New Non-Energy Benefits (NEBs) results in the commercial / industrial sectors: Findings from incentive, retrofit, and technical assistance / new construction programs

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Abstract
Over the years, a variety of commercial and industrial (C&I) programs designed to save energy have been implemented across the US. However, energy efficiency (EE) programs do more than save energy – they deliver an array of other impacts that are traditionally considered hard-to-measure. Recent evaluation work examining non-energy benefits (NEBs) for several different types of C&I programs provides an opportunity to explore the implications and applications of NEBs for program design, marketing, and beyond. More than 300 interviews with multiple decision-makers – end-users (owners / developers / tenants / facility managers) and specifiers (architects and engineers) – were used to estimate the value of the programs beyond bill or energy savings. Owners / occupants and facility managers were asked about NEB valuations based on experience. Specifiers / decision-makers were asked about their perceptions of the value of NEBs to owners, as well as the use of NEBs in decision-making.

The paper provides detailed information about the NEBs results, and focuses on implications and uses of the information, including and beyond the benefit-cost implications. Results show that bill savings or energy benefits are important – but may not always be the most important program benefit – to program participants. The results show that NEBs can be equal to or exceed the value of the direct energy savings associated with the program. The paper illustrates applications for program refinement and marketing – positive effects for marketing, and negative values that have implications for detailed barriers analysis and program improvement. Differences in perception by group may indicate other types of useful program refinements. The results imply that greater use of NEBs to promote efficiency programs could be effective – even to the "bottom line-oriented" commercial sector. NEBs appeal in the commercial / industrial sector, and NEBs analysis provides useful information toward practical program improvements.

Introduction
Energy efficiency (EE) programs in the commercial and industrial sectors (C&I) across the US have led to very large bill savings. Program evaluation efforts focus on assessing and tracking indicators of attributable energy savings and other market progress indicators related to program efforts and interventions. However, energy savings encompass only a subset of the program effects; there is a substantial array of omitted effects that are not related to energy that occur due to program interventions. These non-energy benefits (NEBs) provide information that helps explain participant decision-making, enhance program benefit-cost analyses (beyond that due to energy savings alone), and help inform program design and marketing. This paper has two main purposes:

- to provide information on NEBs associated with various program types, and
- to demonstrate the enhanced results that can be obtained as more stakeholder types are interviewed.

Analysis of Non-Energy Benefits (NEBs) grew from conceptual lists to a significant body of work including a growing literature around recognizing and measuring non-energy ben-

efits (NEBs) that started with substantial measurement work in 1994[1]. Since that time, NEBs work has been conducted for scores of programs across the country. This paper highlights results and implications of NEBs analyses from non-residential programs.

NEBS AS OMITTED PROGRAM EFFECTS

NEBs include a variety of program impacts– positive and negative – other than energy savings and which result from energy efficiency (EE) programs.[2] Starting with work in the mid-1990s, the literature began to sort these omitted effects into three "perspectives" (Skumatz and Dickerson 1997):

- Utility / Agency NEBs:[3] Net benefits accruing to the utilities or program-sponsoring agency, including fewer billing-related calls and other follow-ups, lower bad debt from unpaid bills, lower transmission and distribution (T&D) losses, and other benefits, which result in lower revenue requirements for the agency, and are appropriately valued at the agency's marginal cost and discount rates.
- Participant NEBs: Positive and negative impacts that are realized and recognized by program participants. For commercial buildings these translate to reduced maintenance, fewer tenant complaints, productivity, and a variety of other benefits for building owners / managers. These effects are measured using valuation methods appropriate to the tenant or owners.
- Societal NEBs: Net benefits beyond those accruing to the utilities / agencies or directly to participants, including economic multipliers or job creation benefits, reduced environmental impacts from emissions, and other benefits valued at societal costs and discount rates.[4]

This paper concentrates on the net benefits from the second category – participant NEBs – and examines implications of NEBs analyses for commercial and industrial (C&I) programs. The benefits to commercial/ industrial participants derive from several main "drivers" – specifically "net" impacts from:

- Payment and collection-related effects,
- Education and knowledge of energy use, building, and equipment,
- Changes in building stock / building value,
- Direct / indirect health-related changes,
- Direct / indirect changes from equipment service (e.g. productivity, comfort, maintenance, etc.),
- Changes in other utility bills (e.g. water bills, etc.), and other changes,
- Other changes.

REASONS AND METHODS FOR NEBS ANALYSIS

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 the effects – both for explaining program effects (illustrated especially in utility and societal NEBs), as well as providing information useful in understanding participant and non-participant decision-making (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.[5] . Running scenario analysis around imperfect estimates, ranges, or order of magnitude values would be preferable to excluding the impacts altogether.

