed. In some cases, internal models have been developed to conduct the estimation work. This may or may not be necessary, but if the results are to be used for regulatory purposes, they probably need to be provided to allow vetting.
- Significant progress has also been made in the area of estimating emissions effects. Simple and complex approaches have been used, using varying degrees of complexity in generation mix and the associated emissions. The literature is moving away from the simple methods (system-wide average) toward variations based on at least peak/non-peak generation mix, or hourly dispatch permutations. Where local plant emissions data are available, that may be a useful tailoring of the results.
- A great deal of activity has also focused around developing defensible methods for estimating participant-perspective NEBs, including indirect and "soft" benefits. Variations representing nearly a dozen methods have been used. Many have represented promising approaches, depending on the types of NEBs and the level of detail. Promising approaches include comparative methods, ranking methods, and regression / statistical methods. Willingness to pay/accept methods perform poorly. However, more work is needed in this area;

With exceptions, utilities and regulators generally have not incorporated NEBs into the regulatory or program approval process. This may be partly due to the relative newness of quantitative information, a lack of comfort with the estimation of important, but “soft,” NEBs, and concerns about reliance on self-report survey methods. Exceptions and new directions include:

- multiplicative adders to represent some or all of NEBs,
- incorporation of “readily measured” subsets of NEBs; or
- consideration of hybrid approaches including readily measured and some multiplier values.

6. IMPLICATIONS FOR NEBs APPROACH FOR CALIFORNIA LOW INCOME (LIEE) PROGRAMS

6.1 State of Use and Applications of NEBs in Low Income Programs

NEBs are understood and recognized by a number of states, provinces, utilities, and regulatory bodies. A couple states have begun to formally include NEBs in their regulatory tests for low income programs (from Table 2.6), most aggressively VT, NY, and MA, which include NEBs with categories beyond emissions in cost-effectiveness tests. A number of the categories formally included reflect the types of goals commonly associated with low income weatherization programs, including health improvements, safety, IAQ, and of course, payment-related NEBs.

The California program analyses do not currently include as broad an analysis of NEBs as some of these New England states. As mentioned in the earlier chapters, a number of states and provinces use NEBs informally for program design, marketing, outreach, and other applications.

Table 6.1: Formal Use of NEBs for Low Income Programs

Formal Inclusion	Discussion	State(s)
NEBs including reduced air emissions, property value increases, tax benefits, health improvements, and employment impacts are incorporated into formal benefit-cost analysis for the low income program, which is required by the state legislature. Low income programs are the only ones quantifying NEBs.	NEBs are also used for marketing and outreach. NEB estimates for 1999 report were adapted from California LIPPT; for 2007 report estimates NEBs using a combination of program, primary, and secondary data.	VT
NEBs including comfort, safety, IAQ, included in regulatory cost-effectiveness tests for low income. Over the last several yeas, the regulatory agency also sees the results of ALL NEBs from all three perspectives presented along with the benefit-cost work using 'scenarios" – Benefit cost with 25%, 50%, and 100% of NEBs – for all programs including low income.	NEBs used for analyzing marketing and outreach	NY
Benefit-Cost model used for regulatory cost-effectiveness evaluations includes Utility-perspective NEBs (arrearage, termination, collections) and Participant benefits (mobility, comfort, etc.),		MA
10% broad environmental "adder" to benefits for Low Income Programs for cost-effectiveness tests if allowed by regulators	Limited arrearage analyses, and some NEBs estimated if program doesn't meet thresholds to see if NEBs improve cost-effectiveness	CA, ID, OR, UT, WA (in past; now lower B/C ratio allowed instead), WY, PacifiCorp
Use a 20% adder for electricity and 5% for gas benefits to reflect variety of NEBs; not just for low income programs		Xcel Colorado
TRC calculations include value of air emission reductions. Energy Trust of Oregon allows addition of "readily measured" NEBs in cost-effectiveness	NEBs are "measure", not program specific, so protocols include some measures associated with the Low	Pacific NW, BPA, Energy Trust of Oregon, NEEA

Formal Inclusion	Discussion	State(s)
reporting. "Soft" / participant effects are not measured / included, although water savings are considered easily measured.	Income programs (CFL, appliances, etc.). Protocols have not been developed for whole house measures / programs. .	
Not officially incorporated.	Have included NEB quantifications in a number of program evaluations (including participant NEBs) particularly in low income / weatherization side.	WI
Utilities Commission does not require NEBs to be reported and utilities do not. .	Possible exception of the weatherization program where some NEBs have been reported for federal requirements in MT.	MT, GA, SC, AR, other

The literature has largely considered three main approaches for integrating NEBs into tests and program applications:

- Measured NEBs: in this case, NEB values are measured or estimated based on specific program data for individual NEB categories. Some of these measured NEBs may be easily measured; others are not.
- "Adders": in this case, an adder is included in a cost-effectiveness analysis to represent a range of 1) individually small or 2) consistently-valued non-energy benefits.
- Hybrids: Utilities or regulators could consider measured NEBs for some NEB categories, and some "adders" for other values.

The utilities listed above have included both measured (Vermont, New York, Massachusetts, Pacific NW), and adder (Xcel Colorado, California) approaches. The discussions seem to revolve around the accuracy of "measured NEBs", the difficulty of measurement and verification of the values, and the potential transferability of estimated values, weighed against the relative (potential) size of the impact. The Northwest may be considered to use a hybrid approach (environmental plus readily measured, which are discussed in the next section).

6.2 Discussion of Measurement of NEBs in Low Income Programs

Basic best-practices of NEBs have been fairly-well adopted within the literature. These include basics like including positive and negative NEBs, and consideration of "attributable" NEBs above what would have happened without the program. This last element assumes consideration of net-to-gross ratios; however, the special case of low income programs may support an assumption that the NTG is 1 because, in many cases, the investment may not have occurred without the program.

The state of measurement of NEBs falls into several major categories. The traditional treatment, and concerns / revised considerations are discussed below.

Arrearage analyses: Arrearage studies for low income programs have been conducted for several decades, and are generally conducted using control and program groups, with straightforward analyses of the net impact of the (low income) program on arrearage, bad debt, consumer calls, shut-offs and reconnects, and other financial or "collections"-type factors. The statistical methods are well-known. There are scores of examples of these studies for utilities across the nation.

"Readily-measured NEBs": These NEBs are easily measured with direct computations of impacts or direct application of readily-accepted secondary data. An example of these computations includes the water savings from low flow showerheads or faucet aerators, or from efficient clothes washers, as well as the associated "soap" savings from these washers. These NEBs are computed based on average showers or laundry loads per household from established sources like the AWWA (American Water Works Association), or others, and the results tend to lead to minimum controversy.[66] These types of NEBs are measured around the country, but are formally included particularly in the Northwest, and are included for programs above and beyond just low income programs (particularly commercial / industrial programs).

Model-based societal NEBs: Third party models have been developed that provide well-founded estimates of the impacts of low income (and other) programs on emissions and on job creation / economic development.[67] These models are of varying degrees of detail / sophistication / cost, but the number of studies and models addressing these impacts (developed / published by universities and consultants) at the local, state, and national level are increasing – and are being accepted in the literature.

Survey-based Participant NEBs: Organized, statistical surveys have been used as the basis for computing a subset of participant-based NEBs since 1994. From nearly the beginning, the methods have been based on approaches drawn from the academic literature. The survey-based approaches have been used to measure the benefits related to: performance (comfort, etc.), lifetime, maintenance, property value, noise, safety, mobility, education impacts, "doing good" for the environment, and stability-type metrics, and any negative impacts associated with the programs. A number of main measurement approaches have been used for these survey-based studies: contingent valuation and willingness to pay / willingness to accept; relative scaling (percentage and labeled magnitude scaling); and ranking methods. Each has demonstrated academic and statistical underpinnings. The survey-based approach has been used for several reasons:

- **Some of the values can only be derived from user perceptions**: Examples include: impacts related to knowledge / understanding of bills, feelings of doing good for the environment. It might be argued that perceptions of comfort are more relevant than measurements of thermal comfort.
- **Some of the values are most readily derived from user perceptions**, although they could theoretically be measured in other ways. Examples include: noise, thermal comfort, likelihood of moving due to high bills. In some cases studies are lacking that could provide independent[68] values for some program-related changes (e.g. sick days from work or from school, incidences of moving, etc.). In other cases, the studies to conduct the analyses on a program-by-program basis would be expensive[69] (e.g. metering statistical samples of homes for noise, lumens, temperatures), or if the incidences of occurrences are low and would require many samples to identify impacts (for example, high value health and safety events).
- **Surveys are the fastest way of gathering data on multiple NEB categories**. This is certainly true; however, the values gathered via survey should be compared with the

[66] Savings in other fuels may also be a potential category of NEBs that could be "readily measured".
[67] Note that the tax impacts of the economic development impacts have not been frequently measured, but would be fairly readily measured as well, given information on local tax codes.
[68] and potentially transferable, at least within climate zones
[69] For some it would be expensive relative to the potential values, although this needs to be better demonstrated

values computed via other means to assess the credibility and consistency of survey-based measures.[70]

Based on further analysis, we believe some of the NEB categories that have been measured via survey could and should be moved from survey-based estimation methods to more direct financial computations / estimations (see next category).

Financial Computations: The potential exists to use age, manufacture data, and third party information to compute some NEB values in low income programs; however, this has rarely (or never, as far as we can find) been done. The most appropriate NEBs for this approach include valuations from lifetimes or from maintenance. Using information on the average age (cohorts) of equipment replaced in the participant homes (to be gathered as part of program records) and records / expectations related to new equipment, replicable valuations for these types of NEBs could be computed.

Weak / unexplored NEBs: A number of NEBs have barely or never been measured. These include, most particularly, a host of important health-and-safety effects relating to both the participants and utility, including utility insurance savings; indoor air quality impacts (particularly on occupant health); doctor visits, etc. A number of others have also been little-explored, including national security, tax benefits, and others.

There are several additional notable measurement issues in NEBs in addition to those discussed above.

1) Statistical / academic grounding: There are several threads of the survey-based NEB literature that specifically address the statistical and academic grounding for the use of the survey method(s). These include: work by Skumatz or Skumatz and Gardner (about a dozen papers starting in 1995); a paper by Summit Blue (2007) and several papers by Lutzenhiser.

2) Use of regression analysis for estimating impacts: Researchers at Heschong-Mahone used regression approaches to relate academic test scores to daylighting in schools, and sales to daylighting in retail outlets. However, these methods have not been applied to low income programs or measures, and show most promise for measuring just a couple of NEB effects, and require considerable data collection to control for other contributing factors (affecting, for example, sales or test scores).

3) Comparisons of values derived from different survey measurement methods: Only two authors have conducted this type of work: Skumatz (many papers, starting in 2000) and Hall (2007). More work of this nature is important to identify the most credible, consistent, and robust measurement methods.

