NAESCO ANALYSIS OF NON-ENERGY BENEFITS OF EFFICIENCY RETROFITS FOR ESCOS AND ESCO CUSTOMERS

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Introduction

The New York State Energy Research and Development Authority (NYSERDA), in conjunction with the National Association of Energy Service Companies (NAESCO) designed this study as part of an effort, to develop a methodology to quantify the most valuable non-energy benefits resulting from energy efficiency building retrofits. The study team designed and conducted a literature review and survey to identify the state of empirical knowledge about the quantification of non-energy benefits and to better understand the role of non-energy benefits in the pursuit of energy efficiency implementation within the US building stock. The four project objectives were:

- To examine existing research on the quantification of non-energy benefits;
- To determine whether and how these non-energy benefits might be monetized;
- To assess how monetizing these non-energy benefits could affect customer building improvement investment decisions; and
- To evaluate the extent to which non-energy benefits are already driving market demand for energy efficiency solutions.

This study presents the results of a NAESCO survey on the importance of non-energy benefits to ESCOs and their customers. It also provides an analysis based on the survey and a literature review of the frequency of use and economic size of these non-energy benefits in ESCO projects. Various barriers to the data collection and analysis required to monetize non-energy benefits are identified and evaluated. A draft research plan is outlined, which identifies additional data to be collected by ESCOs and owners to quantify non-energy benefits. Based on the results of the survey responses and literature review, several policy recommendations are offered to facilitate future research on non-energy benefits.

Background

There is a great deal of interest in high-performance buildings and employing green products. The LEED-EB rating system is predicated on the achievement of five key elements of building envelope design including ensuring the use of energy efficiency technologies. The LEED-EB program is certainly one of the best known entities in the marketplace promoting the idea that environmentally sustainable and energy efficient buildings are highly desirable for reasons beyond just reducing energy usage and generating dollar savings. Benefits commonly cited include:

- Improving worker/student productivity;
- Decreasing work absenteeism due to “sick building syndrome,” asthma or other respiratory ailments;
- Reducing the physical manifestations of indoor air quality problems like mold, mildew and noxious emissions which negatively affect building occupants’ health;
- Worker/tenant retention;
- Operations and maintenance cost savings;
- Risk reduction for building owners.

There is a general consensus that these benefits are real, that building owners have a genuine interest in improving their buildings’ performance and that all of this can be achieved at no additional cost. However, despite the efforts of the U.S. Green Building Council and other groups to promote high-performance building design, there is little analytical documentation of the claims being made. Better

health and productivity would appear to be intuitively a direct product of utilizing high-performance design elements. However, the supporting data does not yet exist in quantity or rigor to dispositively support these claims.

NAESCO's findings prior to initiation of this study, through interviews with experts and presentations at its conferences, have shown that there have been limited studies on the impact of energy efficient and other green technologies and products on productivity and health claims (Fisk, Heschong). Moreover, the study results are not conclusive and the studies are limited to relatively narrow aspects of the benefits under review.

Understanding and quantifying such benefits can provide an additional rationale for aggressively pursuing both traditional energy retrofits and high performance upgrades. To be able to conclusively demonstrate to facility owners an increased value beyond energy savings should stimulate the economic appetite to undertake more retrofits and performance upgrades.

This project was designed to support Rebuild America's goal of increasing the number of high-performance buildings; specifically, it supports the Rebuild strategy to "confirm realistic and compelling metrics needed to quantify results from projects planned and completed by partnerships" and to "develop effective methods for gathering meaningful data for these metrics." The metrics of energy savings are clearly well understood, but the less tangible benefits of employing retrofits and performance upgrades have not been as well documented.

Highlights from the Literature Review

The literature on the non-energy benefits, generated though the implementation of energy efficient improvements, in new as well as retrofitted buildings, suffers from a variety of limitations primarily because of its reliance on survey research and a lack of consistent and transparent analysis methods. Self-reported survey data on occupant perceptions of indoor environmental quality is not generally considered a credible source of data for independent researchers seeking to monetize these benefits. There is little uniformity in the types and methods of data collection currently used for evaluating health improvements and productivity benefits. Moreover, it is typically difficult to measure and monetize changes in white-collar productivity.

It is generally easier to focus on empirical data, such as employee turnover and absenteeism and employee health complaint statistics. For example, the type of data required to track the health impact of energy efficiency upgrades in the facility on building occupants might include tracking the number of sick days taken by workers in the building before and after the energy efficiency project implementation or annual health care costs per worker in the building before and after project implementation. Barriers to the collection of these types of data may include:

- Security and privacy of the data
- Time and cost requirements for collecting the data
- Separate organizational budgets for personnel and employee benefit issues and building operations and maintenance concerns
- Doubts about the cost of the data collection effort relative to the value of health-related non-energy benefits

The last barrier could be overcome once some well-designed and replicable studies that demonstrate the magnitude of the achievable costs benefits that could, in turn, motivate additional follow-on research.

