

# Commissioning in public sector building – Non-Energy Benefits (NEBs), not savings, are the selling point

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## Abstract

As part of a broader study to examine the cost-effectiveness of commissioning public buildings, the authors examined the non-energy benefits (NEBs) (or non-energy impacts) from commissioning efforts in a sample of public buildings, including schools, offices, prisons, and other buildings. Phone surveys were used to gather data to measure “hard to measure” NEBs (both positive and negative), and values were computed based on multiple measurement methods. Results showed the highest-valued (positive and negative) NEBs for key stakeholders, included:

- For occupants: changes in comfort, indoor air quality, productivity, light quality, safety,.
- For facility operations: changes in tenant complaints, operational deficiencies, system documentation, knowledge for O&M staff, equipment lifetime, equipment O&M,
- During design and construction: changes in contractor call-backs, change orders or warranty claims, time to optimize systems, project schedule, coordination between team members.

Interviewees were generally pleased with the commissioning process and results, and we also found patterns based on interviewee roles, building and business type, systems commissioned, new vs. retrofit commissioning, and other subgroups.

Disconnects in perceptions between groups provide intriguing results for program design, outreach, and education.

The analysis showed that non-energy benefits can be measured and attributed for commissioning / retro-commissioning projects, and priority benefits for decision makers, building staff, and occupants can be used for program promotion, targeting, design, and barriers analysis. Non-energy benefits add significant value above and beyond the direct (energy & cost) benefits, often more than offset the commissioning costs, and lead to strong benefit cost ratios for commissioning projects. NEBs delivered are stronger selling points than energy savings, and incorporating NEB values into case studies on commissioning may improve outreach materials and attract additional buildings to commissioning programs because they speak to participants in terms they value most highly.

## Introduction and Definitions

The Non-Energy Benefits work described in this paper was part of a much larger analysis of a commissioning and retro-commissioning program for public buildings in the Northwest. The program provided rebates, incentives, and technical expertise for new construction buildings in the northwest to add a commissioning stage, and for retrofit commissioning of existing buildings. The buildings that participated included libraries, schools, offices / courthouses, and prisons in four states across the Northwest. These facilities varied in size from 18,000 square feet to more than 350,000 square feet in size. To conduct the NEB analysis, we conducted detailed interviews with facility managers; facility and maintenance staff; construction managers; design-related staff (A&E, mechanical engineers, etc.), and directors of operations. The project was sponsored by the

Northwest Energy Efficiency Alliance and the NEB analysis was conducted by Skumatz Economic Research Associates (SERA) under subcontract to SBW Consulting.

The overall project was designed to examine cost effectiveness of the program. SBW was tasked with developing estimates of the energy savings of the program – the main focus of the program – as well as tasked with reviewing the program's operation. SERA's task was to examine whether indirect effects – impacts realized by participants beyond energy savings – could be identified and attributed to the program. We determined to use NEB techniques to try to quantify and value (in dollar terms) these normally difficult to analyze non-energy benefits, both positive and negative, associated with commissioning efforts. If additional values that were realized and recognized by the building stakeholders could be quantified, the program could more fully identify the effects (beyond energy savings) that derive from commissioning work and from the program. Definitions of commissioning and retro-commissioning follow, to provide the reader with background on the types of activities associated focus of the program.

- Building commissioning is the systematic process of ensuring that a building's complex array of systems is designed, installed, and tested to perform according to the design intent and the building owner's operational needs. These efforts result in direct energy savings. In addition, it provides a reduction of the risk associated with new construction and major renovation projects to ensure that building systems meet their design intent, operate and interact optimally and provide the owner what he or she expects. This systematic process typically includes building HVAC, controls, lighting, hot water, security, fire, and life and safety systems. Total building commissioning often includes additional essential buildings systems such as the building's exterior wall, plumbing, acoustical and roofing systems. Commissioning these additional systems can reduce moisture penetration, infiltration and noise problems, and contribute to the building's energy and resource efficiency and occupant productivity. To be most effective, building commissioning begins in the planning phase and continues through design, construction, start-up, acceptance, training and the warranty period, and continues throughout a building's life cycle.
- Retro-commissioning<sup>1</sup> applies to existing buildings that have never been commissioned to restore them to optimal performance. Retro-commissioning is a systematic, documented process that identifies low-cost operational and maintenance improvements in existing buildings and brings the buildings up to the design intentions of its current usage. These efforts lead to energy savings through consistent, integrated, and efficient performance of the equipment. It typically focuses on energy-using equipment such as mechanical equipment, lighting and related controls and usu-