4) Cross-program studies identifying patterns in NEBs (sizes and variability): Few studies have looked beyond the single utility program being analyzed to compare results to other

[70] Literature has suggested that for businesses, specific research on key topics by those businesses may be a valuable and especially accurate source of information on the measure's NEBs. However, 1) that is not very practical for low income programs, and 2) the statistical reliability of those estimates in a commercial setting are suspect, as only a few businesses would be conducting these studies, and those results would tend to be computed only for businesses that did, or expected to have, large values for that NEB, biasing the ultimate results.

programs. The exceptions for low income include: Skumatz (1998 and others), Hall et.al.(2007), Skumatz and Cadmus (2009).

5) Measure- vs. Program- Based NEBs: Within the low income sector, almost all NEB work has been conducted as program-wide estimations.[71] Only one study (Skumatz and Gardner 2004) has tested the potential of disaggregating program-wide NEBs to the specific measures installed. Although NEBs from appliances have been measured, measure-based NEB work has not been conducted estimating NEBs from insulation, caulking, education, or many of the types of measures included in California- and other low income programs.[72]

6.3 Issues, Gaps, and Next Step Recommendations for NEB Analysis

The review of the literature as it applies to low income programs, suggests a number of gaps. These are highlighted in the bullets below.

- **Cross-program studies better identify patterns and consistent drivers / relationships**: This research would focus on identifying which NEBs have consistent values, and which vary a great deal based on 1) program design; 2) climate, or 3) other. This would indicate which values might easily be addressed through "adders" or multipliers or similar – assuming buy-off on the existing values – or new values – could be achieved. This report has included a discussion of a number of these issues / findings / patterns.

- **Cross-program studies to prioritize NEB research on key gaps**: Analysis across programs to identify which NEBs are important vs. unimportant, large or small, and variable vs. consistent so that priorities can be established for direct measurement of NEBs will be valuable. Targeted research should be conducted on high value, volatile / variable NEBs. This report has worked to illustrate some of these patterns.

- **Survey including multiple valuation approaches**: A survey that asks the same program participants about their valuations of NEBs using different data collection / analysis methods to allow comparison of the resulting values. Within-survey validation of multiple measurement approaches is vital to identifying the most effective, robust, consistent, and cost-effective methods of measuring some NEB categories.

- **Comparisons between survey and financial computations**: The feasibility of computing maintenance and lifetime benefits using financial methods (remaining lifetimes, expected maintenance curves per year of life, etc.) needs to be tested, and the results should be compared with survey-based valuations. Financial computations can be attempted for several basic (or simpler) measures, and then compared to results that arise from surveys. The work can compare lifetime (replacement) and maintenance costs from a specific piece of equipment installed or tuned as part of the state low income programs

[71] Measure-based work has been conducted for commercial – industrial programs (which tend to be measure- based, like boiler, motor, and lighting studies).

[72] Some household appliances have had specific NEB estimation work, including clothes washers, air conditioners, refrigerators, dish washers, and CFLs. Skumatz has conducted some work on just insulation, but this is related to measures installed overseas, not in US low income programs.

(e.g. CFL, heating equipment). We will test the availability of data (and decay curves) to estimate maintenance costs to identify the feasibility of this financial approach in the future.

- **Survey with modules for measure-based NEB impacts**: Conduct a survey asking about impacts from specific measures, or carefully stratify the survey to identify some participants that received only one or two measures to help attribute NEBs to specific measures. Compare results to regression-based decomposition (below).

- **Use statistical methods to assess whether measure-based NEBs can be derived from programmatic NEB surveys**: There are difficulties inherent in getting participants to be able to attribute NEBs to a specific measure when multiple measures have been installed (e.g. particularly weatherization programs). A study re-testing the potential for decomposition of measure-based NEBs from program-wide NEBs – and comparison with financial computations (where possible) – is needed.

- **More studies on health impacts, and health / safety effects**: These studies are largely lacking (with the exception of one by Blasnik, and a series of health-related impact studies by Fisk)

- **Develop well-accepted indicator of "household hardship / stability" indicators**. A solid start has been achieved in a series of projects by Quantec / Cadmus Group, but should be further explored, especially as they may relate to the goals of low income programs.

- **Explore NEBs associated with kW impacts**: Very little estimation work has examined the NEB impact on kW, not just kWh (or on gas). This is an important addition when considering programs as a potential alternative to new supply, and especially considering that construction of new generation facilities in California (and other locations) are largely driven by peak demand. It is important to examine reliability, brown-out, and similar issues, which are important NEBs.

- **Develop widely-applicable tools:** If broad value ranges can be agreed upon, work to develop a tool to facilitate NEB computation: A tool for easier computation of NEBs associated with measures, and scenarios for programs would be valuable. This may involve easy adders for some; measure-based research may show easy incorporation into a tool similar to DEER.

6.4 Recommendations for NEB Approaches for California LIEE Program NEBs

Table A.2 provides detail on the current NEB estimation method contained in the existing California model. As part of the initial project kickoff and interviews, a few key issues and weaknesses were identified in association with the current modeling approach. These issues are summarized in Table 6.1 below.

Table 6.1: Issues / Gaps in the Current California Low Income NEBs Model

Weaknesses / Issues with the Current California Low Income NEBs Estimation / Modeling Approach
• Revise to measure, not participant, basis: The preferred basis for analysis is measure-based, and the model is currently based on households and kWh. Attribution by measure is important. • Consider non-modeling options: The project should consider not just a modeling approach, but also consider other approaches, like "adders", hybrids, etc. • Improve coordination, consistency, communication: The approach should be consistent with the protocols, and communicate with the updated E3 calculator, and avoid administrative "workarounds. The model or tool should more easily support consistency between the utilities (keeping consistency in methods, assumptions, etc.). • Incorporate climate zones and regulatory tests: The low income programs have a goal of 100% participation by 2020. Although the TRC is not used for low income, the new criteria requires either the modified participant test or the utility cost must be 0.25 or better, and some measures do not pass this test in certain climate zones, and the model does not support (easy) estimation of impacts by climate zone. • Better support scenario analysis: The new tool or method support scenario analysis around climate zones, measures in/ out, and support analysis over time. Make the model less cumbersome for weather sensitive measures and climate zones, fuel, housing type variations – which can add up to 2000 lines of options. Incorporate more of the inputs on one or fewer pages, and minimize the time spent for small, unimportant NEBs. • Support unincluded measures: The model does not compute air conditioner or some furnace savings, especially related to variations in saturation. • Limited interest in societal perspective values: There are currently no uses for computations of NEBs in the societal perspective categories, although TRC, by theory, incorporates some of these effects. • Examine participant NEBs: There is some debate about whether comfort, health, safety, and some other NEBs should be line-itemed. Some program staff would like access to a better understanding of key NEB elements of value. • Allow more flexibility / incorporate more enhancements: There is no consideration of kW in the model, which would especially be useful in the utility and societal perspectives. In addition, the tool could be enhanced to support more than one value for avoided cost for each year; and provide a way to allow to estimate effects for more than one year at a time. • Demonstrate NEB shares in benefit computations more clearly: It would be useful to see what percent of total benefits are NEBs – the percent for major NEBs should be clarified.

In addition, a review of the literature outlined in this report shows some areas in which additional, and more substantial, research is needed. To develop priorities for additional research, we examined each NEB category to assess:

- The values of the NEBs estimated in low income studies around the nation to identify whether values had been estimated and how well they "clustered" or compared between studies. Using this, we ranked how much variability or "uncertainty" seemed to be associated with estimates for the NEB category.
- The importance of the NEB category in application to low income programs.

The detailed results of this analysis are included in the Appendix, in Table A.3, which is ranked by the highest priority research needs to the lowest. The summarized results are presented below in Table 6.2.

Table 6.2. Summary of Priority / Needs Ranking for Research on NEB Categories

Priority	Description	NEB Categories	
Very high priority	Very relevant to low income; little reliable estimation work	• Health care / health effects (societal)	• Changes in dependency / social indicators of family

		• Indoor air quality / relation to health effects (Participant)	stability, reliance on state assistance / hardship (societal and participant)
High priority	Relevant to low income and needs more research; or somewhat relevant to low income and little reliable estimation work	• Health / sick days lost from school or work (participant) • Family stability / fewer household moves (participant) • Property value benefits / neighborhood improvement (societal and participant)	• Health and Safety / fires and insurance / damage (participant, society) • Emergency gas calls (utility) • Insurance savings (utilty) • Power infrastructure (substations, power quality / reliability) (utility) (NOTE: T&D included in California computations)
Medium priority	Relevant to low income; fairly reliable data or estimation methods, but some complexities / variations	• Control over bill / knowledge / understanding of energy use (participant) • Reduced subsidy payments (utility) • Economic development / job creation (societal) • Water / wastewater bills (participant) • Savings in other fuels (participant)	• Emissions / environmental benefits (NOTE: basics of this included elsewhere in California computations) • Participant perceptions including: comfort, noise, doing good for environment, equipment maintenance / performance / lifetime, lighting, etc. • Negative impacts
Low priority	Relevant to low income and well-known computation methods; or not particularly relevant to low income	• Shutoffs and reconnects, arrearages, bad debt, notices / calls (participant and utility)	• Fish and wildlife (no estimates) • National security (no estimates)

A number of activities that can help address the bulk of the gaps listed in Tables 6.1 and 6.2 are presented below.

6.4.1 Translating “Per Participant” NEBs to a “Measure” Basis

A key enhancement needed to make the model and computations more suited to the protocols is to revise the basis for the NEB computations from “per (average) participant” to “per measure”. The project team assessed the ease with which translation between the current “per participant” values could be translated into “measure-“ based NEBs for each of the NEB categories within each perspective. The detailed results are provided in the far right columns of Table A.1. The analysis indicated that most of the categories could be fairly easily translated, because many tended to vary directly with either the kWh saved, or the close relative – the dollars saved (affecting the financial measures related to bill-payments). Table 6.2 below summarizes the results of this analysis, grouping the findings into categories of how the NEBs would be treated and “translated”.

Table 6.3. Summary of Strategies for Translating "Participant" NEBs to "Measures"

Effort	NEB Categories	Assignment to Measures
Easy	• Carrying costs on arrearages (utility) • Bad debt written off (utility) • Shutoffs and reconnects (utility, participant) • Notices (utility) • Customer calls / bill or emergency-related (utility, participant) • Other bill collection costs (utility) • Changes in low income subsidy payments (utility) • Transmission and distribution (Utility) • Reduced dependency / improved social indicators of family stability and unemployment; reduced dependence on state assistance (societal)	Once the overall participant NEB is estimated (not always easy), translation to measure basis is largely a "sharing out" of kWh and the financial implications; some peak / off-peak enhancements may improve estimates, but generally straightforward
Easy	• Transmission and Distribution (utility) (NOTE: T&D is included in avoided cost for California / not a priority for research) • Changes in number of substations (utility) • Changes in power quality / reliability (utility) • Changes in emissions / environmental effects (NOTE: Emissions are included in avoided cost for California – not a priority for research)	Need to discuss relationship with peak / off peak and other factors, but straightforward construction from kW or kWh savings, utility marginal cost (Note: much harder if hourly loads are used instead of peak / off-peak).
Easy	• Tax effects / unemployment (societal)	Relatively easily accomplished- closely related to job creation income
Easy to difficult	• Water / Wastewater bill savings (societal, participant)	Once participant basis is computed, the assignment to measures is very direct using figures from literature / databases. The difficult part is infrastructure savings, and if it is the "last measure" that pushes the infrastructure to capacity, it may be difficult to assign to measures.
Medium	• Property value improvements (participant, neighborhood)	Although the initial computation of NEB may be complex, translation to values are most closely related to dollars invested and kWh savings. However, exterior improvements may be more valuable complicating relationships; needs more study.
Easy to Medium	• Economic development / job creation (societal)	Economic development impacts are already measure-related, but may be difficult to get to individual measures, depending on NAICS category refinement; may need to "share out" on proxy basis.
More complicated	• Emergency gas service calls	Already based on whether gas measures installed; may need analysis to decide threshold measures to activate the effect.
Complicated	• Insurance savings / Health and safety • Health care	Assigning measures with risk is complicated and not well researched to date.
Easy to Complicated, depending	• Participant effects / survey-based (comfort, light quality, lifetime, noise, etc.)	Straightforward to ask these NEBs based on "overall" measures installed, very lengthy survey to ask about the NEB contribution associated with each measure, plus interactions may make it impossible for households to respond sensibly. Pilot investigations imply it may be possible to statistically assign impacts to individual measures; needs further investigation.

