Non-Energy Benefits (NEBs) in the Commercial Sector: Results from Hundreds of Buildings[1]

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ABSTRACT

As one component of the evaluation of several commercial programs, we augmented the survey discussions of barriers, budgets, decisionmaking and other topics to also gather detailed information on the array of benefits participants recognized from the program. A host of detailed questions about non-energy benefits (NEBs) were incorporated into a large scale set of surveys used to evaluate high performance building, commercial / industrial audit and retrofit, new construction, and commissioning programs. The data collection involved 350 telephone surveys and detailed interviews with building managers, occupants, owners and developers, architects and engineers (A&Es), contractors, and other actors involved in the programs.

These data allowed us to estimate the value of the programs' benefits 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 NEBs and perceptions of the value to owners. The presentation provides detailed information about the distribution of values of the "net" NEBs by NEB category, and negative outcomes associated with the equipment or services provided by the program.

The results showed that bill savings or energy benefits are important – but not necessarily the most important program benefit – to program participants. Other benefits mentioned by participants included fewer tenant complaints and higher tenant satisfaction, comfort, performance, productivity increases, improved working environments, safety, and a host of others. The results pointed out "disconnects" in the value specifiers think owners gain compared to the responses from owners. The paper argues that selling energy efficiency and programs solely on "efficiency" or bill savings – even to the "bottom line-oriented" commercial sector – may not be the most effective approach – interviews and valuations indicate that NEBs appeal.

Introduction

This paper presents and compares findings on non-energy benefits (NEB) from a number of commercial programs:

- A program providing outreach and training on high performance building techniques and measures in Wisconsin;

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[1] The views expressed in this paper are those of the authors and do not represent the views of the organizations being discussed.

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- A commercial / industrial audit and incentives program in Seattle;
- A commercial new construction program in New York; and
- A program providing incentives for commercial commissioning in the Northwest.

For most of these programs, the NEB work was a small component of a much larger evaluation or assessment of the program. However, in each case, the results of the NEB analysis helped provide a better understanding of those factors that the variety of commercial building actors regard as important in decision-making regarding energy using equipment in buildings.

Measuring Non-Energy Benefits

While energy savings and other metrics provide direct indicators of program effects, a significant body of work has been developing around recognizing and measuring non-energy benefits (NEBs). NEBs include a variety of program impacts – positive and negative – that result from the program. The literature tends to sort these benefits into three "perspectives": [3]

- Utility / Agency NEBs: 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 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.
- 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.
- 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.

This paper concentrates on the net benefits from the third category – participant NEBs. Many of these participant benefits are hard to measure (e.g. "comfort"); however, it is important to estimate dollar values for these benefits in order to allow comparison with direct energy benefits, and to provide more comprehensive information for cost-effectiveness assessments of the programs.

There are several measurement methods to estimate dollar values and ratios for participant NEBs. A method that has proven most successful in previous work is used in this analysis. It might seem that the direct approach – asking the value of the NEBs through a willingness to pay (WTP) approach – would be the best way to gather these data. However, past research has shown that this approach has two significant problems in these types of applications (Skumatz 2002): 1) participants have significant difficulty answering the question, leading them to "don't know" or to make pure guesses, which tend to be unreliable and 2) the results from WTP responses are more volatile than the comparison approaches used for this study.

[3] Space does not allow a listing of the background studies used in developing our approach to NEBs; however most of the citations are included in Skumatz (2001), which the interested reader can consult.

Based on the approach recommended in Skumatz (2002), several steps were used to derive the dollar estimate of participant NEBs. A list of categories of NEBs that are relevant to the program was assembled, using information from literature and past research (Pearson and Skumatz 2002, Coates *et.al*. 2000, Bensch *et.al*. 2003, Skumatz 2001). For each of the NEB categories, respondents were asked whether the energy efficient equipment or design features led to a positive or negative effect or no effect compared to standard equipment or design features. The same battery was asked for the overall or total of all the individual NEB categories. Finally, for those NEB categories with an effect (either positive or negative), respondents were asked about the relative value of the NEB, usually compared to the energy savings from the measures. As an internal "check", the relative value of the overall NEBs were also asked (Skumatz 2002).