Auxiliary reasons for business owners and managers to concern themselves with collection of data about the effect of energy efficiency upgrades on worker behavior and health have to do with the costs associated with employee recruitment and retention. When facility owners and managers consider the average cost to hire a worker for a job in the building, the rate of job offer acceptances for jobs in the building, the annual percent of voluntary terminations of workers in the building, and the average length of employment for workers in the building, they may be more motivated to understand and quantify the relationship between improved indoor environmental quality and worker health and productivity. Clearly, this level of data collection is far beyond what is normally collected by ESCOs as part of their measurement and verification of project benefits. However, where the building owner or manager see the value of identifying and tracking such data, they can work with ESCOs to establish mutually agreed upon data points related to health and productivity as part of an energy performance contract, data which the ESCO can then collect as they design and implement their projects.

Who Benefits from the Quantification of Non-Energy Benefits?

A fundamental issue when considering the monetization of non-energy benefits is the determination of who owns the benefits and can recognize as revenue the value created. In some cases, the non-energy benefits are monetized in the form of a receipt of a payment from a utility company or an emissions

trading exchange. The allocation of the revenue stream at this level is a decision as to which organizational entity is entitled to claim ownership of the revenue stream. The resolution of ownership claims to the revenue stream is both a market design issue as well as a tax obligation issue.

The vast majority of ESCO projects are for tax-exempt governmental entities. These governmental entities tend to make decisions about buildings based on annual budget cycles. This short-term focus is at odds with the multi-year timeframe required to track and monetize the non-energy benefits of energy efficiency measures. The typical focus on short-term cost benefit analysis of economic decisions precludes the life cycle cost analysis required to properly evaluate many non-energy benefits. Even in cases where decision-makers look beyond the annual budget cycle, they may still be constrained by the political electoral cycle or the cycle of turnover in key policy or decision-making staff.

Within the organization, there are revenue recognition issues as well. The determination of which department within the organization will be permitted to recognize the value of the benefits captured from the expenditure of existing budget appropriations or whether the organization recognizes the revenue receipt on a consolidated basis may have an impact on how eager individuals within the organization or departments within a government agency will be to pursue energy efficiency and green strategies. This was initially a challenge in the federal market when agencies and military branches were encouraged to enter into energy savings performance contracts (ESPCs) but all of the savings went back to the Treasury. Only when the federal authorizing legislation was changed to permit the contracting governmental entity to keep some of the energy savings generated, did the use of ESPCs achieve significant traction. The challenge with the allocation of the revenues associated with non-energy benefits is further complicated by the fact that many of these non-energy benefits are not explicitly part of any performance evaluation system nor may it be clear which entity within the organization is accountable for the cost of tracking and documenting those benefits. A strong virtue in accounting for these benefits within a performance contract is that the party who has entered into the performance contract has established a clear custody chain for the receipt and recognition of the revenue stream.

Currently, the level of demand by customers to monetize non-energy benefits is muted largely because there is incomplete understanding about what constitutes non-energy benefits and concerns about issues of measurement and verification. There is some public focus on the recognition of the value of the reduction of greenhouse gas emissions, but monetization efforts are still under development as the credit trading exchanges are still struggling to achieve a level of trading activity commensurate with what many policy makers feel would be the right economic catalyst to accelerate market activity. There is very little demand from public agencies to identify and monetize the avoided utility system costs because these costs are relatively invisible to end-users. However, providers of energy services like ESCOs have long recognized that energy efficiency resources are undervalued when compared to supply resources largely because the avoided utility system costs have not been recognized by utilities or regulators when setting or approving prices for energy efficiency resources or developing incentives to acquire energy efficiency savings.

There is a high demand to reduce operation and maintenance costs in the short term; however, there is less focus on reducing the long-term or life cycle costs, which may actually increase the cost of short-term operations and maintenance investments for the purpose of reducing long-term costs (e.g., the implementation of a computerized maintenance management system). Energy savings performance contracts typically blend longer and shorter payback measures to create comprehensive energy efficiency projects, which minimize life cycle costs. Incorporating the value of non-energy benefits

created through the retrofit provides the private or public sector customer an even more economically attractive choice.