1. Recommissioning arises because building systems can be purchased from different vendors, installed by different contractors and operated by different facilities staff, who is under pressure to resolve occupant complaints about comfort. Quick fixes may resolve an individual complaint, but can lead to other systems becoming out of balance and losing the persistence of benefits from initial building commissioning or retro-commissioning. Additionally, building systems require periodic analysis and adjustment.

ally optimizes existing system performance, rather than relying on major equipment replacement, typically resulting in improved indoor air quality, comfort, controls, energy and resource efficiency. Retro-commissioning typically includes an audit of the entire building including a study of past utility bills, interviews with facility personnel, diagnostic monitoring, tests of building systems and other work to allow fine-tuning of energy equipment. This process helps find and repair operational problems.<sup>2</sup>

In all cases, the primary goal of the Public Buildings commissioning / retro-commissioning program was to save energy by improving the operation of systems. Successful commissioning results in optimal energy efficiency – as well as an array of other supporting benefits, including: indoor environmental quality, reduced change orders during construction, extended systems life and reduced operation and maintenance costs, often paying for itself before construction is completed. The analysis – and quantification – of some of these additional / indirect impacts – was the goal of this stage of the project.

### Why Study NEBs: What Can They Tell Us?

Clearly there is a host of potential NEBs, and traditionally, because of measurement difficulties, they have remained “omitted” effects in program analysis. Depending on how the results might be used, we can determine if it is worth spending efforts to try to quantify these effects. This project provided an opportunity to quantify the array of NEBs that have been associated with commissioning and retro-commissioning– and develop information that serves a number of purposes:

- **Marketing:** NEBs inform efficiency-related marketing, targeting, design, and outreach efforts. Previous research demonstrates that reliable methods can be used to derive quantitative estimates (Skumatz 2002, Skumatz and Gardner 2006) of NEBs, and these estimates identify which NEBs are especially valuable to participants – both in dollar terms and relative to direct benefits from energy savings from the program. These results point out which benefits are most important to various groups, providing opportunities to design program interventions and outreach activities to target groups such as builders, decision-makers, and other sub-groups. It will permit them to address those energy technologies which show the greatest NEB benefits, using terms and benefits that the end users value and respond to. 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.
- **Benefit-Cost:** The NEB information provides data for improved program benefit-cost analyses. The quantitative values for program- or intervention-related NEBs provide more complete information for assessing benefits and costs associated with programs – for the agency / utility, for societal or regulatory tests, and for participants deciding

2. Definitions from Green California Commissioning Guidelines website.

whether to install efficient measures or undertake commissioning efforts.<sup>3</sup> The NEB values provide information for the benefit/cost analysis from participant point of view, and may be useful as inputs for scenario analysis around regulatory tests as well.

- **Analysis of Program Barriers:** Negative benefits are indications of program barriers that remain – either perceived or real (or both) depending on which actors report the negative NEB. If non-participants or vendors report a negative NEB but the participants do not, then the program may benefit by providing greater education or data on that factor. The program would likely obtain more applicants, and the vendors may be able to make a stronger case for the energy efficient equipment. If, however, the barrier represents a real cost – 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 the barrier – and spur participation and adoption of new measures. Tracking these negative values over time provides useful information feedback to let program staff check whether the program is decreasing these barriers over time.<sup>4</sup> The dollar value provides information on the level of investment that may be needed to overcome the barrier.
- **Analysis of differences in decision-maker perceptions:** The authors have demonstrated in other work that gathering NEB information from multiple actors and decision-makers involved in a program can provide an even more robust analysis. These results allow an examination of differences in positive and negative perceptions about NEBs as well as differences in associated values (“disconnects”). Using this approach, the literature (Skumatz, et. al, 2003, Skumatz and Gardner 2005) 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 in some cases, builders may be including less energy efficiency than owners might be willing to “buy”. In some cases, these analyses may highlight where additional education, incentives, or other program interventions targeted at those with more scepticism may aid the program.

The majority of previously completed NEB studies have focused on the benefits associated with measure-based programs or audits that lead to measure changes. However, this project is unique in its effort to identify whether commissioning led to similarly recognized benefits. The benefits that this study uncovered that were attributed to commissioning were subse-

quently assigned an actual dollar amount, or range, to better determine the value of the benefit.