The projects had different objectives and thus, not all of the programs present the information in exactly the same way. However, each section provides information on the most important recognized NEBs and most provide feedback on the value actors place on the NEBs.

Results for a High Performance Building Training and Outreach Program

SERA conducted an assessment of the High Performance Building outreach and training program run by the Wisconsin Department of Administrative Services, Focus on Energy, Energy Center of Wisconsin. The program provides training and outreach materials largely focused on architects and engineers, to encourage integration of the following building and design techniques into offices and schools in the state. Measures and practices encouraged by the program include: active daylighting and daylighting lighting controls; high efficiency lighting equipment, and occupancy sensors; high performance glass; premium efficiency motors and VFDs; high efficiency HVAC; sustainable or recycled materials; commissioning of major building systems, testing of building equipment performance and building control, training of building operators, and delivery of O&M manuals; inspection of systems during construction; energy management systems; integrated or collaborative design process, documentation of design intent, delivery of as-built drawings; design or materials to improve indoor air quality; and other techniques and features.

More than 140 interviews were conducted with owners, developers, architects, and engineers to ask about familiarity and use of these practices, training needs, and many other topics. Included in these interviews were questions about the perceived non-energy benefits coming from high performance designs and equipment. The results showing the percent of respondents (overall and for subgroups) that saw positive or negative effects from high performance building techniques are shown in Table 1.

Table 1. Non-Energy Benefits for High Performance Buildings in Wisconsin – Percent Positive and Negative by Subgroup

Positive% /negative%	Overall	Developers	Owners	Architects	Engineers
Operating cost	46% / 21%	50% / 14%	60% / 16%	36% / 29%	44% / 24%
Initial cost	3% / 93%	3% / 93%	10% / 81%	0% / 100%	0% / 97%
Equipment maintenance	11% / 51%	20% / 36%	16% / 48%	12% / 59%	0% / 56%
Equipment performance	61% / 8%	92% / 0%	82% / 6%	43% / 18%	30% / 6%
Productivity	56% / 0%	50% / 0%	61% / 0%	80% / 0%	26% / 0%
Tenant satisfaction	70% / 2%	62% / 7%	62% / 0%	91% / 0%	64% / 0%
Comfort	73% / 3%	74% / 4%	76% / 0%	91%/ 0%	53% / 9%
Appearance	38% / 0%	30% / 0%	56% / 0%	41% / 0%	26%/ 0%
Quality of light	71% / 3%	64% / 11%	76% / 0%	86% / 3%	54% / 0%
Ease of selling / leasing	49% / 4%	48% / 7%	14% / 0%	54% / 7%	69% / 0%

The results show that a majority of the responding decision-makers view the following to be positive impacts from HP / Efficient equipment: tenant satisfaction; quality of light; comfort, productivity, appearance and equipment performance (e.g. pushing air through the building more effectively, etc.). HP / efficient equipment was perceived to have a negative impact on several categories – particularly initial cost and equipment maintenance. Negative impact on initial cost is a logical result because first costs are commonly perceived to be higher for HP equipment. Equipment maintenance results are discussed below.

Table 1 also shows the percentages of each of the actor subgroups who thought of each factor as positive or negative. The results show that the negatives associated with first cost are mentioned less frequently by owners than other decision makers. Owners and architects are also more likely to associate productivity benefits with HP buildings and design. Architects more frequently attribute a variety of "soft" benefits to HP equipment, including tenant satisfaction, comfort, and light quality. However, they are split as to whether high performance equipment / design would have a positive or negative effect on operating costs.

Interviewees contacted about additions / remodels indicated that high performance features have a positive effect on operating cost and tenant satisfaction more often than respondents contacted about new buildings. Employees of smaller and larger firms also thought more often that high performance features had a positive effect, when compared with employees of mid-sized firms. We also examined the results for remodel versus new construction, for large versus small firms, and for large versus small buildings. No patterns were uncovered.