In seeking to monetize non-energy benefits, the trade-off between the cost of the measurement and the projected monetary value of these benefits, several factors need to be considered:

- Are the relative values of the monetized non-energy benefits significant enough to drive investment decisions by the building owner?
- What is the cost to quantify the value of non-energy benefits?
- Is it possible to clearly identify and define the variables used for measurement and calculation purposes for specific non-energy benefits?
- Is there a reasonable consensus on the appropriate quantification and measurement of the non-energy benefits?
- How feasible is it to collect accurate baseline data on the specific non-energy benefits being evaluated?
- What is the appropriate timeframe over which the measurement and verification of non-energy benefits should occur?
- What is the level of uncertainty associated with calculating or estimating the value of non-energy benefits?
- Are energy efficiency projects the most efficient way to capture the value of the non-energy benefit being evaluated?
- Is there a liquid, open and transparent market or bilateral agreement in which the value of that non-energy benefit can be exchanged?
- What incentives do building owners currently have to evaluate and monetize non-energy benefits?
- If there are no existing monetary incentives for building owners to measure and monitor non-energy benefits, would incentives in the form of cash payments or rebates be the most efficient way to motivate building owners to collect the data needed in order to quantify these non-energy benefits?

Data Collection Barriers

Although utility bill data is a source of much baseline information about changes in energy consumption units and offers, in some instances, the ability to utilize real time pricing information to further refine the calculation of the actual value of energy saved and non-energy benefits, there are significant organizational and technical barriers to the collection and use of utility bill data by both non-utility providers and customers.

- The existence of master metering in many multi-building facilities. For example, individual buildings on many military bases and campuses lack meters that make it difficult to measure building energy usage let alone measure non-energy benefits.

- Separate silos of information collection and dissemination within organizations. For example, the accounting department that processes utility bills may not share energy consumption data with building operations and maintenance staff. This may be a deliberate choice or a tradition that no one has thought to alter. In addition, the cost to collect data not normally collected or disseminated may be perceived as a hindrance.

- The pursuit of data collection to support the valuation of non-energy benefits may expose building operation and maintenance errors or facility owner/management negligence and raise liability concerns. In work done by NAESCO for the U.S. EPA Office of Air and Radiation Las Vegas, researchers surveyed a number of schools nationwide and came to the conclusion that many school administrators chose not to evaluate the indoor air quality status in their facilities because of their concern that, if a problem was discovered and not resolved, the school district could be held liable for tort actions to be brought against the school district. Even though they knew or were told that ignorance is not a defense, they chose not to pursue opportunities to improve indoor air quality in their facilities.

- In some cases, the organization may not have retained historical records vital to defining certain baselines.

- Unwillingness by the utility to provide third parties like ESCOs with customer energy data based on the belief that the sharing of that data is not permitted as it is confidential or proprietary.

- Concern by ESCOs or other providers to make contractual guarantees based on the valuation of non-energy benefits since there are still concerns about the validity of the measurement and evaluation methodologies used to verify the valuation.

- Whether the tenure of the contract between the customer and the provider is sufficient to gather the appropriate data to establish the validity of the valuation.

Survey Results

In order to assess the level of awareness of non-energy benefits and the perceived importance of these benefits in marketing energy efficiency projects to end-use customers, NAESCO created an online survey for Energy Service Companies (ESCOs), Building Owners, and Owner Representatives. The purpose of the survey was to collect current attitudes about valuing non-energy benefits when establishing the overall value of an energy efficiency project as well as to identify how market participants view existing quantification and measurement efforts. Sixty responses were received over a six-month period. Of these 60 responses, approximately 50 respondents (83%) provided a strong and sufficient set of responses, enabling the authors to rely on the quality of the responses in developing this report.

Structure of the Survey

- Question 1 requested contact information; 51 respondents provided contact information (name and company).

- Questions 2 - 13 focused on specific non-energy benefits and potential barriers to quantification of non-energy benefits.

- Questions 14 - 31 were specifically directed at building owners to collect baseline project data for specific projects.

Eighteen ESCOs and 22 owners or owners' representatives provided complete responses for Questions 1-13. Eleven owners or owners' representatives provided partial responses to Questions 14 – 31.

Respondents were asked to rank their responses on a five-point scale

- 1 - not at all significant
- 2 - somewhat insignificant
- 3 – neutral
- 4 – significant
- 5 - extremely significant

Survey Questions and Responses

The responses are listed in the order of importance that is 1st had the highest ranking of all responses; 2nd had the second highest ranking, etc. The numbers following the response indicated a weighted average of all responses to the question. For example, in question number 2, the respondents in aggregate ranked "building maintenance and operation cost saving" as most important overall and on a five point scale as between significant (4) and extremely significant (5).

Question 2:

Which of the following non-energy benefits were the most persuasive in motivating your organization to implement an energy performance contract?