## NEBs: Alternative Estimation Methods

It is one thing to conjecture that NEBs exist; it is quite another to attempt to quantify these varied (and sometimes “soft”) effects in dollar terms. The ongoing difficulty in NEB research is converting the value of these qualitative benefits into a unit, such as dollars, than can be compared to other more quantitative benefits for further cost/benefit analyses. The authors have conducted extensive research to develop several measurement methods to quantify and “value” a wide range of participant and other NEBs. More than a dozen measurement approaches to estimate participant NEBs have been applied, representing variations on several core methodologies (Skumatz 2002, Skumatz and Gardner 2006):

- **Willingness to pay (WTP) / willingness to accept (WTA) / contingent valuation (CV):** In this method, respondents are asked to estimate the amount of money they would be willing to pay to get back all the NEBs if they were taken away, or the amount of money they would need to be reimbursed (WTA) if the NEB benefits were taken away. The authors find this method leads to high variability in results, and considerable confusion on the part of respondents. The difficulties of this method are described in detail in Skumatz and Gardner 2006.
- **Alternative methods of comparative, scaling, or relative valuations:** In this method, respondents are asked how valuable the NEBs are relative to a numeraire for which a dollar value is known. These multipliers then provide the means by which specific dollar values can be computed (See Skumatz 2002 and other). We have found these methods to be reasonably quick to answer over the telephone, respondents understand the question, and the results do not seem to lead to high variations in results.
- **Direct computations of value to owner:** In some cases, businesses have conducted studies of specific NEBs; for instance, they may have measured productivity changes or reductions in sick days or other benefits from the energy efficiency work. The difficulties with this approach is that most businesses do not conduct these analyses (or only conducted them on a few of the benefits), leading to small sample problems. Further, those that conducted studies tend to be businesses that expected or received a high value of NEBs. They do not tend to be “representative”, and combined with small samples, bias is a significant concern.
- **Other methods, including discrete choices or ordered logit, and other revealed and stated preference and other approaches.**

The authors have spent years refining and implementing these various and often complex techniques in quantifying NEBs. They have been applied to more than 50 programs across the US and internationally, and have worked very successfully. Our research over 10 years of performing these analyses has found

3. Dollar-related NEB benefits (“net” including positive and negative NEBs) can be added to direct cost and benefit information, enhancing program-related cost/benefit computations. The user may choose to include all NEBs or only a subset of the overall NEBs in the cost/benefit computations – or there may be different cost/benefit computations depending on the perspective upon which the test is based. One specific application for quantified non-energy-benefits may include programs in which post-evaluation shows that the projected energy savings have not been achieved. Rather than considering these programs as failures, the financial valuation of non-energy-benefits can demonstrate a quantifiable positive outcome nevertheless – albeit not the originally intended one.

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

that generally, comparative or relative valuations<sup>5</sup> perform substantially better than other methods. Willingness to pay (WTP) can often provide very volatile numbers and respondents have an extremely difficult time understanding the concept of stating a dollar amount they would be willing to pay for these benefits. We have incorporated multiple measurement methods into the same studies, and have found that on average, WTP is volatile (and less conservative), and that scaling, discrete choice, and other measurement methods we have adapted perform more reliably; our research incorporates these approaches.<sup>6</sup>

In most of our previous projects we have used at least two of these approaches – allowing a “check” on the computation of values. Given the findings on the performance of various approaches, we selected the two options we believed were best suited to this project. For this project, we used two methods: willingness to pay and scaled valuations<sup>7</sup> valuation methods. To quantify the occupants’ value perception of energy technologies, we used detailed surveys directed at managers, owners, engineers, and other stakeholders involved in the commissioning work and building operation, as described below.

### Steps in Estimating NEBs for the Commissioning Program

The purpose of this study was to assign quantitative dollar values to the normally difficult to analyze non-energy benefits, both positive and negative, associated with commissioning efforts, as realized and recognized by the building stakeholders. The information is provided on a building-by-building basis, as well as “averages” and analysis by a variety of strata (e.g. business/building subgroups, etc.). The NEB work conducted in this study was part of a much larger comprehensive analysis and thus, the data collection was specifically designed to gel with the work, interviews, and data conducted in other portions of the project.