We felt that simple percentages did not tell the entire story. To gather information about how important these associated benefits and negatives were, we followed up with a question asking "how important is this factor in influencing whether HP features were employed in buildings you've worked on." We used a 5-point scale, where 1 meant the factor was not important, 5 meant it was very important, and the responses counted for either direction – positive or negative. A negative 5 indicates a very important negative factor influencing installation of HP equipment / design. This factor provides an indication of both the direction and relative size of the relationship with the NEB categories. These results are provided in Table 2.

Table 2. Indicator of Influence of Non-Energy Benefit on Decision to Include HP Equipment

(+5=very important positive factor influencing installation; -5=very important negative factor influencing installation)

	Overall	Developers	Owners	Architects	Engineers
Operating cost	1.23	2.23	2.00	0.50	0.70
Initial cost	-4.00	-4.30	-2.75	-4.41	-4.32
Equipment maintenance	-2.01	-1.90	-0.72	-2.61	-3.05
Equipment performance	2.60	4.19	2.71	1.41	1.92
Productivity	3.23	2.63	3.20	3.89	2.60
Tenant satisfaction	3.38	2.81	3.67	4.14	2.61
Comfort	3.26	3.08	3.48	4.03	2.05
Appearance	2.95	1.50	3.10	4.00	3.38
Quality of light	3.31	2.71	3.31	3.68	3.21
Ease of selling / leasing	2.58	3.19	0.64	3.06	2.85

The results show that cost and maintenance of HP is a major concern. The results show that all actors see initial cost as a very significant negative factor affecting whether or not high performance (HP) or efficient equipment (EE) is installed in a building – the indicator is –4 out of a maximum negative score of –5. Note that the indicator for operating cost is small and positive. This seems to indicate that there is a recognition that operating costs may be lower, but may be small, or unreliable, or may not rank highly for decision makers. The other major negative factor

is equipment maintenance (with a score of –2). The respondents seem to feel that maintenance or risk of poor reliability is a problem with HP or EE equipment.

Overall, the NEBs that positively influence consideration of HP / EE equipment, ranked from highest to lowest, are: tenant satisfaction (3.38); quality of light (3.31); comfort (3.26); productivity (3.23); appearance (2.95); equipment performance (2.60); ease of selling / leasing (2.58); and operating cost (1.23)

There is a cluster of factors that rank fairly highly (3.2 or higher of a maximum of 5). These factors are similar to those found in other work by the author (Skumatz, Dickerson and Coates 2000, Pearson and Skumatz 2002). However that work relied on interviews with owners or occupants; in this study, we can also examine the perception of NEBs by a variety of other actors (A&E) involved in decision making regarding new buildings. Examining the findings by subgroup (including an additional analysis that looked at new construction versus remodel, firm size, and building size) shows the following:

- Engineers (and architects) were especially negative about equipment maintenance issues associated with HP / EE equipment. This may be an important barrier in attempting to increase the integration of efficient technologies into buildings in the state.
- Owners view the initial cost and operating cost tradeoffs more favorably than others. They ranked the negatives associated with first cost at only –2.75 (compared to scores exceeding –4 for all others). They (and developers) also gave operating cost an indicator of +2.0, which was considerably higher than the A&E respondents.
- Productivity was perceived positively and highly by both owners and architects.
- Architects were more likely than others to view tenant satisfaction, comfort, appearance, and quality of light features as important influencing factors in adoption of HP / EE equipment. Given the critical role of architects in basic building design, this can be a favorable factor.
- Developers were most positive about equipment performance, comfort, and perceived ease of selling / leasing the building.
- Respondents contacted about additions / remodels were more positive in general about high performance features / design than respondents contacted about new buildings.
- Larger firms tended to be slightly more concerned about initial cost than smaller firms.
- Interviewees contacted about larger buildings were more positive about high performance features in general, though they thought the initial cost would be more prohibitive than did respondents contacted about smaller buildings.
- The responses indicate that non-energy benefits (NEBs) influence building design; in addition, there are strong NEBs that apparently result from the incorporation of HP design into new buildings. Disseminating information about the NEBs may provide opportunities to influence design. The NEB research also points out perceived non-energy weaknesses (and strengths) associated with HP design, which may be useful to address in training.