In addition, to assure the NEBs measured are those actually attributable to the program, the results were computed in a manner to allow them to be "net"[6] in several key ways: net of positive and negative effects, net compared to standard efficiency equipment, and net of free riders to assure attributability.[7]

Methods for measuring specific categories of participant NEBs vary based on the category, with some based on program data and others involving secondary information. In some cases, businesses measure specific categories of impacts from implementing energy efficiency equipment. However, these measurements have not been conducted for the vast majority of participants in programs, and using the values from a few firms as "proxies" for others might lead to concerns about the results.[8] Furthermore, for many of the categories (comfort, etc.), the topics are conceptually "hard to measure." In these cases, the challenge is to come up with a consistent, reliable, defensible, *and practical* way of valuing these "real", but hard to measure, impacts caused by program interventions. Therefore, for the vast majority of participant impacts, participant surveys are needed.

We have examined a number of different approaches, and have had the opportunity to evaluate a number of them with respect to a number of criteria: credible methods / demonstrated

1. See citations in Skumatz 1997; and Hall, Skumatz, and Megdal, 2001, which incorporated a review of 300 papers. Space does not allow exhaustive references in this paper and they were not used in the development of the research in this paper.

2. The literature historically calls these effects "non-energy benefits" even though they may be negative in the "net". Some suggest calling them non-energy effects or non-energy impacts. Using the traditional term better respects the literature, there is nothing lost by calling them net-NEBs or NEBs, and the literature remains more robust.

3. Note that benefits can arise in multiple perspectives without being redundant. For instance a reduction in bill-related calls to the utility company benefits both the utility / ratepayers and the participating businesses / households making or receiving those calls. This is not double-counting benefits – rather, it recognizes that some effects have multiple beneficiaries and each is valued at the appropriate tailored valuation method.

4. Space did not allow a detailed list of benefit categories in these three areas. See Skumatz and Gardner 2005.

5. Measurement methods have been discussed in detail in previous papers including in Skumatz 2002, and data have been collected using phone, in-person,fax, web, etc. Choice models have also been applied in several projects, including results in this paper, with strong results. See Skumatz and Gardner 2005.

6. Despite the historical name for these impacts (non-energy benefits), both positive and negative impacts must be incorporated. We respect the terminology from the literature, but imply a term of "net" NEBs when using NEBs.

7. 1) Net positive and negative -- the results measure the "net" of both positive and negative NEBs. 2) Compare efficient to new standard efficiency equipment they would have purchased, not to the old equipment. – not to equipment removed. 3) Net of free riders – If a share of participants would have purchased the same equipment without the program, then the NEBs associated free riders should not be attributed to the program (or apply NTG ratio). However, if no equipment replacement would have occurred without the program (some low income cases) or if the equipment would not have been replaced for a long time, it may be appropriate to ignore free ridership. See Skumatz and Gardner 2005.

8. Relying on these data for NEBs estimates would bias the results as there are significant missing data problems, and those with values tend to be those businesses that anticipate high savings and NEBs

in literature; ease of response by respondent / comprehension of the question by respondents; reliability of the results / volatility; conservative / consistent results; and computation clarity, among others. Using phone, mail, web, and email approaches, the authors have tested, refined, and used more than a dozen variations based on several basic measurement approaches:

- Willingness to pay (WTP) / willingness to accept (WTA) / contingent valuation (CV),
- Alternative methods of comparative or relative valuations,
- Direct computations of value to owner,
- Discrete choice and ordered logit approaches, and
- Other revealed preference and stated preference approaches.[9]

Detailed studies of the relative performance and consistency of these results have been conducted to identify the "best" and most defensible methods of measuring NEBs (Skumatz 2002, Skumatz and Gardner 2005). Although the computed dollar or energy savings values associated with NEBs are useful, analysis of NEBs has wide applications beyond the simple "valuation" of the net benefits. Examining the perceptions of NEBs that are positive and negative, and the relative values between categories, provides information important to program evaluation and other applications, including (as we will illustrate in the remainder of this paper):

- **Barriers**: NEBs can be used in the detailed analysis of program barriers,
- **"Disconnects"**: NEBs provide feedback on "disconnects" in understanding or beliefs about equipment operations and NEBs by different program actors, or by program participants vs. non-participants;
- **Marketing**: NEBs provide information on equipment features and effects that may be "sell" equipment or aid in targeting market segments; and
- **Benefit-cost**: NEBs valuations provide information to support enhanced benefit-cost analysis program-wide as well as for more complete payback analyses for the participants.