6.4.2 Recommendations for an Upgraded Model-Based Tool

A key direction of the work was to develop a revised tool that supported linking NEBs to measures (rather than "programs / program participants"). One other assumption was that we want to develop estimates of all, or most of, the NEBs that have been researched to date. This is because, even though only a subset might be included in near-term regulatory benefit-cost work, the case of low income programs is special. Many of the NEBs are closely aligned with the types of impacts that would reflect progress in the various goals established for low income programs. The evaluators and regulators should be able to 1) select "in" or "out" specific NEBs based on their current application, 2) prepare for flexible inclusion of additional NEBs as regulatory tests evolve, and 3) provide opportunities to estimate NEBs to reflect goals and identify measures with greatest overall benefits for the investment.

There are two levels of effort addressed here:

- Simple adaptations to the modeling approach that would be measure-based, support enhanced benefit-cost work, and be easier to use, and
- More enhanced work that addresses key gaps in the research, and may require additional research, surveys, or construction of more advanced database and tools. This focuses on improving estimates, enhancing / "firming up" the relationships between NEBs and measures and climate zones; adding key missing NEBs, etc.

We considered development of an "adder". However, there were very few NEB categories with that "fixed" dollar relationship with kWh savings (the main candidates include transmission and distribution losses and low income rate subsidy avoided)[73]. The literature review indicates that most of the NEBs vary somewhat based on the types of measures included (gas emergencies avoided) or the financial situation of those participants targeted and associated with the program (the whole list of arrearage- and collection-based NEBs). Finally, there are several other categories of NEBs that influence the ability to take action in Phase 1 vs. Phase 2:

- There are several NEBs (based on participant surveys) that need additional research to "firm up" the relationship between the impacts and measures (comfort, etc.)
- There remains a series of NEBs that have not been well-researched based on the literature review (health, safety, etc.)
- There are NEBs that would benefit from additional work on the "peak" value elements that should be associated with the NEB (substation, power quality, etc.)
- There are NEBs that have not been researched at all, and may need review to determine their priority in near and future-term work (fish and wildlife, national security, etc.)

The model that currently exists can be modified in two key ways to enhance its performance and suitability:

- support NEB estimates associated with measures, and
- allow data entry on three (large) pages, one associated with each perspective, to facilitate data entry for users and clarify assumptions used for a particular "run" (making it easier to be consistent between utilities).

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[73] Values for arrearage-related data varied based on the 1) level of arrearages the average low income participant had at various utilities (even within California) and based on whether the program targeted high arrearage households, and potentially, whether education was included in the program.

The measure-basis can be accomplished through the use of kWh shares for a number of NEB categories (see Table 6.2 and A.2 - all arrearage- and collection-based measures, with a minimum "threshold" value before arrearage benefits are assumed to kick in; T&[74]D; and rate subsidy savings). Other NEBs will only activate if certain measures are included (e.g. gas safety NEBs only arise if relevant gas checks are initiated; water savings compute if water savings measures are installed, etc.). The NEB values are then computed "as is" and they are reported as associated with specific measures.

The model can be revised to incorporate data entry on specific measures included in the program, their savings, and percentage of participants receiving the measure (allowing up to 4-5 measures for a program at a time). The model's structure will make it easy to switch measures in vs. out for scenario analysis. This upgrade will only address climate zone differences by changes in the (deemed / estimated) kWh savings associated with the measures and carried through the computations. More enhanced climate zone work will require a more significant investment in time and upgrades, and may relate to the DEER enhancements suggested below.

The model's computations of several NEB categories should be upgraded to reflect the current state of research (e.g. emissions, and economic impacts for key measures). In addition, the model should be upgraded to incorporate the new literature on impact values for various NEBs, in cases in which new findings are available.

Finally, "next steps" with the model should explore the feasibility of incorporating a communication link between DEER and the model to help reduce data input required in running the model and trading out different measures (and potentially climate zones).

The user will still need to input the following data to develop estimated NEBs:

- **Measure-related**: Measures included for the program; estimated savings per measure, number of measures per participant, percent of participants receiving the various measures, and whether the measure / program is assumed to be assigned to peak vs. off-peak times, assumed measure lifetimes, and number (and cost) of "repairs" conducted as part of the program. Some of these values and inputs may derive from the DEER model, and links can be developed if desired.

- **Arrearage-related**:, initial arrearage and bad-debt values, initial shut-off percentages for participants, utility marginal cost for various debt-collection activities; and results from an arrearages study for program impacts on debt-collection activities (arrearages, notices, call, shutoffs, reconnections, reconnection fees, etc.) unless the user elects to select values from the updated literature list in the model.

  Other Utility-and local data: interest rates for arrearage carrying costs, transmission and distribution losses, utility generation fuel mix for peak and off-peak; local water and sewer rates, number of program participants, and whether the program targets high arrearage customers.
- **Financial Approach for Some NEBs**: Incorporate improved methods for the estimation of some participant NEBs - measure lifetime and O&M effects. These should be translated into more straightforward estimations using financial computations and assumptions and age distribution cohorts of equipment removed, rather than survey-based perceptions.

[74] Recognizing that in California, T&D effects are incorporated into the avoided cost computation. However, should that change, this would be the appropriate treatment.

These fairly straightforward enhancements to the tool are summarized in Table 6.4.

Table 6.4: NEBs and Modeling Gaps Addressed in Basic Upgrades of Existing Model

Addressed – Utility Perspective	Addressed – Social perspective	Addressed – Participant perspective	Enhancements Addressed or partly addressed
Arrearages, Bad debt, Shutoffs / reconnections Notices Calls Other collection activities Transmission & distribution Utility rate subsidy	Economic development Emissions Possibly social indicator / hardship indicator	Water / sewer savings Shutoffs / reconnections Calls and notices Property value Sick days Moves "Soft" NEBs in total, not associated with measures Maintenance / lifetime – financial approach tested / incorproated	Translate model to measure basis for most NEBs Improved coordination / communication Easier scenario analysis Add some unincluded measures Incorporate key participant benefits Illustrate NEB shares Support better transparency of assumptions and consistency between utilities
Not addressed	**Not addressed**	**Not addressed**	**Enhancements not Addressed**
Health Safety Insurance / self-insurance Substation / infrastructure Power quality	Tax impacts Water / wastewater infrastructure Fish/wildlife National security Health[75] Full treatment of social hardship indicators	Performance / operations of measures Fires / safety Chronic health / indoor air quality Other "soft" participant benefits Negative impacts	Incorporation of climate zone[76] More than one avoided cost per year Incorporate non-modeling options Incorporate kW as well as kWh

6.4.3 More Detailed Research and Tool-Building

- **Conduct a survey with embedded tests and modules**: Conduct a survey of a sample of participants / non-participants in the California Low Income Energy Efficiency (LIEE) programs that includes modules or separate samples addressing the following:
    - Asks households about NEB values related to specific measures, potentially by including in sample households with combinations of 1 and 2 measures, or possibly using statistical decomposition / regression analysis.
    - Tests variations in NEB values for households with specific demographics (elderly, chronically ill, etc.)
    - Tests and compares results from several measurement methods to identify reliable, conservative, robust NEB estimation methods for key "soft" participant NEBs
    - Tests variations in NEBs with respect to climate zone

- Conduct estimation / analysis on potentially high-value health impacts from various whole house / weatherization measures
- Conduct estimation / analysis on potentially high-value safety impacts from various weatherization measures

[75] We will review additional research by Fisk to identify whether there are sufficient data to incorprare a "proxy" value in the model update.
[76] unless it can be accomplished with coordination with DEER

- Conduct additional research on peak / off-peak enhancements for the following subset of NEBs: Substation / infrastructure, power quality, and emissions (NOTE: T&D would be included, except that California incorporates T&D into the avoided cost computation).
- Work with the utilities to define a uniformly agreed method for measuring improvements in "quality of life", "household stability" or other hardship metrics that can be used across utilities. Then craft elements of a survey or other computations that will reflect this metric.

- **Develop a revised, more user-friendly, but credible method of associating NEBs to program measures.**
    - **Consider a "Deemed" NEB tool**: For this tool, we suggest developing 2-3 "classes" of NEBs (basic, enhanced) that relate to regulatory tests or high priority "needs", and model the NEB results associated with specific measures. Develop mean values (or ranges) and IF DEER will remain a tool used in conjunction with program planning, and then add values for NEBs along with the savings, EUL, and other values.
    - **Consider an "adder" or multiplicative factor for some NEBs:** If some of the small NEBs remain small and relatively consistent (after survey work), create an adder to use as a proxy for these values (or proxies valid if certain measures are included). Candidates include: arrearages / collection impacts for both utility and participant perspectives, safety measures; possibly lifetime / maintenance, and some "soft" impacts including noise. Health effects are unlikely to be relevant as adders because they may be large, they vary with the presence of chronic conditions or elderly residents, and they will only be relevant when certain measures are included.
    - **Consider a hybrid option.**
    - **Examine a convenient manner of linking E3, DEER, and other tools, and develop a tool that supports scenario analysis and multi-year studies.**

Economic Impacts: Conduct additional research linking economic / job creation impacts to specific measures for the State of California. The studies incorporated into the model address weatherization, but not other possible measures, and not individual measures within "weatherization".

- Other research: The area of Health and safety is theoretically important, but needs to be further researched, and where possible, the effects incorporated into the modeling efforts. This may take primary research, or additional research may uncover ways to better leverage the work identified in the literature review and adapt it to the California low income programs.