Results for a Multi-Resource Audit Program in Seattle

The Operations Resource Assessment Program (ORA) offered by Seattle City Light offered multi-resource audits for commercial and industrial buildings in the City. These audits,

which ranged in complexity from basic walk-throughs to more complex multi-building projects, provided feedback on electricity, gas, and water use.[4] The audited businesses were also hooked up with the utility's financial incentives program to help facilitate implementation of high priority measures.

As part of a process evaluation of the program, SERA conducted detailed interviews with 100 participants, and asked a series of questions to assess the NEBs derived from the program. Table 3 shows the relative values that respondents placed on particular NEBs.

Table 3. Net Non-Energy Benefits (NEBs) Value as Percent of Energy Savings – Seattle City Light ORA Program

Type of NEB	Wtd. Avg. NEB Value as % of Energy Savings Adjusted for multiple NEB mentions[5]	Type of NEB	Wtd. Avg. NEB Value as % of Energy Savings Adjusted for multiple NEB mentions
Better lighting	53%	Less water use	65%
Lower maintenance	44%	Guests return, happier workers	42%
Comfort	33%	Increased eqpt life	47%
Aesthetics	44%	Better eqpt control	33%
Productivity	33%	More/better airflow	50%
Efficiency	27%	Environmental	42%
Equipment works better	62%	Lower operating cost	N/A
Fewer complaints	28%	Shelf life, lower product losses	54%
Safer	51%	Labor savings	N/A

Table 3 provides a weighted average of the value of the NEBs relative to the energy bill savings. We find here that lower water use and better functioning equipment have the highest values (over 60% of energy savings), and comfort, and other benefits are relatively less valuable to participants. When paired with information on the savings from the measures with which the NEBs were associated, we find the highest NEB values were associated with lower water use, lower maintenance, comfort, aesthetics, safety, productivity, and better lighting.

After aggregating the results for various end-uses, we found that across all end uses, NEBs were equal to about 40% of the value of energy savings, and that NEBs as a share of energy savings were 45% for lighting measures, 40% of HVAC, 40% for water measures, and 50% for refrigeration measures.

The results showed that bill savings or energy benefits are important – but not necessarily the only important program benefit – to program participants. The research showed that a high percent valued benefits related to fewer tenant complaints and higher tenant satisfaction, safety issues, productivity increase, and other benefits considerably higher than the bill savings associated with the program.

Overview of the New York Energy $mart^{SM} New Construction Program

The **New York Energy $mart^{SM}** New Construction Program (NCP) was established to encourage energy efficient design and practices among architects and engineers (A&E firms), and to encourage A&E firms to inform building owners about the advantages of building to higher

[4] Only an abbreviated discussion of this program is presented here; readers may find a longer discussion of NEB results for this program in Pearson and Skumatz 2002, and Skumatz 2001.

[5] This column corrects for the fact that in many cases, multiple NEBs were mentioned at one time. We "shared out" the total multiplier among all the NEBs mentioned, and the second figure is the multiplier taking this into account.

energy-efficiency standards. The NCP provides opportunities to implement permanent improvements in building envelopes and major systems (e.g., HVAC, lighting, controls, and processes) at the time of new construction or substantial renovation. The program offers incentives in three categories – Custom Measure, Whole Building Design, and Pre-Qualified Equipment – to encourage participation.

As part of a market assessment and attribution project, we gathered data on the NEBs associated with the New Construction Program. This is the first time NEB data was collected in this manner for the **New York Energy $mart**[SM] programs. Table 4 includes preliminary results on the importance assigned to various NEB categories and the percent ranking the benefit highly. The right hand columns provides the preliminary rating that respondents gave the NEBs as a multiplier of energy savings and the estimated dollar value[6] benefit of NEBs by category and overall for the Commercial NCP respondents.

Table 4. Summary of Valuation Scores of Net Non-Energy Benefits by Program Actor – NYSERDA Commercial New Construction Program

Actor	Average valuation score (1=slightly valuable; 5=very valuable)	Percent ranking 4 or 5 (5=very valuable)
Participating A&E	3.3	69%
Non-participating A&E	2.9	50%
Participating Owner	3.2	48%
Non-participating Owner	3.1	67%

As Table 5 shows, overall, all key actors considered NEBs valuable (generally a 3 or better on a 5 point scale). They also valued these benefits as approximately equal to the energy savings from the program measures. Even non-participants ranked NEBs fairly highly.