Implications for Non-Residential Programs

Analysis of NEBs can be less or more robust depending on the types of interviews that are conducted.

- Interviews with participants provide useful information on value, perceptions, and barriers – providing strong information on benefits to focus on in marketing and targeting, as well as useful data to provide an enhanced understanding of the benefit-cost analysis – both for the program as well as the individual participant's point of view.
- Specifiers and Decision-makers: NEB interviews with the actors responsible for specifying the energy-using equipment in commercial / industrial[10] buildings provide additional insight into the sources of hesitance (a.k.a. barriers) that decision-makers may have regarding new, cutting-edge, or energy efficient equipment encouraged through programs. The analysis provides information to help identify whether there are specific differences in perception about equipment or their features / effects – indicated or illustrated through the NEBs – that can be addressed by refinements to the program, outreach, incentives, or other means. This may help increase the program's impact and increase adoption of the program. In addition, it provides feedback on the degree to which program messages are being incorporated differently by the actors.
- Non-Participants: Comparing NEB results for participants and non-participants can provide insight into the participation decision, and indicate program, performance, or other non-energy factors that create barriers to adoption of energy efficient equipment.

In each case, the NEB work has the potential to provide direct, actionable suggestions and implications for program design, outreach, training, and marketing. It can also provide information related to measure selection and incentive adjustments. Certainly, the specific results and implications for each program will differ, depending on program design, measures included, targeted participants, region of the country, and many other factors – in fact, that is the power of program-specific research on NEBs (and all evaluation work). And if fact, while the discussions below provide results for specific programs, their larger purpose is to provide an illustration of looking beyond the basic NEB results – for these programs or for any programs. In addition to providing program-specific implications, the discussions below illustrate the *types and range* of issues and implications that can be identified from NEBs work – designed to illustrate the robustness of applications of NEB analyses.[11]. This paper focuses on the power provided by NEB analyses of participants and specifiers / decisionmakers.[12]

EXAMPLE 1: NEBS BASED ON PARTICIPANT INTERVIEWS ONLY – A COMMERCIAL LIGHTING EXAMPLE

This example is from a program that provides subsidized lighting upgrades and free professional assistance to help businesses lower energy bills. This program provides incentives and assistance to small / medium commercial businesses to retrofit with energy efficient lighting equipment. The measures included upgrades and expert assistance, Energy Star® equipment, high performance fluorescents, de-lamping, task lighting, exit light replacement, and an array of other measures and retrofits. The results are based on interviews with 100 businesses that participated in the program.

9. As mentioned, some analysis of approaches is provided in Skumatz 2002 and Skumatz and Gardner 2005.

10. And residential as well.

11. The purpose of this paper is to address the implications of NEBs that have already been estimated. For information on methods for estimating the value of individual and total NEBs categories, there is a growing literature. See Skumatz 1997; Hall, Skumatz, and Megdal, 2001, Skumatz 2002, and other sources, and other ACEEE and IEPEC proceedings for guidance on estimation techniques.

12. The additional power provided from non-participant interviews are left for another paper.

Table 1. Direction and Share of Effects by NEB Category

Lights	% Neg	% Pos	% of Total NEB value for each NEB category
Equipment maintenance	5%	20%	6%
Equipment lifetime	4%	24%	7%
Quality of Light	9%	55%	14%
Quantity of light	13%	49%	13%
Building safety	1%	14%	4%
Impact on sales/productivity	3%	15%	4%
Noise	1%	20%	5%
Control over the bill, understanding of energy use	0%	10%	3%
Flicker	1%	35%	7%
Doing good for the environment	0%	88%	27%
Sick days	0%	0%	0%
Having program available to them/underserved sector	1%	37%	10%

Positive and Negative Perceptions and Valuations

Respondents from a random sample of program participants were asked whether the Program had any impact on a variety of NEB categories, positive or negative.[13] Responses for positive vs. negative NEB effects are provided in Table 1.[14] "Doing good for the environment", and quality and quantity of light were most commonly noted as positive effects. In addition, more than one-third of the respondents saw a positive benefit in the fact that their utility was offering a program to small commercial customers, a traditionally underserved population. Both positive and negative feedback was provided on quality and quantity of light.

These results are also reflected in the valuation estimates (last column) which provide feedback on most highly valued NEBs.[15], [16]

- The most valuable NEBs were "doing good for the environment" (representing 27% of the overall NEBs), quality and quantity of light, and satisfaction that small commercial businesses were receiving program attention.
- Maintenance and lifetime considerations had fairly low value (although not negative), representing potential areas of concern for participants.