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APPENDIX A: NEB ESTIMATION METHODS IN CURRENT CALIFORNIA LOW INCOME MODEL

Table A.1 Values for NEBs for Low Income Programs for Utilities around the Country
(color groupings indicate "perspective"; LIPPT values summarize values prior to 2000; remainder updates that literature)

ID	Perspective or NEB Category	NEB Impacts from Other Low Income Programs - % or $	Summary of Values (per participant / yr); Implications
#	*UTILITY PERSPECTIVE*		
1	Carrying cost on arrearages	• 10) LIPPT: $3.75. • 10) LIPPT review of literature through 2000: Range / mean / median for program-associated change: 0-90% / 28% / 16%, • 3) Quantec PacifiCorp: Energy Share, Eugene- annual decrease in arrears per part. $374, decrease in annual carrying cost per participant, $32. • 6) Howat/Oppenheim NE– noted CO study (Magouirk) said arrearages dropped 26%. • 21) Tellus Institute- A review of studies found Energy Efficiency (EE) programs reduced arrearages between $0-$469. • 22) ORNL National WAP found reduced arrearages of $32 per household (HH) relative to program cost of $1,550. • 23) SERA/PG&E CA; program found reduced carrying charges from $4 to $63 per HH based on program costs of $719 per HH, a NEB adder range of .6% and 8.8% is justified. • 7) Oppenheim NE: Oppenheim NE; programs targeting arrears customers produce about 9.5 times the benefit as non targeted programs which had average arrearage reductions of $7.6. • 9) Quantec WA: Quantec WA; participant arrearages dropped $35 (from $207 to $172). Non part. arrearages rose by $29. Net impact is decreased. arrearages. by $64. Total program impact arrearages. $26, 816. • 13) Dalhoff VT: Average Impact/unit with program- reduced arrearages-$606, carrying cost of arrearages. $76. • 14) TecMRKT VT: Average per home in weatherization program- Reduced Arrearages $458, reduced cost of carrying $57. • 16) PA WI: Skumatz- NEB changes/Participant/year- $1.37 • 17) Skumatz MA;, Reduction: 34%, Annual Benefit per HH: $1.71; • 18) Skumatz CT, Reduction: 32%, Annual Benefit per HH: $2.03; • 19) Skumatz WI; Estimated Annual NEBs per Participant per Year Lower arrearages: $1.37	Impact values are higher for programs targeting high arrearage customers; Most standard programs in the 20-30% impact range. Dollar values clustering around $2/participant, and $32 (several in range of $60). High estimates values are reduced into this general range when translated into annual carrying cost terms.
2	Bad debt written off	• 10) LIPPT: $0.48 • 10) LIPPT review of literature through 2000: Range / mean / median for program-associated change: 0-36% / 24% /18%, Magouirk is the main study source. • 6) Howat/Oppenheim NE: CO study found weatherization program lowered write offs by 18%. • 13) Dalhoff VT: Average Impact/unit with program- $79. • 14) TecMRKT VT: Average per home in weatherization program- reduced write-offs- $64. • 17) Skumatz MA; Reduction: 34%, Annual Benefit per HH: $3.62; • 18) Skumatz CT; Reduction: 32%, Annual Benefit per HH: $2.21	Impact values usually in the 20-35% range; not many studies specifically on this feature. Values $60+ for those affected, $2 when averages across all participants.
3	Shutoffs	• 10) LIPPT: $0.05	Values on order of $2 or

ID	Perspective or NEB Category	NEB Impacts from Other Low Income Programs - % or $	Summary of Values (per participant / yr); Implications
		• 10) LIPPT review of literature through 2000: Range / mean / median for program-associated change: 1-84% / 34% / 30%, • 6) Howat/Oppenheim NE: Quoting Skumatz- avoided utility costs range between $2- $12 per weatherization. Hh. Under reported total program cost of $719/HH, a range of avoided cost adders of 0.3% to 1.1% accounts for this NEB. • 13) Dalhoff VT: Average Impact/unit w/ program- $133. • 14) TecMRKT VT: Average per home in weatherization program- $100. • 18) Skumatz CT; Reduction: 16%, Annual Benefit per HH: $0.07; • 19) Skumatz WI; Estimated Annual NEBs per Participant per Year Fewer Shutoffs and Reconnections: $0.13	less for many utilities; several found very high values ($100+)
4	Reconnects	• 10) LIPPT: $0.02 • 10) LIPPT review of literature through 2000: Range / mean / median for program-associated change: 1-84% / 34% / 30%, • 3) Quantec OR-Pacificorps: Disconnect/Reconnect cost CA/$112.15 ID/$19.75 OR$24.79 UT/$20.34 WA/$25.14 WY/$56.78 • 16) PA WI: Skumatz- NEB changes/Participant/year- Fewer shutoff/reconnection- $.13 • 17) Skumatz CT; Reduction: 16%, Annual Benefit per HH: $0.03; • 19) Skumatz WI; Estimated Annual NEBs per Participant per Year Fewer Shutoffs and Reconnections: $0.13	Net values from pennies to $50+ reconnect charge (many did not multiply times incidence)
5	Notices	• 10) LIPPT: $1.49 • 10) LIPPT review of literature through 2000: Range / mean / median for program-associated change: 0-90% / 25% / 10% • 3) Quantec OR-Pacificorps: Energy Share of Eugene- average annual cost savings per participant, door hangers $10.5, Final Notice $.56 • 19) Skumatz WI; Estimated Annual NEBs per Participant per Year Fewer Notices: $0.30	Few study these separately
6	Customer calls / bill or emergency-related	• 10) LIPPT: $1.58 • 10) LIPPT review of literature through 2000: Range / mean / median for program-associated change: 1-90% / 25% / 10%, • 16) PA WI: Skumatz- NEB changes/Participant/year- $.43 • 17) Skumatz – MA; Reduction: 34%, Annual Benefit per HH: $0.59; • 18) Skumatz – CT; Reduction: 32%, Annual Benefit per HH: $0.55; • 19) Skumatz WI; Estimated Annual NEBs per Participant per Year Fewer Customer Calls: $0.43	Values on order of $0.50.
7	Other bill collection cost	• 10) LIPPT: not estimated. • 6) Howat/Oppenheim NE: actual arrearage reduction represents a transfer payment when written off as uncollected debt. However, admin plus collection costs generate a NEB adder of 2.1%. • 13) Dalhoff VT: Average Impact/unit w/ program- notices- $98, reduced transaction costs $47. • 14) TecMRKT VT: Average per home in weatherization program- $75, reduced transaction costs- $36. • 16) PA WI: Skumatz- NEB changes/Participant/year- fewer notices- $.30	Few study these separately.
8	Emergency gas service calls (for gas flex connector and other programs)	• 10) LIPPT: $0.07 • 10) LIPPT: 2 studies ranging 23-57% • 6) Howat/Oppenheim NE: CO study calls dropped 74%. PSCo estimated savings from better maintenance. In DSM program reduced the cost for emergency. Calls saving on average $16 per weatherization HH in first year.	Based on 2 main studies – Magouirk and Blasnik. Needs more work.

ID	Perspective or NEB Category	NEB Impacts from Other Low Income Programs - % or $	Summary of Values (per participant / yr); Implications
		• 16) PA WI: Skumatz est. value over time to range from $84 to $170 resulting in an adder range of 11.6% to 23.6%. • 17) Skumatz MA; Reduction: 25.9%, Annual Benefit per HH: $0.40; • 18) Skumatz CT: Reduction: 25.9%, Annual Benefit per HH: $0.21	
9	Insurance savings		Very rarely examined
10	Transmission and distribution savings (usually distribution)	• 10) LIPPT: $0.94; cited NW study assuming 7.5% reduction • 16) PA WI: Skumatz- NEB changes/Participant/year- $2.59 • 17) Skumatz MA: Reduction: 6.5%, Annual Benefit per HH: $1.10; • 18) Skumatz CT, Reduction: 6.5%, Annual Benefit per HH: $1.00; • 19) Skumatz WI; Estimated Annual NEBs per Participant per Year T&D Savings: $0.13	Not often separately studied; embedded in utility avoided costs for some. Rules of thumb estimated percentages for some.
11	Fewer substations, etc.		Not studied to date
12	Power quality / reliability		Not studied to date
13	Reduced subsidy payments (low income)	• 10) LIPPT: $3.32, based on 15% rate subsidies for low income on programmatic energy savings • 3) Quantec OR-Pacificorps: In PacifiCorp coverage areas, those states with rate discounts had better customer bill coverage, CA 92%, UT 80%, WA 75% vs. ID 65%, OR 66%, and WY 57%. • 4) Quantec OR-REACH: LI- participants increased the number of payments by 7.1% compared to non participants. • 17) Skumatz MA; Reduction: 35%, Annual Benefit per HH: $23.57;	Very directly related to the energy savings and utility's discount rate
14	Other	• 6) Howat/Oppenheim NE:Cite CO study- reduction in payment-related costs generated a NEB adder of 8.47%. From Skumatz, subsidies or rate decreases for LI increase their ability to pay, but as DSM measures take effect overall amount decreases, an estimated range of $42-$270/HH is used to account for this NEB. Based on reported program costs of $719 per weatherization HH, an adder of 5.8% - 37.6% is appropriately applied to cost-effectiveness testing.	Tbd
	Total Perspective Utility	• *10) LIPPT: total $11.64; 9% of total NEBs across 3 perspectives.* • *9) Quantec WA: Benefit/Cost ratio including NEBs Utility, .43, ratepayer, .31, total resource cost, 1.12. (without NEBs Total resource cost .65)* • 24) Equipoise CA; Benefits w/ NEBS: PG&E $10,269,895; • 25) SERA LIPPT; SDG&E $3,561,770; SCE & SoCalGas $9,802,003; Costs: PG&E $25,211,144; SDG&E $6,414,269; SCE & SoCalGas $21,382,824; B/C w/NEBS: PG&E 0.41; SDG&E 0.56; SCE & SoCalGas 0.46; • 17) Skumatz MA; Total Annual Benefit per HH: $31.00; • 18) Skumatz CT: Total Annual Benefit per HH: $6.12; • 19) Skumatz WI: Estimated Annual NEBs per Participant per Year Total: $4.82	Lowest of the 3 perspectives. Totals range from $4-$31/HH.
15			
16	***SOCIETAL PERSPECTIVE***		
17	Economic development benefits – direct and indirect	• 10) LIPPT: $35.95 • 10) LIPPT review of literature through 2000: Range / mean / median for program-associated change: 13-320% multiplier / 126% / 83% • 1) PA/Wisc: Contribution, Year 1 $2.6, year 1-25 $426.2 ($000,000)	Very dependent on measures and program type.