All the respondents valued the total of the annual participant NEBs at nearly equal to the value of the annual energy savings from the program. If considered in benefit-cost analysis scenarios at this level, these benefits would halve the payback period.

Respondents were also asked about the role that NEBs play in decision making. The analysis also found that NEBs are used in decision-making and in information about long term benefits. A&E firms indicate they use NEBs in helping to explain benefits from energy efficiency between 35% and 55% of the time. Owners indicated that non-energy benefits were used in trying to inform them about long term benefits of energy efficiency appliances and measures about 2/3-3/4 of the time.

The NEB analysis indicates the NCP program has led to significant benefits that are recognized by participants, but have not yet been recognized by the program's accounting of benefits. Now that these data are available, their uses can be explored by program evaluation and implementation staff. There is also some disconnect[7] between the value that owners place on NEBs in energy-related decision making, and the degree to which A&E use NEB-related arguments in helping "sell" energy efficient equipment. It may be worth working with A&E firms to highlight NEBs associated with the program so the word can be passed to owner/decision makers more often. The NEBs provide some guidance on factors beyond energy savings that are valued by participants – and that may provide methods to attract additional program participants.

[6] The dollar value is based on the average kWh savings per building times the average cost per kWh for commercial customers in New York, obtained from NYSERDA's "Fast Facts".

[7] This same disconnect has been found in earlier research (Bensch, Skumatz, and Share 2003).

Table 5. Comparison of NEB Value Shares by Respondent Type – NYSERDA Commercial New Construction Program

NEB	Partic. A&E[8]	NonPart A&E	Partic. Owners	NonPart Owners
Equipment maintenance costs	-3%	-1%	0%	-5%
Improved occupant productivity	3%	0%	5%	6%
Equipment performance	14%	18%	12%	14%
Equipment lifetime	2%	2%	3%	3%
Total operating cost	5%	5%	6%	13%
Tenant satisfaction	16%	12%	10%	10%
Comfort	12%	10%	13%	15%
Lighting / quality of light	14%	10%	13%	5%
Safety	4%	10%	3%	7%
Ease of selling / leasing the building	9%	11%	11%	10%
Environmental effects	16%	20%	18%	21%
Other NEBs	8%	5%	7%	0%
Overall NEB multiplier: NEB/energy savings	1.0	0.9	1.0	1.0

Results from a Commissioning Project in the Northwest

The Northwest Energy Efficiency Alliance undertook a long-term effort to expand and institutionalize the practice of building commissioning among state and local governments in the Pacific Northwest (SBW and SERA 2003). Started in 1998, this Commissioning in Public Buildings project is coordinated on behalf of the Alliance by the Oregon Office of Energy. An important component of this effort is providing government officials with detailed case studies of commissioned buildings and the costs and benefits of the commissioning process for these buildings. Building commissioning is the systematic process of ensuring that building systems, such as HVAC and lighting, are designed, built, and operate according to the owner's operational needs. Commissioning for new buildings typically involves design review, construction review, testing, adjustment, and maintenance planning. Retro-commissioning can restore existing buildings to high productivity through renovation, upgrade and tune-up of existing systems. The NEB work was conducted as part of a larger study to estimate the costs and impacts from commissioning, and compute paybacks from the program. Table 6 summarizes feedback from program participants on NEBs from the commissioning project.

Mostly positive and a few negative impacts were attributed to the commissioning work. Positive impacts most likely to be attributed to the commissioning by the respondents included:

- Correction of operational deficiencies,
- Knowledge for O&M staff,
- Improved equipment maintenances, and
- Improved comfort.