The total value of the NEBs were also computed using much-tested valuation approaches (See Skumatz 2002 for explanations).[17] The total value is presented as a proportion of the energy savings delivered by the energy efficient equipment. The results show that the NEBs are reported by participants to be worth just about what they received in energy savings:

- NEBs are estimated as 104 %-115 % of energy bill savings.[18]

As the results illustrate, the average NEB estimates still reflect a high degree of non-energy benefits.[19]

Respondents were also asked whether NEBs arguments were used in order to help convince them to install the program measures and methods. We found 54 % say NEBs were used to help influence the equipment purchase; 36 % said these NEB-based appeals were not used. The respondents were also asked which NEB categories were most important or "convincing" in that discussion. By far the most important factor mentioned was "quality of light". Two-thirds of the respondents also mentioned the importance of discussion about the quality of the new energy efficient lighting equipment. Other factors that were often mentioned as important included environmental benefits, lifetime, and quantity of light.

Apparent Barriers

The only NEB category with a significant number of negative responses was quantity of light; however, more than three times as many labeled it a positive NEB.

Overall Results, Benefits and "Selling Points"

Table 2 summarizes the barriers and selling points associated with the lighting retrofit (Example 1) program. The results show that the lighting program delivered strong traditional-unincluded effects to program participants. They highly valued a variety of effects including a chance to "do good" for the environment, improved quality and quantity of light, valued a program finally delivering services to the often-ignored small / medium commercial sector, and valued the lower flicker and noise and longer lifetime associated with the energy efficient equipment. The valuation of the NEBs was 105 %-115 % of the value of the energy savings. The NEB values are somewhat higher than the energy savings, indicating that the perceived total payback years for participants is less than half the energy-only payback (104 %-

13. While our research attempts to create an independent set of NEB categories, it is useful to check theoretical underpinnings with empirical results. Only 9 % of interviewees felt that some of the NEB categories overlapped; 91 % of respondents, therefore, indicated that the categories were clearly separated, suggesting that aggregation across benefit categories is a legitimate technique for estimating overall percentage and dollar levels of NEBs.

14. Obviously, the percent that stated "no effect" are represented by the remainder from 100 % across a row.

15. A specialized series of survey questions were used to derive quantitative estimates of the NEBs. The approach is described in several previous ECEEE and ACEEE papers by Skumatz . Space does not permit a detailed description of this estimation approach in this paper.

16. Using a technique discussed in the estimation publications referred to elsewhere in the paper, the average value for each NEB category was computed, the sum of the individual categories was normalized to add to the reported NEB value for "total" NEBs, and the shares computed and reported in the table.

17. In these computations, we asked whether the value of the total of all NEBs was positive or negative. If they responded that there was some effect (positive or negative – "zero effect" respondents were not further queried), they were asked whether that effect was more valuable or less valuable than the energy savings associated with the measures. As a follow-up, they were asked what percent more or less valuable the effect was as compared to the energy savings. If the effect was negative, they were asked the similar question on a negative side. These effects were added up, and the average multiplier relative to the energy savings was computed. This figure is the one reflected in the last column

18. In a detailed NEB analysis, we would also reduce these values by 5 % free ridership found for the program – a small adjustment in this case. However, this last refinement is not important to the point of this paper. See Skumatz and Gardner 2005 for a more detailed discussion of this point.

19. Note results are presented in terms of energy savings multipliers; conversion to dollars is straightforward based on kWh savings and relevant energy rates.

Table 2. Summary of Barriers and Selling Points

	Participant
Barriers – Negative NEB	No negative values.
Barrier – High % negative perceptions	Concerns about quality and quantity of light
Selling Points	Environment, Quality and quantity of light, Program specifically for small / medium commercial, Less flicker / noise / longer lifetime equipment

115 % value added to energy savings). Therefore, the benefit-cost ratio is more than doubled for participants – or their payback is halved.[20] This computation makes it clear that a payback period that incorporates these effects would be half the length of a payback based on energy savings alone

EXAMPLE 2: NEB INTERVIEWS WITH DECISION-MAKERS / EQUIPMENT SPECIFIERS

This program worked to increase the use of high performance building design and equipment in commercial buildings in the US in order to deliver energy savings to buildings and educate the market on the energy savings technologies. The program's delivery methods were technical assistance, training, and incentives for new commercial construction projects. Our overall project assignment examined NEBs, as well as attitudes, awareness, decision-making, and current practices concerning high performance building design. The program focuses on educating about and encouraging use of:

- High efficiency HVAC,
- Energy efficiency (EE)-based siting, envelope, and orientation,
- Daylighting, daylighing controls, and daylighting architectural features like light shelves, etc.,
- Sustainable materials,
- Indoor air quality reducing practices and measures,
- And whole-building-based approaches, among other messages.