The basic approach involved telephone interviews with several<sup>8</sup> key building actors – including potential building operators and owners/occupants – to ask about specific NEBs (positive and negative) associated with commissioning efforts. The authors developed questionnaires and conducted interviews to ask about the presence and values of associated NEBs. Preliminary work suggested some NEBs associated with commissioning, including:

- *For occupants:* improved comfort, improved indoor air quality, improved productivity, improved light quality, safety, and other benefits.
- *For facility operations:* fewer tenant complaints, fewer operational deficiencies, better system documentation, improved

knowledge for O&M staff, increased equipment lifetime, lower equipment O&M, and other NEBs

- *During design and construction:* fewer contractor call-backs, fewer change orders or warranty claims, less time to optimize systems, project delays, coordination difficulties, or increased conflicts between team members, and other NEBs.

On previous projects, we have asked sets of questions to support different derivations of valuation – and to “bracket” estimates. In this project, we assessed the total benefits two ways – WTP and comparison methods. Although there were differences between the different metrics, the feedback and valuations from the respondents make it clear that there are NEBs deriving from commissioning work and it is highly valued. The results are presented in the following sections.

### DATA COLLECTION

The interviews for this project were conducted with facility managers; facility and maintenance staff; construction managers; design-related staff (A&E, mechanical engineers, etc.), and directors of operations. Libraries, prisons, schools, offices / courthouses, and prisons were the buildings included in the interviews, and they varied in size from 18,000 square feet to more than 350,000 square feet in size. The projects were completed in 2000 – 2003, and commissioning costs varied from \$ 12K to \$ 225K. Rebates for the projects varied from \$ 6K to \$ 90K.

Most of the benefits could be separately identified with the exception of “coordination” and “team member relationships”. In many cases, these were jointly addressed. In addition, a subset of respondents noted some overlap or difficulties in separating indoor air quality and sick days. We analyzed several key types of results:

- The share of respondents that recognized positive or negative NEB impacts from commissioning,
- The total value of the non-energy benefits (NEBs),
- The percentage of value deriving from each of the NEB categories, and
- Ratios of benefits compared to commissioning cost.

We analyzed the results in overall terms, on a building-by-building basis, and for key subgroups, including respondent type, type of commissioning conducted, etc. The detailed estimated NEB results are presented below.

The surveys completed by the stakeholders allowed room for the interviewees to share their comments about the non-energy benefits regarding the commissioning work. The comments from the stakeholders ranged from very positive to negative and other general comments regarding commissioning. Selections of these comments are displayed in Table 1.

### Value of NEBs from Commissioning

The survey asked participants about the positive and negative non-energy outcomes from the project. We found that the most common negative effects included: negative impact on project schedule (15 %), difficulties with coordination and team member relationships (12 %), and increased time to optimize the

5. Methods pioneered by the authors, based on the academic literature; see descriptions in Skumatz (2002) and Skumatz and Gardner (2006).

6. For an analysis of comparative, willingness to pay, and labeled magnitude scaling methods, see Skumatz (2002) and Skumatz and Gardner (2006).

7. Our “scaling” or comparison approaches to measuring NEBs requires a value against which to compare the value of benefits. Rather than energy savings, as we use in many other projects, we identified a more suitable comparison factor for this project, and it worked very successfully.

8. Usually one or two per building, depending on the actors involved and likely to be knowledgeable about the commissioning and impacts.

**Table 1. Stakeholder Comments**

Positive effect noted about commissioning work	Commissioning work was worth the cost. The building now works-and this includes many aspects including control, comfort, and other systems They got things fixed up front. The commissioning agent was a valuable inspector and arbitrator. The commissioning will help improve maintenance over time.
Major categories of negative benefits	No negative impacts. The cost. Commissioning agents should be brought in early in the process to avoid problems. There were complaints from the contractors and others that were being "checked" by the commissioning agent.
Other comments	I would do it again-it turned out well Bring in commissioning agents at the beginning of the process. It is important to get this work done up-front so occupant don't get an initial negative impression of the building that is very difficult to ever get them to lose. It is cheaper to commission up front than to constantly tweak and fix ("jerry-rig") the system(s) over time.