In addition to the impacts shown in the overall results, facility managers attributed both reductions in contractor callbacks and tenant or worker complaints to the commissioning work. Relatively large discrepancies occurred between offices and classrooms in several categories. Team member relationships, reduction in time to optimize the system, reduction in tenant and

[8] Note that the A&E and Owners were asked about a shorter list of NEBs, so the presence of zeros in several categories means the assigned percentages will be higher for those categories that were measured because both liss must sum to 100%.

worker complaints, and reductions n sick days were less commonly attributed to commissioning in universities than in office situations. Quality of light was a recognized benefit for offices.

Retrofit commissioning work resulted in particular patterns of attributed benefits, including: higher levels of recognized benefits from correction of operational deficiencies, equipment maintenance, indoor air quality, sick days, and productivity. Buildings commissioned at construction were more likely to have improvements in the following items attributed to the commissioning: time to optimize the system, warranty claims, and coordination / team member relationships. All these benefits were design / construction-related benefits, which would tend not to apply to retrofit commissioning.

Table 6. Importance of Building-Related Concerns and NEB Attributions to Commissioning Program – All NEB Respondents

Benefit / Impact Category	Importance Score (1=low, 3=high)	Percent reporting Commissioning provided…		Avg. Percent of total NEB Values
		Positive NEBs	Negative NEB	
Design / Construction				
• Contractor call-backs	2.1	65%		7%
• Change orders	2.1	19%	4%	3%
• Warranty claims	2.1	46%		4%
• Time to optimize system	1,9	58%	8%	7%
• Project schedule	2.3	15%	15%	3%
• Coordination	2.4	58%	12%	5% (jointly)
• Team member relationships	2.3	54%	12%	
O&M				
• Operational deficiencies	2.7	88%		19%
• System documentation	2.4	69%		6%
• Knowledge for O&M staff	2.7	81%		11%
• Equipment maintenance	2.6	73%		7%
• Equipment lifetime	2.2	42%		2%
Occupants				
• Comfort	2.6	73%	4%	7%
• Indoor air quality	2.6	58%		10%
• Illnesses / sick days	2.3	31%		3%
• Tenant or worker complaints	2.3	62%		7%
• Productivity	1.2	19%		1%
• Safety	1.6	15%		2%
• Quality of Light	1.4	27%		1%

Overall, we found that the total benefits were valued at about 1.0 times the cost of the commissioning work. The individual benefits reported to have greatest perceived value to the respondents include correcting operational deficiencies and increased knowledge by O&M staff. Correcting operational deficiencies represent almost 18% of the total NEBs reported by the average participant. This, in many cases, was reported to be the real purpose of the commissioning work – not energy conservation. The results also show that increased knowledge gained by the O&M staff represented 11% of total NEB value. Respondents readily reported that they became better educated, were better able to manage building settings, and they were more efficient at fixing building problems. These two benefits account for more than one-fourth of the total NEB value. Other relatively high individual benefit categories included improved indoor air quality (10% of value), reducing time to optimize the system, fewer change orders, equipment maintenance, and improved comfort, each representing at least 7% of the benefits.

We also investigated the patterns in which benefits were most valuable based on groupings of job titles / responsibilities; building types; business types; whether only HVAC was commissioned, or additional systems were also commissioned; and new versus retrofit / recommissioning efforts. Based on job titles or roles, we found that the bulk of NEB for construction staff is concentrated in the design and construction phases. Design staff (including architects and mechanical engineers, etc.) recognized benefits in the areas of reduced time to optimize the system, and operational / documentation benefits. Facility managers showed higher levels of concern about occupant-related benefits, especially in indoor-air-quality (IAQ), and tenant / worker complaints. Facility and maintenance staff placed especially high relative value on correcting operational deficiencies and improved knowledge for O&M staff.

There was some variation based on systems commissioned. Those buildings with more than just HVAC commissioned showed roughly the same relative rankings for key benefits categories, with the exception of equipment maintenance (higher for HVAC only buildings), and greater concern with operational deficiencies. Other systems commissioned included fire alarms, lighting, plumbing, electrical, and other systems.

Also, there are differences for new versus retrofit commissioning. The benefits for the design/ construction phases of new commissioning projects were much higher than for retrofit / recommissioning efforts. Most notably, however, operational deficiencies and IAQ, and to some degree, comfort, were ranked very highly for retrofit commissioning projects. Correcting these types of problems may have been the particular drivers for undertaking the commissioning work in the first place.