This program illustrates the additional information that can be provided when interviews are conducted with an array of program decision-makers and "specifiers". More than 200 interviews were conducted with random samples of developers, owners, architects and engineers involved in the EE program. Separate from the energy impact evalution work, our NEB surveys ask each respondent whether they noted or perceived positive or negative changes, or no effect, from each of a list of possible NEBs that pre-test interviews indicated that participants tended to associate with the program's eligible / encouraged equipment.

Positive and Negative Perceptions

Table 3 presents a summary of the results on the direction of NEBs effects (negative or positive, with "no effect" as the remainder).[21]

- Many of the respondents reported positive effects in the NEB categories, and the reports of positive effects were spread across all actors. Those NEB categories with highest positives were improved quality of light, comfort, tenant satisfaction, equipment performance, and productivity. Ease of selling/leasing the building, non-energy operating costs and quality of light were also positively perceived.
- Architects were most strongly positive about tenant, comfort, quality of light, and productivity effects. Architect and engineer (A&E) actors tended to be less positive about equipment performance benefits than other actors.
- The NEB factors with highest reports of negative effects are maintenance and non-energy operating costs. For both, architects and engineers were more negative than other groups.

The positive and negative perceptions carried through to survey responses asking whether these (positive and negative) factors affected decision-making regarding implementation of the high performance measures into the buildings. Survey responses indicated:

- All respondent types suggested that negative perceptions of maintenance of "high performance" measures – and concerns about whether their janitorial staff and local contractors could adequately maintain the equipment or obtain replacement parts – tended to decrease their interest in implementing the package of measures. Equipment maintenance considerations were a negative influence affecting implementation for all actors, with owners least concerned.[22]
- Architects and owners were more positively influenced by potential productivity, tenant satisfaction, and comfort benefits than other groups.
- The most important drivers for developers were equipment performance and ease of selling or leasing the building. Owners, however, were most influenced by in-house issues like comfort, tenant satisfaction, productivity, and quality of light. A&E differed in the degree of influence they assigned to several NEB categories. In particular comfort, tenant satisfaction, and productivity considerations were lower for engineers; architects were less influenced by equipment performance and maintenance.

Apparent Barriers

The NEB analysis identifies one key barrier to widespread incorporation of the program measures into new buildings (Table 4) – perceptions of troublesome (in-house or contracted) maintenance associated with EE equipment. Education, training, or data to address these concerns could aid in addressing this concern held by various decision-makers.

20. and for the utility running the program.

21. No detailed computations were necessary – the direct responses to positive vs. negative effects are presented in the table.

22. And owners may also be least experienced or may have less responsibility for these problems, although the degree to which the "specifying" A&E "live" with the equipment or track its performance after the fact is unknown.

Table 3. Percent reporting positive / negative impacts from the NEB

	Overall		Developer		Owner		Arch		Engineer	
Percent positive or negative	%Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos
Operating Cost (excluding energy)	21%	46%	14%	50%	16%	60%	29%	36%	24%	44%
Equipment Maintenance	51%	11%	36%	20%	48%	16%	59%	12%	56%	0%
Equipment Performance	8%	61%	0%	92%	6%	82%	18%	43%	6%	30%
Productivity	0%	56%	0%	50%	0%	61%	0%	80%	0%	26%
Tenant Satisfaction	2%	70%	7%	62%	0%	62%	0%	91%	0%	64%
Comfort	3%	73%	4%	74%	0%	76%	0%	91%	9%	53%
Appearance	0%	38%	0%	30%	0%	56%	0%	41%	0%	26%
Quality of Light	3%	71%	11%	64%	0%	76%	3%	86%	0%	54%
Ease of Selling/Leasing	4%	49%	7%	48%	0%	14%	7%	54%	0%	69%

Table 4. Summary of Barriers and Selling Points

	Developer	Owner	Architect	Engineer
Barriers – Negative NEB	Equipment maintenance	Equipment maintenance Low (but not negative) ease of selling or leasing	Equipment maintenance	Equipment maintenance Low (but not negative) non-energy operating cost
Barrier – High % negative perceptions	Equipment maintenance	Equipment maintenance	Equipment maintenance	Equipment maintenance
Selling Points	Eqpt.performance, ease of selling/ leasing, Comfort, Quality of light, Tenant satisfaction	Tenant satisfaction Equipment performance Comfort, Quality of Light Productivity	Tenant satisfaction Comfort Appearance Productivity	Appearance, Quality of Light, Tenant satisfaction Ease of selling / leasing Comfort, Non-energy operating costs