ID	Perspective or NEB Category	NEB Impacts from Other Low Income Programs - % or $	Summary of Values (per participant / yr); Implications
	multipliers	• 2) PA/Wisc: Economic Impact of Program Spending- Jobs Year 1 375, yr 1-10 6,870. Business Sales (in Million $) yr 1 $40.3, yr 1-10 $987.4, Value added, yr 1 $26.7, yr 1-10 $601.8 • 8) Cadmus Ontario: Net jobs table showed (per $1 million investment) 3.51 in direct jobs in province; 5.07 indirect jobs in province, and 5.62 jobs indirect nationwide (Canada) when comparing jobs for residential building construction vs. power generation. Contractor responses to the Green Job Survey showed 6% growth in the total number of full time employees. BC Hydro found that with Power Smart program an average of 59 person years of employment are created per million dollars of BCH spending. Pembina Institute found EE investments create over 35 person yrs per million $ invested. Ontario-OPA Energy Efficiency program during 2007-2027 would lead to avoided costs of 16.4 billion and employment of 40,967 person yrs. Entergy Utility found investment in LI EE creates economic impact 23 times the original investment, 216 jobs were created for every $1 in investment. NAPEE with $7 billion/yr investment creates 298,000 jobs/yr. European study of 40 programs found for every 1million Euros spent in EE programs, 11.3 to 13.5 FTE jobs created. Netherlands DSM program of 75 million Euro results in 3,800 person yrs employment. • 9) Quantec WA: 6 net job years and $550,118 added to economy over 2 yr program. • 13) Dalhoff VT: Average Impact/unit with program- community economic benefits- $2223. • 14) TecMRKT VT: Average per home in weatherization program- community econ benefit. $1967. Job creation- .151 job years. • 16) PA WI: Skumatz- NEB changes/Parti/year-$340.94 • 19) Skumatz WI; Estimated Annual NEBs per Participant per Year Economic NEBs GRP: $340.94; • Skumatz WI; Estimated Annual NEBs per Participant per Year Economic NEBs Labor Income: $186.09	
18	Tax effects - (2 possible effects: related to unemployment and income taxes from job creation / economic development; another effect possibly related to tax credits for investment in certain measures / PV / solar, etc.)	• 6) Howat/Oppenheim NE: NEB of unemployment insurance, benefit est. $82 per weatherization. Hh with an adder of 5.29%. • 13) Dalhoff VT: Average/unit- Fed Tax generator. w/ prgm-$138, avoid cost unemployment- $207. • 14) TecMRKT VT: Average per home in weatherization program- Fed tax generated- $123. Avoided unemployment costs- $183. • 16) PA WI: Skumatz- NEB changes/Participant/year- $186.09	Directly related to above plus local tax schedules. Can be calculated relatively easily. Not volatile in an unpredictable way.
19	Emissions / environmental (trading values and/or health / hazard	• 10) LIPPT: $7.71 • 1) PA/Wisc: Year 1 $0.0, year 1-25 $3.5 ($000,000). • 9) Quantec WA: WA Program 2003-2005, by 2006 $22,809 worth of air emission reductions. Total program environmental impact, $125, 529. • 13) Dalhoff VT: Average Impact/unit with program- Air emissions $2748,	Dependent on fuel mix, time of day (peak / off-peak) or can use more complex algorithms. Varies by utility.

ID	Perspective or NEB Category	NEB Impacts from Other Low Income Programs - % or $	Summary of Values (per participant / yr); Implications
	benefits)	Water issues $2483. • 14) TecMRKT VT: Average per home in weatherization program-air $875, water- $184. • 16) PA WI: Skumatz- NEB changes/Parti/year-$128.35 • 17) Skumatz MA; Multiplier: 35% Annual Benefit per HH: $9.13; • 18) Skumatz CT: Multiplier: 35%, Annual Benefit per HH: $5.37; • 19) Skumatz WI: Estimated Annual NEBs per Participant per Year Environmental/Emissions effects: $128.35	
20	Health and safety equipment	• 10) LIPPT: $0.29 • 6) Howat/Oppenheim NE: Reduced Emergency service calls due to weather. Program is $3/weatherized HH. Therefore use an adder of less than 1%.	Very few studies; presumably very dependent on measures
21	Water and waste water treatment or supply plants	• 10) LIPPT: $0.28	Rarely or never studied
22	Fish / wildlife mitigation		Never studied
23	National security	• 13) Dalhoff VT: Average Impact/unit w/ program- $205. • 14) TecMRKT VT: Average per home in weatherization program- $202.	Rarely studied
24	Health care	• 4) Quantec OR-REACH: LI -participant health insurance scores improved 3%, nutrition improved by 5%. • 6) Howat/Oppenheim NE: One study estimates the value of reduced illness and increased health is $1300 per weatherized HH. Under the reported program cost of $719/weatherized HH, and adder of up to 181% reflects this value.	Rarely studied
25	Reduced dependency / Improved social indicators of family stability and employment / reduced dependence on state assistance	• 4) Quantec OR-REACH: LI net present value of participant income increases- $751,125. Income increase vs. those not in program, 4%. Employment scores increase 6% over course of program • 12) Quantec Indiana REACH: Improvements in social indicators included: 18% reduction in school absences; 52% reduction in family moves; 9% increase in federal and state benefits per month; variable impacts on family debt; 15% and 36% reductions in electric and gas debt ratios, respectively; increase of 22% in total income; increase of 28% in total employment income; reduction of 12.5% in annual energy consumption expenditures, and reduction of 28% in energy burden.	Rarely studied, important
26	Other		
	Total Perspective Societal	• 10) LIPPT: Total perspective NEBs $72.05, 55% of total NEBs • 17) Skumatz MA; Multiplier: 35% Annual Benefit per HH: $9.13; • 18) Skumatz CT: Multiplier: 35%, Annual Benefit per HH: $5.37	Potentially valuable when economic development and emissions effects included.
27	***HOUSEHOLD PARTICIPANT PERSPECTIVE***		
28	Water / wastewater bill savings	• 10) LIPPT: $15.48 • 16) PA WI: Skumatz- NEB changes/Parti/year-water/sewer-$4.89, water bill- $8-10. • 17) Skumatz MA: Calculation Complicated, Annual Benefit per HH: $3.65; • 18) Skumatz CT; Calculation Complicated, Annual Benefit per HH: $11.49; • 19) Skumatz WI: Approximate Value Using $268-$344 Total NEB Value	Somewhat valuable, especially in California with high water and sewer rates. Easily computed from secondary data; depends on measures installed. $5-12/HH/yr

ID	Perspective or NEB Category	NEB Impacts from Other Low Income Programs - % or $	Summary of Values (per participant / yr); Implications
		Per Year: $8-$10, Share of Total Benefits: 3%; • 19) Skumatz WI: Estimated Annual NEBs per Participant per Year : $4.89	
29	Operating costs (non-energy)		Rarely studied.
30	Equipment maintenance	• 16) PA WI: Skumatz- NEB changes/Participant/year- $17-22	Survey-based; $17-22 estimates.
31	Equipment performance (push air better, etc.)	• 16) PA WI: Skumatz- NEB changes/Parti/year-$14-18 CA Retro HP Program 2004-5, • 26) Lutzenhiser, 2006 Pursuing retrofit for: 13%; • 19) Skumatz WI; Approx Value Using $268-$344 Total NEB Value Per Year: $14-$18, Share of Total Benefits: 5%;	Many studies; important, especially with comfort; extant values $14-18
32	Equipment lifetime		Few quantitative results separate from surveys.
33	Shutoffs	• 10) LIPPT: $0.60 • 5) Quantec OR-HEAT: LI- frequency of disconnects, or threats of, dropped 17%. • 6) Howat/Oppenheim NE: Report value to customers as high as $425/weatherizated HH with program cost $719 with an adder of to 59.1%. • 18) Skumatz CT: Reduction: 16%, Annual Benefit per HH: $0.18; • 19) Skumatz WI: Approx Value Using $268-$344 Total NEB Value Per Year: $9-$12, Share of Total Benefits: 3%;	Survey based or based on computations of time value. Seems to indicate small values because of low incidence. Current values vary from a few cents to $12. Varies based on procedures at utility and charges.
34	Reconnects	• 10) LIPPT: $0.08 • 17) Skumatz CT: Reduction: 16%, Annual Benefit per HH: $0.03	Same as above.
35	Property value benefits / selling	• 10) LIPPT: $17.80 • 5) Quantec OR-HEAT: LI- those owning homes in safe neighborhoods increased by 8%. • 7) Oppenheim NE: Increased property values $20.70/$ in annual energy savings. . • 14) TecMRKT VT: Average per home in weatherization program- $5413. 26) Lutzenhiser CA: Pursuing retrofit for: 8%; • 17) Skumatz MA: Average Cost Improvements: $17.46, Annual Benefit per HH: $2.84; • 18) Skumatz CT: Cost Housing Repairs: $15.80, Annual Benefit per HH: $2.57; • 19) Skumatz WI: Approx Value Using $268-$344 Total NEB Value Per Year: $17-$22, Share of Total Benefits: 6%;	Potentially very important, but also very local and program-specific (what measures, etc.). Needs more study, but likely very hard (costly) to compute because of data collection (not because it is complex). Varies from a few dollars to more than $20.
36	(Bill-related) calls to utility	• 10) LIPPT: $0.18 • 17) Skumatz MA: Reduction: 34%, Annual Benefit per HH: $0.31; • 18) Skumatz CT: Reduction: 32%, Annual Benefit per HH: $0.29; • 19) Skumatz WI: Approx Value Using $268-$344 Total NEB Value Per Year: $6-$8, Share of Total Benefits: 2%;	Time value of data from arrearage study. Generally around $0.30; one study finds up to $8.
37	Comfort	• 4) Quantec OR-REACH: LI- 95% of participants said more comfortable in home with weatherization. • 7) Oppenheim NE: from Skumatz IEPEC '99 comfort 12% of total benefit, Oppenheim suggests 12% of energy benefits. • 12) Quantec IN-REACH: warmer house- 28%. CA Retro HP Program 2004-5,Lutzenhiser, 2006 Pursuing retrofit for: 18%; • 17) Skumatz MA: Most important reason participants participated; 2% MA • 18) Skumatz CT: Most important reason participants participated: 8% total, 10% CT;	Valuable in almost all studies; see line 31. Up to $50+ per year in one study. Commonly one of the top benefits from low income programs.