The study demonstrates that NEBs from commissioning can be estimated – and the responses also indicate that there are strong benefits from commissioning above and beyond the direct benefits. These benefits are recognized by an array of stakeholders – stakeholders that can be targeted for commissioning information, rebates, and other programs. In addition, the NEBs are probably also strongly recognized by occupants, who may not know the source of their improved comfort. Overall, the results suggest that there are strong benefits that appeal to the types of stakeholders who were interviewed in this project. The overall experience – with very few exceptions – has been positive, and most respondents plan to commission in the future if the budget can be raised.

Facility managers appreciate NEBs from commissioning work and they should be a key target for marketing efforts. They value the benefits highly. A&E staff also value the NEBs highly, and represent another target. The two groups value different categories of benefits, which supports tailoring of the design, outreach, and program materials. Offices recognized especially high benefits and may represent a useful focus for future marketing.

Summary and Implications

These four programs provide insight into the types of NEBs recognized by commercial building actors in association with different types of programs. The information on key positive and negative NEBs, values, and discrepancies between NEBs valued by different decisionmakers are summarized in Table 7. Top ranked benefits reported by actors are summarized in Table 8.[9]

As Table 7 shows, the NEB values from the programs are fairly high – on the order of ½ to 1 times the value of the energy savings. While there are similar benefits that are highly valued,

[9] The results within the sections describe the results and perceptions by various actors, and the projects themselves were able to associate particular benefits with specific measures and building types (but this work could not be presented here because of space considerations).

these benefits may vary based on the measures included in the program and the type of program being considered. Based on the summaries in Tables 7 and 8, we find several themes:

- Top NEBs: Several NEBs were recognized across programs. Tenant satisfaction, comfort, equipment performance, productivity, quality of lighting, and were among the top NEBs reported associated with the programs. Some differences in priorities arise between different programs, reflected in some cases as differences between new construction versus retrofit programs. For the commissioning program dealing with operational deficiencies, improving the knowledge base for O&M staff, comfort and maintenance issues were important. *Implications: Using the benefits that participants have expressed that they care about in program outreach and in program design – rather than focusing efficiency or bill savings – should be a way to appeal on items valued by participants. We can learn lessons from product sales firms – they advertise features the buyer wants to buy instead of focusing on the terms or features we want to sell.*[10]
- Perspectives / Actors: Table 8 shows that while there was a great deal of overlap, most of the actors also expressed priority NEBs that were consistent with their job perspectives. Architects and engineers were both concerned with tenant satisfaction, comfort, appearance; owners and developers were concerned about internal comfort and productivity issues, as well as the ultimate ability to sell the building.[11] *Implications: Tailoring outreach, training, and program literature to those benefits with highest priority for each actor should help make energy efficiency practices and measures (and programs) more attractive to the decision-makers that need to be convinced to adopt modified practices.*
- Negatives: Equipment maintenance has been expressed as a concern (by most of the actors except developers). In detailed interviews with one program, design decision-makers had several concerns about maintenance with newer or advanced energy efficient equipment. They were concerned it might be too advanced for janitorial staff or local contractors to keep up, parts might not be available were some of the concerns expressed. Extra cost was another non-energy problem that was mentioned. *Implications: These may represent high priority "barriers" to address in training, equipment literature, warranties, demonstration projects, or other means. Addressing these concerns to A&E and owners is particularly important; also, considering the type of concern, maintenance staff or contractors may be important targets for concrete / believable evidence addressing the concerns .*[12]
- Actor disconnects: Based on findings from a couple of the programs, we find that architects and engineers were less positive about NEBs than owners. In addition, owners seem to view first cost versus operating cost tradeoffs more favorably than A&E decision-makers – A&E decision-makers overestimate owner concerns about first cost.

[10] For these programs, we combined the multipliers with appropriate dollar energy savings to quantify the savings. Applying the relevant energy savings estimates provides dollar valuations to help prioritize NEBs and can also be used in benefit cost work.