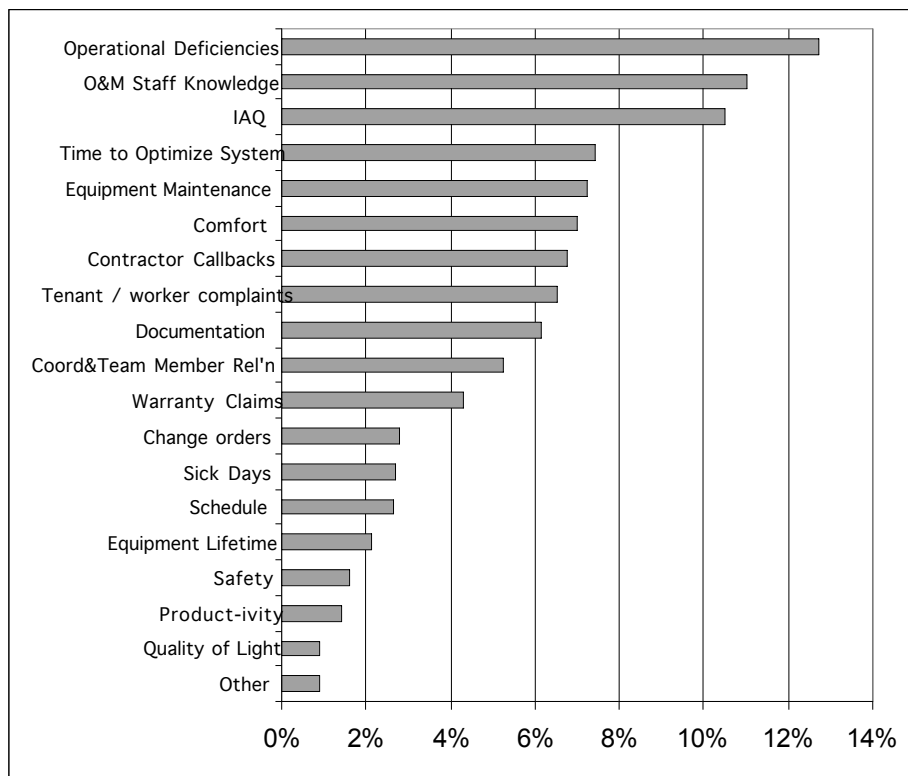


Figure 1. Overall NEB Valuation Results: Percent of Total NEBs by Category

system (8%). The NEB factors with overwhelmingly positive reports included: correcting operational deficiencies, knowledge for O&M staff, equipment maintenance, and comfort improvements. They also ranked reductions in contractor call backs and improved system documentation as positive.

Although reports of positive effects are important, we also examined the "importance" of particular NEBs, and found high scores for operational deficiencies, knowledge for O&M staff, equipment maintenance, comfort, and IAQ.

Finally, we computed NEB values. Figure 1 shows the percent of the total average NEBs that derive from each of the NEBs categories asked about. The results show that the commissioning NEBs of greatest value well-reflected the key services provided by commissioning: correction of operational deficiencies, in-

creased knowledge and improved maintenance, and IAQ and comfort advantages. In many cases, the primary driver for having commissioning done is not energy savings, but operational and maintenance concerns.

We examined the non-energy benefits, grouped into three main categories of benefits:

- Design/ construction benefits, including: reduced contractor call-backs, change orders, warranty claims, time to optimize the system, project schedule, and coordination and team member relationships. In total, these categories of benefits combined accounted for just over 31% of the average reported NEBs.

- The “operational” benefits included: correcting operational deficiencies, improved system documentation, knowledge for O&M staff, equipment maintenance and equipment lifetime benefits. These benefits accounted for 44 % of the benefits reported by the respondents.
- The “occupant” benefits included: comfort, indoor air quality, fewer illnesses/sick days, tenant or worker complaints, and other benefits mentioned by respondents. The combination of these benefits represents 25% of the reported NEBs.

Overall, the individual benefits reported to have greatest perceived value to the respondents include:

- Correcting operational deficiencies, representing almost 18 % of the total NEBs. This, in many cases, was reported to be the real purpose of the commissioning work – not energy conservation.
- Increased knowledge gained by the O&M staff, representing 13 % of total value. They 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 almost one-third of the total NEB value. Other relatively high individual benefit categories included reducing time to optimize the system and indoor air quality benefits, each representing more than 8% of the benefits.

#### DIFFERENCES IN NEBS BY RESPONDENT AND BUILDING TYPE

We 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 vs. retrofit / recommissioning efforts.

We conducted a detailed analysis of the NEB results by category for each of these subgroups. Our results are summarized below.