"Disconnects"

In this case, architects and engineers are more negative about equipment maintenance, equipment performance, and non-energy operating costs than the owners and developers. Given the importance of these factors, this may imply that A&E firms are more conservative about the degree to which they recommend EE equipment, and thus, less is installed than might otherwise happen.[23] Therefore, *if* these perceptions are not appropriate or "accurate" given true performance of the technology in the field, targeted education – in terms that A&E accept – may be a useful addition to the program. However, *if* the perceptions are true, then the program may need to add maintenance training to the program and/or identify certified maintenance firms, work to make sure parts for the equipment are readily available, "buy up" the warranties, or make other program changes to address the issue.

Benefits and "Selling Points"

Improved equipment performance and tenant satisfaction are strong positive factors in the decision whether to install these EE measures. Productivity improvements were also generally noted by owners.

EXAMPLE 3: NEB INTERVIEWS WITH PARTICIPANTS AND NON-PARTICIPANTS (AND VENDORS)

This example provides an opportunity on the uses and implications of NEB results when interviews with both participants and non-participants are interviewed. Under this program, the utility intended to reduce energy use through rebates for the purchase of qualifying energy efficient boilers by commercial and industrial businesses. In this case, we illustrate the enhanced results that can be obtained when both participants and non-participants are interviewed. The interview of both participants and non-participants allowed an opportunity to explore whether differences in perceptions of NEBs are an element in self-selecting as a participant. The evaluation also provided an opportunity to interview participating boiler vendors. As before, each respondent was asked whether they noted or perceived positive or negative changes, or no effect, from each of a list of possible NEBs that pre-test interviews indicated were associated with the equipment that were eligible for rebate under the program.

Positive and Negative Perceptions

The results summarizing the share of respondents that assigned positive and negative NEB effects – as well as the share of total NEB value associated with each NEB category -- are presented in Table 5.

- About one fourth of vendors cited negative effects, and about one-third noted positive NEBs. There was little variation by NEB category. Lifetimes are the one category for which negatives are larger than positives for this group.
- The results show that non-participants were considerably less positive about NEBs from the new equipment than were respondents that participated in the program, particularly for maintenance, performance, control / features, noise, and footprint.[24] This may suggest that marketing (and data) to highlight benefits from these factors may resonate in encouraging non-participants to join the program.

Participants are more likely to note negative impacts from changed maintenance, shorter lifetimes, and "other", and these negatives are higher than for non-participants.

23. On the other hand, architects are more positive about comfort, appearances, and ease of selling / leasing than owners.

24. Respondents were recent participants, so they were responding more regarding expectations than long-term first-hand experience with the new equipment.

Table 5. Direction and Share of Value by NEB Category– Equipment Rebate Program

	Vendor		NP		Part		Vendors	NP	Part
	%Neg	%Pos	%Neg	%Pos	%Neg	%Pos	% of Total NEB Value		
Change in maintenance	26%	31%	7%	29%	20%	42%	4%	9%	7%
Performance	26%	31%	0%	37%	2%	69%	28%	20%	20%
Lifetime	29%	26%	5%	39%	16%	28%	-6%	18%	6%
Tenant / occupant complaints	28%	28%	5%	20%	4%	22%	6%	8%	14%
Control of equip / features	26%	31%	0%	44%	9%	66%	31%	22%	16%
Noise	24%	32%	5%	17%	6%	31%	5%	6%	14%
Footprint	23%	33%	2%	27%	6%	50%	28%	13%	17%
Other	0%	40%	0%	5%	33%	67%	4%	3%	7%
Overall NEBs, - compared to standard equipment	26%	30%	2%	71%	4%	83%	100%	100%	100%

Table 6. Summary of Barriers and Selling Points

	Vendor	Non-Participant	Participant
Barriers – Negative NEB	Negative Value: Lifetimes	No negative values	No negative values.
Barrier – High % negative perceptions	Lifetime, tenant complaints, maintenance, performance, equipment control/features, noise, footprint	Possibly maintenance	Maintenance, lifetime
Selling Points	Better performance than standard equipment Better control and features Smaller footprint	Better performance than standard Better control and features Longer lifetime Smaller footprint	Better performance than standard Smaller footprint Better control and features

NEBs Values and Distribution

The right-hand columns of Table 5 show the percentage of total NEBs represented by each NEB category. The results show:

- Vendors are clearly concerned about the lifetimes of energy efficient equipment compared to standard equipment (negative NEB). They are generally more positive than building owners (part or NP) regarding features and footprint, and assign a high percent of the overall NEB effects to enhanced performance of the equipment (28 %).
- Non-participants and participants value many of the same features highly; however, participants assign higher values to reducing tenant complaints and decreased noise. Non-participants are more optimistic about lifetime impacts.
- The NEB categories with greatest value for participants include performance, smaller footprint, and equipment control.