[11] The actors involved in the commissioning work varied in their statement of NEB priorities. For all commissioning projects, dealing with operational deficiencies, improving the knowledge base for O&M staff, comfort and maintenance issues were important. In addition, in commissioning of new buildings (where we interviewed those involved in overseeing construction and planning), quicker time to optimize the system, reduced warranty calls, and coordination were important. For retrofit commissioning (where we largely interviewed facility managers), indoor air quality, comfort, and productivity issues were also important. The owners we interviewed about commissioning were

[12] Research in Weitzel and Skumatz (2004) suggests some ways to get past these types of concerns. The "ordered logit" analysis of evaporative coolers indicated that demonstration projects, extended warranties and other interventions could move market acceptance and market share forward by 8 years.

Implications: A&E firms need to become confident that owners are receptive to advanced equipment and the NEBs they deliver. In addition, if owners can be convinced to reassure A&E firms that they are seriously concerned about operating costs – and that A&E firms won't lose bids that include higher first-cost items – then some additional barriers may be reduced.

Table 7. Summary of NEB Results from Four Commercial Programs

	High Performance Training / Outreach	C&I Audit / Incentives program	New Construction Program	Commissioning Program
Interviewees	Owners, Devp, A&E	Owner/facility staff	Owner, A&E	Owner/facility staff, A&E
Building Types	Offices, Schools	Wide variety C&I	Wide variety	Schools, offices, public bldgs
NEB Value (relative to energy savings unless otherwise noted)	Not estimated as part of this project.	All end uses: 40% Lighting: 45%, HVAC: 40%, Water: 40%, Refrig: 50%	1.0 times energy savings	1.0 times cost of total commissioning work
Top benefits	• Tenant satisfaction • Quality of light • Comfort • Productivity • Appearance • Equipment performance	• Water savings • Better equipment performance • Building safer • Improved light quality • Lower Product losses	• Doing good for environment • Equipment performance • Comfort • Tenant satisfaction • Quality of lighting • Ability to sell/lease	• Correct operational deficiencies • Knowledge of O&M staff • Eq't maintenance • Comfort • Reduced callbacks • Fewer sick days • Productivity
Negative effects	• Cost • Maintenance	• No significant mentions	• Eqpt maintenance cost concerns	• Schedules slowed • Team member difficulties
Actor "disconnects"	A&E less positive on NEBs than Owners 1st cost concerns mentioned less frequently than A&E.	N/A	A&E less positive on NEBs than owners	No disconnects examined. However, perspectives varied by occupation: facility managers concerned about occupant issues; A&E and maintenance concerned about operational and eqpt issues.

Table 8. Summary of NEB Results by Actors

Actor	Top NEBs by Decision-Maker Type
Architects	Tenant satisfaction, comfort, building appearance, equipment performance, productivity, quality of light, doing good for the environment. Negative concerns: Maintenance, equipment performance (for 1 pgm)
Engineers	Tenant satisfaction, building appearance, comfort, quality of light, ability to sell building, equipment performance, doing good for the environment. Negatives: maintenance concerns.
Owners	Tenant satisfaction, comfort, equipment performance, productivity, ability to sell the building, quality of light, operating cost. Negatives: maintenance concerns.
Developers	Equipment performance, ability to sell the building, comfort, tenant satisfaction, quality of light. Negatives: quality of light concerns for some programs.
Facility Managers	Water savings, equipment performance, productivity / losses, eq'pt lifetimes, quality of light, building safer

The analysis provides quantitative estimates that support anecdotal evidence that NEBs are important to participants. Valued commercial sector NEBs include tenant satisfaction, comfort, equipment performance, productivity, lower maintenance and better equipment reliability / lifetime / performance, and other benefits, and participants specifically attribute these benefits to measures installed by the programs. This research and related work (Pearson and Skumatz 2001, Skumatz *et.al*. 2001) can be used to help design programs toward measures and actors to maximize NEBs, increase program appeal and improve chances of adoption.

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. We have used this research to develop marketing and targeting

recommendations for programs. Even where programs already market and promote NEBs, additional inroads may be achieved by targeting outreach toward those NEBs that are most highly valued by key market actors.

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