ID	Perspective or NEB Category	NEB Impacts from Other Low Income Programs - % or $	Summary of Values (per participant / yr); Implications
		• 19) Skumatz WI: Approx Value Using $268-$344 Total NEB Value Per Year: $44-$56, Share of Total Benefits: 16%;	
38	Aesthetics / appearance	• 26) Lutzenhiser: Pursuing retrofit for: 2%	Survey-based; should be related to line 35
39	Fires / insurance damage (gas)	• 13) Dalhoff VT: Average Impact/unit w/ program- reduced fire deaths, injuries, $523. • 14) TecMRKT VT: Average per home in weatherization program- fewer emergencies. Calls- $323, fewer fire deaths, injuries, loss- $409. • 17) Skumatz MA: Calculation Complicated, Annual Benefit per HH: $0.02; • 18) Skumatz CT: Calculation Complicated, Annual Benefit per HH: $0.16	Rarely studied; indirect; incidence data very thin.
40	Lighting / quality of light	• 19) Skumatz WI: Approx Value Using $268-$344 Total NEB Value Per Year: $19-$25, Share of Total Benefits: 7%;	Survey-based; depends on measures installed. One study showed $25.
41	Noise (internal / equipment)	• 19) Skumatz WI: Approx Value Using $268-$344 Total NEB Value Per Year: $15-$20, Share of Total Benefits: 6%;	Survey-based; depends on measures installed; extant values $15-20.
42	Noise (external)	• 19) Skumatz WI: Approx Value Using $268-$344 Total NEB Value Per Year: $13-$17, Share of Total Benefits: 5%;	Same as above; extant values $13-17
43	Safety	• 13) Dalhoff VT: Average Impact/unit w/ program- fewer emergency calls- $428. • 19) Skumatz WI: Approx Value Using $268-$344 Total NEB Value Per Year: $20-$26, Share of Total Benefits: 8%;	Few incidence studies – needs more work.; extant values about $20.
44	Control over bill	• 4) Quantec OR-REACH: LI- participants increased the number of payments by 7.1% compared to non participants. • 5) Quantec OR-HEAT: LI consistency of paying bills increased by 11%. • 19) Skumatz WI: Approx Value Using $268-$344 Total NEB Value Per Year: $28-$36, Share of Total Benefits: 11%;	Survey-based historically. Values ~$30.
45	Understanding / knowledge	• 4) Quantec OR-REACH: LI- usefulness of education workshop, very useful 50%, somewhat useful 30%, Usefulness of in home energy education, very useful 63%. • 9) Quantec WA: 75% of respondents vs. 35% previously remember getting education info, 80% implemented a least 1 measure. • 9) Quantec WA: WA, more money to spend on other necessary. went from 61% to 83%. • 17 & 18) Skumatz CT & MA: Most important reason participants participated: 10% total, 14% CT, 5% MA;	Needs more study. Potentially important.
46	"Care" or "hardship" (low income) - and/ or see row 53 - related	• 10) LIPPT: $2.68 • 5) Quantec OR-HEAT: LI- income score (based on Federal Poverty Level) increased 211%. Participants in the Income Level of 150%-219% FPL increased by 25%. Total Relative income score (assets, ability to pay) increased 167%. Those who own nothing, unable to pay bills dropped by 22%. • 12) Quantec IN-REACH: Total income increased 22%. (of the $260 increase, only $68, employment income increase, can be attributed as direct result of program.)	Important for further exploration.
47	Indoor air quality	• 26) Lutzenhiser CA: Pursuing retrofit for: 5% (not low income, but residential)	Not strongly recognized as separate impact in most studies.
48	Health / lost days at work or school	• 10) LIPPT: $3.78 • 4) Quantec OR-REACH: LI -health insurance scores improved 3%, nutrition improved by 5%.	Important; high value for some programs, but most between $4 and $12 / HH

ID	Perspective or NEB Category	NEB Impacts from Other Low Income Programs - % or $	Summary of Values (per participant / yr); Implications
		• 5) Quantec OR-HEAT: LI- health care section total score improved by 133%, those with coverage for all family members increased by 24%. • 7) Oppenheim NE: $150/weatherized HH/yr from Skumatz 1997. • 9) Quantec WA: WA, fewer absences from 36% to 43%. Of respondents 12 (18%), had asthma, 5 (of 12) said reduced complications. • 12) Quantec IN-REACH: absences dropped 18%. Experience fewer illnesses- 17%. • 13) Dalhoff VT: Average Impact/unit w/ program- $1421. • 14) TecMRKT VT: Average per home in weath.prgm-$1805. • 26) Lutzenhiser CA: Pursuing retrofit for: 4%; • 17, 18) Skumatz MA: Most important reason participants participated: 1% total, 1% CT, 1% MA; • 17) Skumatz MA: Reduction: 0.07, Annual Benefit per HH: $3.78; • 18) Skumatz CT: Reduction: 0.07, Annual Benefit per HH: $3.78; • 19) Skumatz WI: Approx Value Using $268-$344 Total NEB Value Per Year: $4-$5, Share of Total Benefits: 1%; • 19) Skumatz WI: Freq/Intensity Chronic Conditions Approx Value Using $268-$344 Total NEB Value Per Year: $9-$12, Share of Total Benefits: 3%; • 19) Skumatz WI: Freq/Intensity Other Illnesses Approx Value Using $268-$344 Total NEB Value Per Year: $5-$6, Share of Total Benefits: 2%; • 19) Skumatz WI: Headaches Approx Value Using $268-$344 Total NEB Value Per Year: $5-$6, Share of Total Benefits: 2%; • 19) Skumatz WI: Doctor/Hospital Visits Approx Value Using $268-$344 Total NEB Value Per Year: $4-$5, Share of Total Benefits: 2%; • 19) Skumatz WI: Medication Costs Approx Value Using $268-$344 Total NEB Value Per Year: $1, Share of Total Benefits: 0%	/ yr.
49	Fewer moves	• 10) LIPPT: $1.30 • 6) Howat/Oppenheim NE: researchers estimated the value of reduced mobility as much as $840/weatherized HH. With a program cost of $719 and adder of up to 117% is justified. • 7) Oppenheim NE: $50/weatherized HH/yr • 9) Quantec WA: avoid moving from 37% to 68%, at about $700/move = $47,600 participant savings. • 12) Quantec IN-REACH: Percent of families that moved decreased 52%. • 13) Dalhoff VT: Average Impact/unit w/ program- $62. • 17) Skumatz MA: Reduction: 0.006, Annual Benefit per HH: $0.65; • 18) Skumatz CT: Reduction: 0.006, Annual Benefit per HH: $0.65; • 19) Skumatz WI: Approx Value Using $268-$344 Total NEB Value Per Year: $1, Share of Total Benefits: 0%;	The mobility value is potentially high, but incidence studies are few. One study found value of more than $60; most use more conservative numbers and derive lower estimates (under $1 because of small incidence)
50	Doing good for environment	• 26) Lutzenhiser CA: Pursuing retrofit for: 15%; • 19) Skumatz WI: Approx Value Using $268-$344 Total NEB Value Per Year: $4-$6, Share of Total Benefits: 2%;	Highly valued by participants; not clear value to programs
51	Savings in other fuels or services (as relevant)	• 9) Quantec WA: annual fuel savings, Nat. Gas, 9,693 therms, Fuel Oil, 7 gal, Coal 116 tons. • 12) Quantec IN-REACH: Gas debt reduced 36%. • 26) Lutzenhiser CA: Pursuing retrofit for: 15%	Direct when measuring gas and electric; not many other services studied.
52	GHG and environmental effects	• 19) Skumatz WI: Emissions Reductions: NOX: 200,639lbs, 1.73 value/lb, $15.43 $/lb emission; SOX: 306,306lbs, 1.20 value/lb, $16.34 $/lb emission; CO2: 133,301,133lbs, 0.0163 value/lb, $96.58 $/lb emission; Hg: 1.226lbs; Total Per Participant: $128.35	Measured under societal.

ID	Perspective or NEB Category	NEB Impacts from Other Low Income Programs - % or $	Summary of Values (per participant / yr); Implications
53	Employment and family stability, reduced dependence on state assistance	• 4) Quantec OR-REACH: LI 4% income increase vs. those not in program, employment scores increase 6% over course of program. • 5) Quantec OR-HEAT: LI-Overall employment category scores increased 165%. Those unemployed dropped by 25%. Those who used soup kitchens monthly dropped 13%. • 12) Quantec IN-REACH: increase in receipt of Fed/St funds by 9%. (however REACH helps families access these programs so may be positive effect). • 17 & 18) Skumatz MA/CT: Most important reason participants participated: 2% total, 3% CT, 1% MA; • 19) Skumatz WI: Approx Value Using $268-$344 Total NEB Value Per Year: $22-$29, Share of Total Benefits: 8%	Important; see line 46
	Other	• 26) Lutzenhiser CA: Pursuing retrofit for rebate: 2%; interest buy down program: 1%; contractor recommended: 1%; HP test recommended: 1%; • 17 & 18) Skumatz CT, MA: Most important reason participants participated - free equipment/installation: 10% total, 8% CT, 13% MA; • 19) Skumatz WI: Estimated Annual NEBs per Participant per Year Customer-Value Participant Benefits: $268-$344	Depends.
55	NEGATIVES include: Installation hassles / mess, negative values from items above	• 12) Quantec IN-REACH: Average family debt increased by 32%, but not always negative, some is do to families now being able to afford houses or cars.	Not usually found to be important / valuable.
	Total Perspective Participant	• 10) LIPPT: "Soft" NEBs estimated at $6.70 across multiple categories. Total Participant NEBs $48.30, or 36% of total NEBs across all 3 perspectives. • 1) PA/Wisc: NEBs year 1 $0.8, year 1-25 $73.6 ($000,000). • 2) PA/Wisc: Economic Impacts of NEBs Res & LI- (fewer shutoff, decreased water etc) Value added ($in Millions) Yr 1 $1.9, yr 1-10 $227. • 24) Equipoise CA: Benefits with NEBS: PG&E $23,700,706; SDG&E $6,292,154; SCE & SoCalGas $20,702,988; Costs: $0 for all; B/C w/ NEBs: Undefined for all; Participant Benefits/Utility Costs w/NEBS: PG&E 0.94; SDG&E 0.98; SCE & SoCalGas 0.97; • 17) Skumatz MA: Total Annual Benefit per HH: $11.25; • 18) Skumatz CT: Total Annual Benefit per HH: $19.14; • 19) Skumatz WI: Approx Value Using $268-$344 Total NEB Value Per Year: $44-$56, Share of Total Benefits: 16%; • 19) Skumatz WI: Approx Value Using $268-$344 Total NEB Value Per Year: $268-$344, Share of Total Benefits: 100%; • 19) Skumatz WI: Estimated Annual NEBs per Participant per Year Total: $272-$348	Majority of value for some programs

Key to source numbers in Table

1) PA Consulting, Low Income Pub benefits, Wisconsin DOE ,February, 2007
2) PA Consulting, Economic Development Benefits, Wisconsin DOE, February, 2007
3) Quantec, Low-income Arrearage Study for PacifiCorp, March 2007
4) Quantec, 2004-2006 Oregon REACH Program, September 2008,
5) Quantec, Energy Smart Program Evaluation, Oregon HEAT, December 2008,
6) Howat/Oppenheim, Analysis of Low Income Benefits in Determining Cost-effectiveness of Energy Efficiency Programs, November 2004

7) Memo from J. Oppenheim to Laura McNaughton"Low income DSM NEB, March 2000
8) The Cadmus Group, Assessment of Green Jobs Created by the OPA Multifamily Buildings Programs, for Ontario Power Authority September 2009
9) Quantec, Washington Low-income Weatherization Program, for Pacific Power, January 2007
10) TecMrktWorks, Skumatz Economic Research Associates, Inc, Megdal & Associates, "Low Income Public Purpose Test (LIPPT) 2000.
12) Quantec, M. Sami Khawaja, Indiana REACH Evaluation, for Indiana Dept of Admin and Family & Social Services Admin, October 2001.
13) Dalhoff Associates, An Update of the Impacts of Vermont's Weatherization Assistance Program, for VT State OEO Weatherization. Program, February 2007.
14) TecMRKT Works, An Evaluation of the Energy and Non-energy impacts of VT's Weatherization Assistance Program, for VT State Office Of Economic. Opportunity, November 1999.
16) PA Consulting , Low Income Pub Ben Evaluation, Non-Energy Benefits of Wisconsin Low Income Weatherization. Assistance Program, Wisconsin Dept of Admin, DOE, November 2005.
17) Skumatz Economic Research Associates; Evaluation of NU - MA ESP Program NEBs 2002,
18) Skumatz Economic Research Associates; Evaluation of NU - CT WRAP Program NEBs 2002
20) Skumatz Economic Research Associates: for PA Consulting for WI Department of Administration Division, Low income program evaluation, 2005
21) Tellus Institute- Review of Energy Efficiency programs.
22) Oak Ridge National Laboratories (ORNL(Program Progress Report of National Weatherization Assistance Program (Schweitzer and Tonn) 2002.
23) Skumatz Economic Research Associates, analysis of PG&E's Venture Partners Pilot Program, - PG&E Low Income Weatherization Assistance Program 1994
24) Equipoise, *LIEE Program Evaluation", California 2001,
25) Skumatz Economic Research Associates: NEB evaluation for 2000 California LIPPT, included in TecMRKT Works / Skumatz / Megdal California LIPPT report, 2001.
26) Lutzenhiser, 2006 California Retrofit High Performance Program 2004-5,