- **Job Titles / Responsibilities:** The bulk of NEBs for construction staff are 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.
- **Building types:** Those involved in commissioning projects for office buildings ranked three benefit categories most highly – correcting operational deficiencies; occupant comfort; and knowledge for O&M staff. University building staff

ranked operational deficiencies and knowledge for O&M staff highly, but comfort, was not highly ranked. These three categories represented a large percent of overall benefits. A set of “other” buildings, including recreation centers, museums, and others ranked operational deficiencies, time to optimize system, and reducing contractor call-backs most highly.

- **Business types:** The largest difference between state and university buildings was that the attributed benefits in reduction in time to optimize the system were rated much more highly for state buildings (12.5% of reported benefits, vs. 3.8 % for universities).
- **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.
- **New vs. Retrofit Commissioning:** As expected, 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.

#### ESTIMATED NEBS PER DOLLAR INVESTED AND PER SQUARE FOOT

The average NEB benefit per building provided a return of \$ 1 dollar of NEB benefits per \$ 1 spent on commissioning costs (gross), and \$ 2.30 dollars per every \$ 1 spent on the rebates. The benefit per square foot was 50 cents. The results are shown in Figures 2 and 3; note, however, that there are small sample sizes for some subgroups (specifically, the prison group).

Figures 2 and 3 show the results for computations of total benefits and ratios by subgroup. The figures show that:

- The highest NEB value per dollar spent for commissioning work derives from work on office buildings (2 dollars of value per dollar spent on commissioning, and 4.9 dollars per rebate dollar spent).
- HVAC-only work tended to have higher NEB returns per dollar spent than broader commissioning work.
- Retrofit work also showed higher value per dollar spent than new building commissioning.

#### Conclusions

This study confirms that not only can valuation be completed for NEBs in commissioning, but that the value of these benefits are important and go both above and beyond the value from the primary program objective – the direct energy savings benefits. The results show that NEBs are realized by a wide range of stakeholders, from maintenance staff to engineers, and are seen in a variety of building types and sizes. These same