The computed value of the NEBs for participants is calculated as:

- 108 % of the value of energy bill savings.

In this case we do not present results before and after adjustments for free ridership and net-to-gross ratios – only the gross results are presented.

Apparent Barriers

The NEB analysis finds several low valuations, and in one case, the NEB value was negative. Vendors perceived that lifetimes for the energy efficient (EE) equipment rebated by the program were lower than lifetimes for standard equipment. If, in fact, this is not true, then the program may benefit by delivering targeted education materials to vendors, or developing test data or demonstration sites, that address this issue.[25] This may help vendors recommend EE equipment to customers with fewer reservations than may currently be the case. Alternatively (or in addition), given that the vendors perceive a cost for shorter lifetimes, we can compute the dollars associated with this negative NEB – which provides a proxy dollar amount for the remediation that may be needed to address this negative effect in the eyes of vendors. Interventions up to some portion of this dollar amount[26] might include extended warranties, additional rebates that balance out the value of this lifetime issue, or other efforts. Table 6 summarizes the resulting barriers and selling points.

"Disconnects"

In this case, vendors are much more pessimistic about the energy efficient equipment than are either participants or non-participants. They assign considerably lower positive perceptions of NEBs than owners.[27] This may mean that vendors will tend under-sell energy efficient equipment, at least relative to the interest expressed by owners. If the vendor perceptions are inaccurate, or if they are not aware of positive perceptions by owners, education or data may help address these issues with vendors. If vendor perceptions are correct, remediation (of the types addressed under "barriers") may be useful, The non-participants show results similar to the participants, with several

25. Similarly, if maintenance or noise effects (which had low NEB values) are positive, these may be additional points to be addressed for vendors.

26. This rebate may be based on the average negative value, or to address 50 %, the median value might be used; the distribution of the negative NEB values may also be used to set a value that will address some desired share of vendors or potential purchasers of the EE measure. We work with clients to help make these numerical tradeoffs.

27. And also assign lower overall value to the NEBs.

exceptions: the positive valuation feedback from participating owners regarding reduced tenant complaints and noise may help reduce some non-participant concerns and improve participation.

Benefits and "Selling Points"

The results indicate that the perceived total payback years for participants is almost cut in half (108 % value added to energy savings, reduced to 89 % by the same NTG ratio effects as energy savings). The benefit-cost ratio is nearly doubled, and payback approximately halved for participants.[28] The analysis also provides quantitative estimates that support anecdotal evidence that NEBs are important, with general agreement that EE equipment has: better performance, better control and equipment features, and smaller footprint than standard efficiency equipment.

Summary

NEB valuations are significant for many commercial and industrial sector programs, and enhance payback performance of programs.[29] Both the first and third examples showed that the (indirect or omitted) NEBs were slightly more valuable than the direct energy savings associated with the program. However, analysis of NEBs has wide applications beyond the simple "valuation" of the NEBs. NEB research can be used to help design programs toward measures and actors to maximize NEBs, increase program appeal and improve chances of adoption. Examining the perceptions of NEBs that are positive and negative, and those that are most valuable, provide information important to program evaluation, marketing / targeting, participant/non-participant decision-making, and other applications, including the following.

BARRIERS ANALYSIS

Negative benefits are indications of program barriers that remain – either perceived or real (or both) depending on which actors report the negative NEB. An example of negative NEBs is found in the High Performance building example (Example 2). If decision-makers report a negative NEB but the participants do not (implying the negativity is a perception, not a reality), then the program may benefit by providing greater education or data on that factor to that audience. The program would likely obtain more applicants, and the specifiers may be able to make a stronger case for the energy efficient equipment. Assume, however, that the barrier represents a real cost (or performance issue, for example). If participants or others (A&E, contractors) notice the problem as well, the NEB results provide an estimate of the cost of the rebate, refund, warranty buy-down or other interventions that may help participants become indifferent to that barrier – and spur participation and adoption of new measures. Tracking these negative values over time also provides useful information feedback to let program staff check whether the program is decreasing these barriers over time.[30] By using the dollar value of the energy savings and the multipliers provided through the NEBs analysis, an easy compution derives the dollar value of the NEBs to the average respondent.[31] The dollar value provides information on the level of investment that may be needed to overcome the barrier.