Table A.2 Summary of Low Income NEBs Estimation Methods in Current California LIEE / LIPPT Model

Row ID		General Description of Current Best Industry Calc method (program-based)	Alternate method(s)	Can "per participant" meaurement method be translated to MEASURE basis? (1=easy; 2=medium; 3=difficult) How? s	
#	*UTILITY PERSPECTIVE*				
1	Carrying cost on arrearages	Average arrearage per low income customer (utility data) times Estimated program-induced percentage reduction in arrearages (arrearage analysis) times Utility interest rate (utility supplied)	If no utility studies, backup for these can be percentage changes or multipliers from published studies that are as similar as possible to the program design / measures / eligibility / climate	1	Based on dollars, so proportioning by kWh suitable translation; peak / off-peak adjustments may improve but not critical.
2	Bad debt written off	Average bad debt per low income customer (utility data) times Estimated program-induced percentage reduction in bad debt write-offs (arrearage analysis)	Above	1	Based on dollars, so proportioning by kWh suitable translation; peak / off-peak adjustments may improve but not critical.
3	Shutoffs	Average shutoffs per low income customer (utility data) times Estimated program-induced percentage reduction in shutoffs (arrearage analysis) times marginal cost of shutoff to utility	Above	1	Based on dollars, so proportioning by kWh suitable translation; peak / off-peak adjustments may improve but not critical.
4	Reconnects	Average reconnections per low income customer (utility data) times Estimated program-induced percentage reduction in reconnections (arrearage analysis) times marginal cost of reconnections to utility	Share of shutoffs reconnected times marginal cost of reconnections to utiltiy OR	1	Based on dollars, so proportioning by kWh suitable translation; peak / off-peak adjustments may improve but not critical.
5	Notices	Average notices per low income customer (utility data) times Estimated program-induced percentage reduction in notices (arrearage analysis) times marginal cost of notices to utility	above	1	Based on dollars, so proportioning by kWh suitable translation; peak / off-peak adjustments may improve but not critical.
6	Customer calls / bill or emergency-related	Average calls per low income customer (utility data) times Estimated program-induced percentage reduction in calls (arrearage analysis) times Utility's marginal cost per customer call (utility supplied)		1	Based on dollars, so proportioning by kWh suitable translation; peak / off-peak adjustments may improve but not critical.
7	Other bill collection cost	Similar to above times marginal bill collection costs	above	1	Based on dollars, so proportioning by kWh suitable translation; peak / off-peak adjustments may improve but not critical.

Row ID		General Description of Current Best Industry Calc method (program-based)	Alternate method(s)	Can "per participant" meaurement method be translated to MEASURE basis? (1=easy; 2=medium; 3=difficult) How? s	
8	Emergency gas service calls (for gas flex connector and other programs)	Percent of participants receiving gas service (utility data) times Percent of eligible customers needing gas appliances fixed (utility data) times Percent of emergencies avoided through program activities (minimum used in literature; see Oppenheim & MacGregor, 2000 and Blasnik, 1997) times Utility's marginal cost per emergency call avoided (utility supplied)		2	Already based on whether gas measures installed; may need some analysis to decide if effect "kicks-in" with just one gas measure or changes with multiple gas measures.
9	Insurance savings	Not much work in this area	Total dollar value of Health and safety claims from fire and other emergency claims per year at utiltiy divided by appropriate number of customers times program-induced percentage reducion in H&S emergencies for each home with H&S measures installed	3	If we can identify measures with greatest risk (gas appliances / connectors? Torchieres? Others?) and the proportion of risk associated, possibly. However the research in this area are very weak.
10	Transmission and distribution savings (usually distribution)	Little work	Net electrical energy savings per household in kWh per year (utility data) times Avoided cost per kWh (utility supplied) times T and/or D loss reduction percentage (rule of thumb based on evaluator's interviews and experience)	1	Relatlively easy. If loss factors vary by peak / off peak, or by season, etc. we maybe able to refine beyond simple proportions of kWh.
11	Fewer substations, etc.	Little work	?construct from kw or kwh savings, utiltiy marginal costs	1	Need to discuss relationship with peak / off peak and other factors.
12	Power quality / reliability	Little work	?construct from kw or kwh savings, utiltiy marginal costs	1	Need to discuss relationship with peak / off peak and other factors.
13	Reduced subsidy payments (low income)	Bill savings per participating household per year (utility data) times Rate subsidy percentage times Percent of participants on low income rate subsidy		1	Based on dollars, so proportioning by kWh suitable translation; peak / off-peak adjustments may improve but not critical.
14	Other				
15					
16	***SOCIETAL PERSPECTIVE***				
17	Economic development benefits – direct and indirect multipliers	Input output modeling using appropriate industry sectors based on measures installed in program		2	Yes. Modeling work depends on the sectors making / installing the measures; however, measures may end up in "groups" depending on the level of detail of industry types included in the model

Row ID		General Description of Current Best Industry Calc method (program-based)	Alternate method(s)	Can "per participant" meaurement method be translated to MEASURE basis? (1=easy; 2=medium; 3=difficult) How? s	
18	Tax effects - (2 possible effects: related to unemployment and income taxes from job creation / economic development; another effect possibly related to tax credits for investment in certain measures / PV / solar, etc.)	Limited research / rarely included. Should be sraightforward computation based on percent of job creation or economic development income "bump". There may be a second effect related to tax benefits from investment tax credits for some measures (solar, wind), but that may be cancel out as negative for society (lost tax revenues) vs. participant recept of those tax benefits. Formulae should be relatively easy to model once the relevant tax code information is identified. Size of this second impact is not well known or estimated anywhere; the first has possibly been estimated in one or two cases.		1, 2	Easily - each should be very closely related to 1) job creation income and 2) presumably related to investment or cost and measure / tax law.
19	Emissions / environmental (trading values and/or health / hazard benefits)	Modeling work	Energy savings (program estimate) times Percent multiplier (literature)	1 or 3, depending	Very straightforward; adjustments for peak/ off peak useful, but unlikely to require hourly load work - but can be discussed
20	Health and safety equipment	Cost of H&S equipment installed through the program times percent of participants with H&S measures installed plus cost of CO monitors installed times percent of homes with CO monitors installed OR	Average crises per household times cost per avoided crisis times reduction in crises per household (unknown source - perhaps percent receiving H&S measures)	2 or 3	Data on relationship for health and safety isn't strong, but when it is available, it is likely to be related to specific types of equipment (e.g. carbon monoxide monitors, etc.) so may be straightforward… need to explore other measures that may arise. This benefit is less explored than most.
21	Water and waste water treatment or supply plants	Difficulty is not in water savings, but in identifying the local system capacity constraints, and thus, the appropriate value to apply.	Water savings associated with percent of homes receiving aerators etc times segment of water rates that represent avoided cost or similar	3	Straightforward to estimate water savings, but capacity of infrastructure and those values will remain difficult to value. Once that is established, sharing it out by measure is not hard.
22	Fish / wildlife mitigation	No estimates yet			Unclear
23	National security	No estimates yet			Unclear
24	Health care	No estimates yet		2 to 3	Will be similar in difficulty to health and safety equipment; may depend on IAQ impacts of specific measures and the health impacts -- which are lacking in the literature.

Row ID		General Description of Current Best Industry Calc method (program-based)	Alternate method(s)	Can "per participant" meaurement method be translated to MEASURE basis? (1=easy; 2=medium; 3=difficult) How? s	
25	Reduced dependency / Improved social indicators of family stability and employment / reduced dependence on state assistance	Estimated from analyses of income effects from kWh / bill reductions / payment improvements and reports of employment effects and reduced absences due to program interventions (Quantec/Cadmus)		1	Once computed, should be easy to "share out" based on kWh because of direct relationship to bills.
26	Other				
27	*<u>HOUSEHOLD PARTICIPANT PERSPECTIVE</u>*				
28	Water / wastewater bill savings	Percent of households receiving aerators (program data) times Water savings per aerator in gallons (literature) plus Percent of households receiving low flow showerheads (program data) times Water savings per showerhead in gallons (literature) total times Water rate per unit (from utility or research); (add sewer rates as well)		1	Very direct - per-measure water savings easily estimated / shared out.
29	Operating costs (non-energy)	None currently estimated (water is main one)			depends
30	Equipment maintenance	Participant survey valuation		2 or 3	Little measure-based information (except CFL, D/W, C/W, refrig, maybe windows, and a few others - but NOT insulation, shell measures, etc.). Will likely take new studies of specific individual measures or statistical decomposition of results from studies (1 example)
31	Equipment performance (push air better, etc.)	Participant survey valuation		2 or 3	Same as above
32	Equipment lifetime	Participant survey valuation	Estimate could be developed from change in lifetime and repair schedule/cost changes	2 or 3	Same as above
33	Shutoffs	Average shutoffs per low income customer (utility data) times Estimated program-induced percentage reduction in shutoffs (arrearage analysis) times average amount of time home is without power time rental value		1	Should be easy to "share out" based on kWh because of direct relationship to bills.