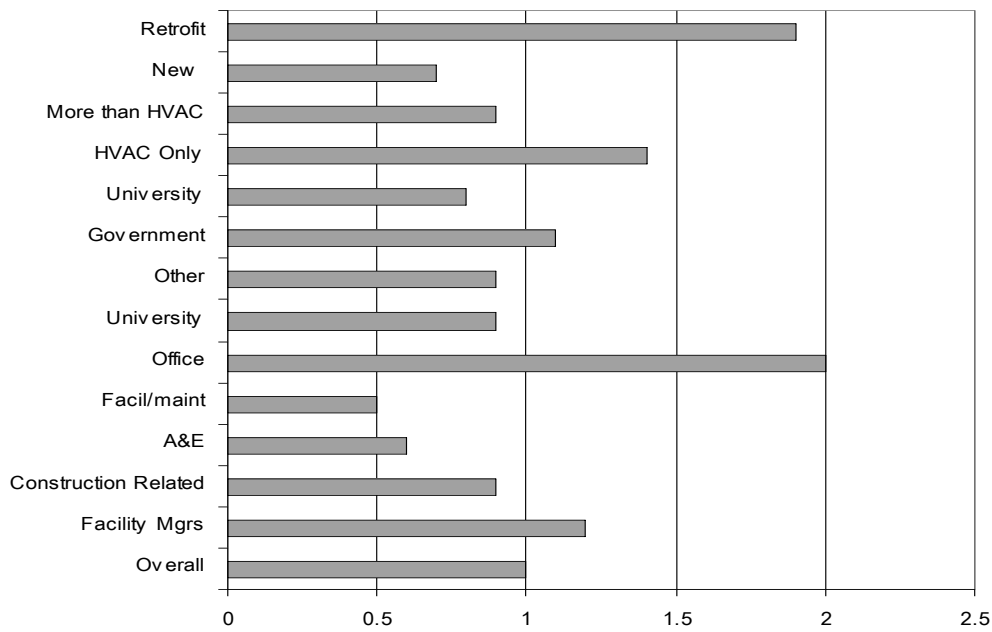


Figure 2. Non-Energy Benefit Value per Dollar of Cx Cost

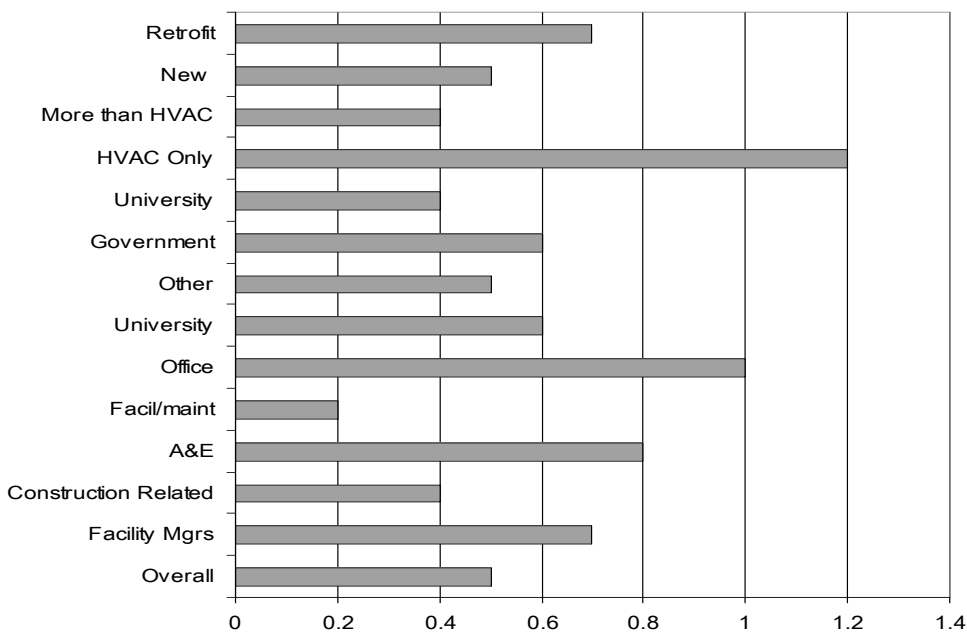


Figure 3. Benefit per Building Square Foot

stakeholders 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 that were interviewed in this project. The total experience – with very few exceptions – has been positive, and most plan to commission in the future if the budget can be raised.

The major findings from the work attributing, assessing, and valuing the NEBs from commissioning include:

- NEBs are valuable and easily / well recognized and appreciated by (a variety of) stakeholders associated with the building.
- There appears to be a strong return on investment (ROI) for the stakeholders. The respondents we interviewed valued the NEBs from commissioning as at least making up for the

cost of the commissioning work – without adding in energy savings and other direct benefits.

- From a program perspective, the return on investment in terms of NEBs from rebates is strong. However, the program costs accrue to the states and programs, while the NEBs accrue to the building stakeholders and occupants. The ROI to the program expenditures will depend on the energy savings or other direct benefits. However, the NEBs provide a way to improve the cost-effectiveness of the programs because NEBs encourage program participation, presumably reducing the marketing and outreach expenditures – and potentially reducing the level of rebate needed to achieve participation.
- The benefits that make up the majority of the value are: correcting operational deficiencies, increasing knowledge for O&M staff, reducing time to optimize the system, and indoor air quality benefits. The first two represent 31 % of all attributed benefits, and the latter two add another 16%. Improvements in comfort, contractor call-backs, and equipment maintenance were also highly rated (adding another 19%) and this list represents potentially effective benefits to recommend commissioning.
- Facility managers appreciate this 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.

There are benefits from both new and retrofit commissioning, although they tend to accrue to different categories of benefits. Commissioning work on retrofits often seems directed to address issues we have categorized as NEBs rather than direct impacts – particularly operational deficiencies, IAQ issues, and comfort.

Using tested measurement approaches, we were able to value the non-energy benefits associated with commissioning and retro-commissioning work in public buildings. The work confirmed that correcting operational deficiencies and addressing O&M (and IAQ) issues are among the most highly prized outcomes of commissioning / retro-commissioning work. We also collected open-ended information and comments about the benefits, negative, and suggestions regarding commissioning. These comments and valuations can be used to update benefit cost and payback assessments, address barriers, allay fears, and reconfirm the clearly positive overall conclusions about commissioning that are held by this sample of participant stakeholders. Although these results are based on public sector buildings, previous research on NEBs in commercial buildings (Skumatz and Gardner 2005, Skumatz, et. al. 2003) suggests that the general results will transfer to offices and other commercial sector buildings, and that commissioning can be a program and activity that provides significant value beyond energy savings.

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