"DISCONNECTS"

The authors believe a robust evaluation of the NEBs should gather information from multiple actors involved in the program.[32] For example, the second example (High Performance program) pointed out that some of the decision-makers were more skeptical about performance issues associated with high efficiency equipment than were owners. These results allow an examination of differences in positive and negative perceptions about NEBs as well as differences in associated values. Using this approach, NEB work prepared by the authors has been able to identify situations in which architects / engineers / contractors assign more "negatives" to NEBs than do owners – potentially leading to underinvestment in energy efficiency. The implication is that bids and construction may be including less energy efficiency than owners might be willing to "buy".[33] Additional education, incentives, or other program interventions targeted at those with more skepticism may aid the program; feedback on the owner perspective may also help.

MARKETING

In each example we noted the highest positive NEBs. These features are clearly appealing to the program participants. Highly valued NEBs are likely easier to "sell" than energy efficiency, and more importantly, they are likely to appeal to owners or decision-makers. Tailoring the program message to the high scoring NEBs for the audience of interest is potentially more fruitful than continuing to push energy efficiency on efficiency or bill savings grounds.[34]

BENEFIT-COST

The NEB values provide information for the benefit/cost analysis from participant point of view, providing one additional element in understanding paybacks to participants, and perhaps better illustrating rationale behind the decision to participate. The results from the lighting program (Example 1) indicate that the paybacks were about half as long when NEBs were included in the equation. NEBs can help make the case for investments by firms.

28. And, if appropriate given program goals, for the utility or agency running the program as well.

29. Information in Skumatz and Gardner (2005) notes that, depending on measures and program design, C&I programs show participant NEB values on the order of 25 % to somewhat more than 100 % of energy savings. The overall NEB values are higher when societal and utility NEBs are included.

30. This feedback is potentially more useful than tracking barrier "scores", which provide less information on the importance of the barrier before or after.

31. And performing the computation for individual respondents provides information on the distribution of the value of this barrier, allowing tailoring to reach 25 % of the distribution, 50 % of the distribution or some other percentage that the program budget may bear.

32. Non-participants can be another set of decisionmakers interviewed as part of an NEB analysis, and additional information and implications can be provided from these actors as well.

33. And there may certainly be an element of owners being more naive and having less direct experience than architects/engineers/contractors; however, the implications for stated preferences of equipment remain.

34. The authors have previously noted that Procter and Gamble doesn't market Tide using the slogan "… please buy Tide because it provides P&G with high profits"; rather, it markets based on features market research has indicated customers desire from the product. Similarly, efficiency programs do not have to be marketed on the features that energy utilities and regulators care about (energy savings / efficiency) but instead on the desirable features indicated by the NEBs analysis. See Skumatz and Gardner (2005) and earlier studies by the authors.

In addition, monetized estimates of the NEBs can be useful as inputs for scenario analysis around regulatory tests as well. Some states are looking into scenario analysis around program benefit costs analysis.[35] A program might never be selected for implementation based on benefit/cost results that fail to account for the effects of NEBs. The conventional candidate-program assessment and selection process in many states forces projects to compare ALL the participant costs with only the energy-saving benefits (plus possibly a very limited set of societal NEBs such as emissions reductions—but no participant NEBs. This may represent an important, widespread barrier to innovative programs that provide substantial NEBs.

This paper provided results from several commercial sector programs that illustrated the values associated with NEBs, the NEBs categories that are especially highly (and lowly) valued, and focused on providing detail on the application of NEBs, including and beyond benefit cost uses. Most importantly, the work indicates that selling programs and measures solely on "efficiency" or bill savings – even to the "bottom line-oriented" commercial sector – may not be the most effective approach because it ignores important information on benefits that participants value from these programs. These results have implications for developing marketing and targeting recommendations for the program. Even if the program already markets and promotes NEBs in general, additional inroads may be achieved by targeting outreach toward those NEBs that are most highly valued by key market actors. Targeted outreach will also be valuable in addressing "disconnects", and barriers identified in the NEBs. The feedback on barriers that can be derived from the NEBs analysis can be used to craft appropriate (and appropriately priced) interventions for the program and actor. In addition, NEBs can be used to enhance benefit-cost analysis, and provide the data to help address biases inherent in current regulatory tests.

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35. One reviewer suggests either NEBs have to be monetized in the benefit/cost analysis or the participant's investment reduced by the fraction of the total value attributable to those NEBs. This is crucial to get a fair benefit-cost ratio, as in the TRC. Otherwise the benefit/cost test is biased against programs with significant NEBs.