Row ID		General Description of Current Best Industry Calc method (program-based)	Alternate method(s)	Can "per participant" meaurement method be translated to MEASURE basis? (1=easy; 2=medium; 3=difficult) How? s	
34	Reconnects	Average reconnections per low income customer (utility data) times Estimated program-induced percentage reduction in reconnections (arrearage analysis) times amount of time household spends arranging reconnection times minimum wage		1	Should be easy to "share out" based on kWh because of direct relationship to bills.
35	Property value benefits / selling	Average cost of housing improvements across participants (program data)		1?	Should be directly related to the repairs conducted; but could use discussion.
36	(Bill-related) calls to utility	Average calls per low income customer (utility data) times Estimated program-induced percentage reduction in calls (arrearage analysis) times Average time per call in minutes (utility supplied) times Minimum wage divided by 60 minutes		1	Should be easy to "share out" based on kWh because of direct relationship to bills.
37	Comfort	Participant survey valuation		2 or 3	Little measure-based information for HVAC, insulation, which should be largest drivers of this NEB. Will likely take new studies or statistical decomposition of results from studies (1 example)
38	Aesthetics / appearance	Participant survey valuation	No market studies conducted to date	2 or 3	Little measure-based information (except CFL, D/W, C/W, refrig, maybe windows, and a few others - but NOT insulation, shell measures, etc.). Will likely take new studies of specific individual measures or statistical decomposition of results from studies (1 example)
39	Fires / insurance damage (gas)	Average property loss from fires per incident per household (literature, e.g. Insurance Institute Fact Book or IIFB) times Average residential civilian loss of life per household (SERA research) times Value of each loss of human life (SERA research) times Percent caused by equipment that might be fixed by program (IIFB & program data) times Percent receiving H&S equipment (Program data) times Percent of fires eliminated by program's efforts (evaluator's judgment – literature?)		2?	Depends on ability to determine which measures relate to property damage / fires / injuries. Data not strong in this area

Row ID		General Description of Current Best Industry Calc method (program-based)	Alternate method(s)	Can "per participant" meaurement method be translated to MEASURE basis? (1=easy; 2=medium; 3=difficult) How? s	
40	Lighting / quality of light	Participant survey valuation		2 or 3	Same as "maintenance" and others above
41	Noise (internal / eqpt)	Participant survey valuation		2 or 3	Same as "maintenance" and others above
42	Noise (external)	Participant survey valuation		2 or 3	Same as "maintenance" and others above
43	Safety	Participant survey valuation		2 or 3	Depends on ability to determine which measures relate to safety. Data not strong in this area
44	Control over bill	Participant survey valuation		2	This element MAY be related only to bill, but it might be that certain pieces of equipment provide more enhanced control than others. Needs further analysis.
45	Understanding / knowledge	Participant survey valuation		1	Only associated with education "measure"
46	"Care" or "hardship" (low income) - and/ or see row 53 - related	Participant survey valuation			Depends on how defined
47	Indoor air quality	Participant survey valuation? Needs assessment / clarification / definition. May be trumped by health-related benefits that derive from this.	Can examine literature on derived illnesses		TBD
48	Health / lost days at work or school	Average sick days from work reduced from program (survey or literature) times Minimum wage times 8- hour work day			This would need to be associated only with measures that affect health and conditioning space (e.g.insulation / shell) but not appliances, etc.
49	Fewer moves	Per Quantec / Cadmus methods, use combination of arrearage and survey work to develop estimates of avoided moves	Older method: Number of moves per participant avoided (Blasnik, 1997) times Search time per move in hours (SERA research) times Minimum wage		Should relate direclty to kWh.
50	Doing good for environment	Participant survey valuation			Should relate direclty to kWh.
51	Savings in other fuels or services (as relevant)	Not currently estimated			TBD
52	GHG and environmental effects	Included above in "doing good for environment"			Should relate direclty to kWh.

Row ID		General Description of Current Best Industry Calc method (program-based)	Alternate method(s)	Can "per participant" meaurement method be translated to MEASURE basis? (1=easy; 2=medium; 3=difficult) How? s	
53	Employment and family stability, reduced dependence on state assistance	Estimated from analyses of income effects from kWh / bill reductions / payment improvements and reports of employment effects and reduced absences due to program interventions (Quantec/Cadmus)		1	Once computed, should be easy to "share out" based on kWh because of direct relationship to bills.
54	Other				TBD
55	NEGATIVES include: Installation hassles / mess, negative values from items above	Participant survey valuation			Depends on item / source… kWh as proxy?
56					

Table A.3. Priority of Research Needs for NEB Categories
Higher rank (right hand column) implies High relevance to low income, and low confidence in current estimates or methods.

NEB Categories - Analysis Priorities based on: relevance to Low Income, and Uncertainty in estimates / methods to date			2=very high relevance,confidence; 0=minimal		NEB Values for various Low Income Program Analyses							Study Rank, hi to low
ID / Order	NEB Category	Perspective	Relevance Level for Low Income	Confidence Level in estimates, methods	LIPPT value-2001	Value/hh/yr - other LI (avg of range)	Cluster Range - Low	Cluster Range - High	Savings multiplier	Value / other terms	Notes	H=relevant, low confidence, etc.
24	Health care	S	2	0					181.0%		One study showed $1300/hh (lifetime?)	VH
47	Indoor air quality	P	2	0					5%? (Lutzenheiser)			VH
25	Reduced dependency / Improved social indicators of family stability and employment / reduced dependence on state assistance	S	2	0							Various indicators - participant income increases, etc.	VH
46	"Care" or "hardship" (low income) - and/ or see row 53 - related	P	2	0	$2.68						Not measured much/ potential high value	VH
53	Employment and family stability, reduced dependence on state assistance	P	2	0								VH
48	Health / lost days at work or school	P	2	0.5	$3.78					0.3	Some values in thousands	H
49	Fewer moves	P	2	0.5	$1.30	$25.50	$1.00	$50.00	117% for 1 study		depends on how measured / which effects - indicator of welfare improvement	H
35	Property value benefits / selling	P	1	0	$17.80	$18.50	$15.00	$22.00			depends on program; some $5K	H

NEB Categories - Analysis Priorities based on: relevance to Low Income, and Uncertainty in estimates / methods to date			2=very high relevance,confidence; 0=minimal		NEB Values for various Low Income Program Analyses							Study Rank, hi to low
ID / Order	NEB Category	Perspective	Relevance Level for Low Income	Confidence Level in estimates, methods	LIPPT value-2001	Value/hh/yr - other LI (avg of range)	Cluster Range - Low	Cluster Range - High	Savings multiplier	Value / other terms	Notes	H=relevant, low confidence, etc.
43	Safety	P	1	0						Dalhoff $428/unit with program		H
8	Emergency gas service calls (for gas flex connector and other programs)	U	1	0	$0.07	$0.25	$0.10	$0.40	23-57%	$16 (lifetime?)	May be higher…?	H
9	Insurance savings	U	1	0								H
11	Fewer substations, etc.	U	1	0								H
12	Power quality / reliability	U	1	0								H
20	Health and safety equipment	S	1	0	$0.29				less than 1%			H
21	Water and waste water treatment or supply plants	S	1	0	$28.10							H
38	Aesthetics / appearance	P	1	0					2.0%		1 study (Lutzenheiser)	H
39	Fires / insurance damage (gas)	P	1	0		$0.09	$0.02	$0.16		$400-500? (maybe 1 time?)	Unclear importance	H
44	Control over bill	P	2	1							few studies	M
45	Understanding / knowledge	P	2	1							related to Line 44 above?	M
13	Reduced subsidy payments (low income)	U	2	1	$3.32	$13.65	$3.30	$24.00			very dependent on local policy	M
17	Economic development benefits – direct and indirect multipliers	S	1	1	$35.95	$260.00	$180.00	$340.00	13-320% /avg 120/med 83		Job multiplers 3-6/million; others 35 -60 person-years;	M
19	Emissions / environmental (trading values	S	1	1	$7.71	$155.00	$130.00	$180.00			Later studies higher; some 800-2000.	M

NEB Categories - Analysis Priorities based on: relevance to Low Income, and Uncertainty in estimates / methods to date			2=very high relevance,confidence; 0=minimal		NEB Values for various Low Income Program Analyses							Study Rank, hi to low
ID / Order	NEB Category	Perspective	Relevance Level for Low Income	Confidence Level in estimates, methods	LIPPT value-2001	Value/hh/yr - other LI (avg of range)	Cluster Range - Low	Cluster Range - High	Savings multiplier	Value / other terms	Notes	H=relevant, low confidence, etc.
	and/or health / hazard benefits)											
37	Comfort	P	1	1	$6.70				2-12%			M
50	Doing good for environment	P	1	1								M
18	Tax effects - (2 possible effects: related to unemployment and income taxes from job creation / economic development; another effect possibly related to tax credits for investment in certain measures / PV / solar, etc.)	S	1	1		$175.00	$150.00	$200.00	5.3%			M
10	Transmission and distribution savings (usually distribution)	U	1	1	$0.94	$1.37	$0.13	$2.60				M
29	Operating costs (non-energy)	P	1	1								M
30	Equipment maintenance	P	1	1							Few estimates	M
31	Equipment performance (push air better, etc.)	P	1	1							several / many	M
32	Equipment lifetime	P	1	1								M
40	Lighting / quality of light	P	1	1							few quantitative	M
41	Noise (internal / equipment)	P	1	1								M
42	Noise (external)	P	1	1								M
52	GHG and	P	1	1							leave under	M

NEB Categories - Analysis Priorities based on: relevance to Low Income, and Uncertainty in estimates / methods to date			2=very high relevance,confidence; 0=minimal		NEB Values for various Low Income Program Analyses							Study Rank, hi to low
ID / Order	NEB Category	Perspective	Relevance Level for Low Income	Confidence Level in estimates, methods	LIPPT value-2001	Value/hh/yr - other LI (avg of range)	Cluster Range - Low	Cluster Range - High	Savings multiplier	Value / other terms	Notes	H=relevant, low confidence, etc.
	environmental effects										societal	
28	Water / wastewater bill savings	P	1	2	$15.48	$9.50	$4.00	$15.00	3.0%			M
51	Savings in other fuels or services (as relevant)	P	1	2								M
55	NEGATIVES include: Installation hassles / mess, negative values from items above	P	0	1							One study showed debt increases	M
33	Shutoffs	P	2	2	$0.60	$0.40	$0.20	$0.60			Some studies showed high numbers (17% drop, $400)	L
1	Carrying cost on arrearages	U	2	2	$3.76	$3.00	$2.00	$4.00	6.5%	$32-$86-not sure if lifetime	Some much higher...25% reduction from arrears common	L
2	Bad debt written off	U	2	2	$0.48	$2.00	$0.50	$3.50			Others as high as 79; reduced by 20%; not clear if per household / year units	L
3	Shutoffs	U	2	2	$0.05	$0.09	$0.05	$0.13		$100-$133		L
4	Reconnects	U	2	2	$0.02	$0.08	$0.02	$0.13				L
5	Notices	U	2	2	$1.49	$0.90	$0.30	$1.50				L
6	Customer calls / bill or emergency-related	U	2	2	$1.58	$1.00	$0.40	$1.60				L
7	Other bill collection cost	U	2	2	$0.00				2.1%		few studies	L
34	Reconnects	P	2	2	$0.08	$0.06	$0.03	$0.08			Few / incorp above	L
36	(Bill-related)	P	2	2	$0.16	$0.25	$0.18	$0.31			probably small	L

NEB Categories - Analysis Priorities based on: relevance to Low Income, and Uncertainty in estimates / methods to date			2=very high relevance,confidence; 0=minimal		NEB Values for various Low Income Program Analyses							Study Rank, hi to low
ID / Order	NEB Category	Perspective	Relevance Level for Low Income	Confidence Level in estimates, methods	LIPPT value-2001	Value/hh/yr - other LI (avg of range)	Cluster Range - Low	Cluster Range - High	Savings multiplier	Value / other terms	Notes	H=relevant, low confidence, etc.
	calls to utility											
22	Fish / wildlife mitigation	S	0.5	0								L
23	National security	S	0.5	0								L
27	Total Perspective Societal	S			$72.05				35% for some			NA
56	Total Perspective Participant	P			$48.58					On order of $300?		NA
15	Total Perspective Utility	U			$11.71	$2.37	$0.98	$3.75			Notes say 4-31 total	NA