- 56 responses
- 1st: Building maintenance and operation cost savings (4.46)

- 2nd: Avoided utility system capacity cost savings (3.67)

Perhaps the most interesting comment received was that while emphasis might be placed on all of these factors during the early stages of project evaluation, actual implementation results were almost always exclusively based on reduced building maintenance and operation cost savings with the other categories of non-energy benefits essentially ignored. Comments from two respondents indicated that an emphasis on reducing or avoiding environmental emissions was becoming an organizational priority.

Question 3: Which of the following ESCO services has the greatest perceived positive impact on occupant health and productivity for your clients?

- 50 responses
- 1st: Lighting (4.12)
- 2nd: Improved ventilation (4.08)
- 3rd: Improved temperature rated (4.0)
- 4th: Improved general maintenance (3.9)
- 5th: Training (3.63)

The diversity and range of ESCO services scoring a high impact are significant because this suggests that customers are placing value on more than product installation but recognize the value of other elements of an energy efficiency retrofit.

Question 4: How significant are the following barriers to proving the economic value of health and productivity benefits of your EPC projects?

- 49 responses
- 1st: Lack of baseline data on productivity benefits (3.59)
- 2nd: No data collection systems to track variables over time (3.58)
- 3rd: Lack of user-friendly tracking tools (3.52)
- 4th: Cost to collect data benefits (3.49)

Two comments focused on the fact that utility budgets and maintenance budgets are separate from employee compensation and benefits budgets, which presents structural barriers to the collection of data on health and productivity. Another respondent noted that claims about enhanced productivity have been challenged by the insurance industry as well as by human resources/personnel groups who are concerned about privacy and perceived infringement of rights and liability concerns. The complexity of variables that may influence employee health and productivity serve in effect as a barrier since it was perceived as difficult to separate and measure specific variables.

Question 5: Which of the following ESCO services has the greatest perceived positive impact on reducing building maintenance and operation costs for your clients?

- 50 responses
- 1st: Equipment improvement (4.1)
- 2nd: Improved control of indoor environment (3.92)

- 3rd: Reduction in the cost of existing external maintenance contracts (3.76)

Question 6: How significant are the following barriers to proving the value of building maintenance and operation cost savings of your EPC projects?

- 49 responses
- 1st: Poor documentation of existing O&M practices (4.65)
- 2nd: Reactive maintenance philosophy (3.63)
- 3rd: Inability to quantify cost savings (3.58)
- 4th: Lack of baseline data on maintenance costs (3.5)

Question 7: Which of the following ESCO services has the greatest perceived positive impact on reducing environmental emissions or compliance costs for your clients?

- 46 responses
- 1st: Quantification of avoided environmental emissions (3.7)
- 2nd: Fuel switching to a source of lower emissions (3.66)
- 3rd: Dedicated controls for an existing central plant (3.61)

Question 8: How significant are the following barriers to proving the economic value of reducing environmental emissions or compliance costs for your EPC projects?

- 43 responses
- 1st: Separate capital and operating budgets (3.79)
- 2nd: Regulatory uncertainty (3.68)
- 3rd: Lack of baseline data about compliance costs (3.67)
- 4th: No data collection system to track variables over time (3.66)

Two respondents focused on the high level of uncertainty about the establishment of the economic value of avoided environmental costs.

Question 9: Which of the following ESCO services has the greatest perceived positive impact on reducing utility system costs for your clients?

- 44 responses
- 1st: Measurement and verification services (3.84)
- 2nd: Dedicated controls for an existing central plant (3.74) tied with automated controls to enable participation in a utility demand response program (3.74)

Respondents pointed out that the market for avoided utility system costs is still in an early stage of development.

Question 10: How significant are the following barriers to proving the economic value of reduced utility system costs for your EPC projects?

- 42 responses
- 1st: Lack of understanding of economic performance metrics (3.54)
- 2nd: No data collection system to track variables over time (3.44)
- 3rd: Inadequate training or knowledge of building maintenance staff (3.44)

Respondents commented that there was a lack of understanding of the connection between energy performance contracts and reduced utility system costs.

Question 11: Which of the following Health and Productivity Metrics would be the most important variables to measure to reveal the value of ESCO services?

- 43 responses
- 1st: Comfort complaints (4.14)
- 2nd: Positive publicity (3.88)

One respondent commented that the ability to reduce health care costs would be valuable.

Question 12: Which of the following Maintenance Metrics would be the most important variables to measure to reveal the value of ESCO services?

- 42 responses
- 1st: Verification that the facility is operating according to design intent (4.12)
- 2nd: Cost of external maintenance contracts and emergency repairs (4.10)
- 3rd: Number of building occupant complaints (4.0)

Question 13: Which of the following Environmental and Reduced Utility System Capacity Cost Metrics would be the most important variables to measure to reveal the value of ESCO services?

- 43 responses
- 1st: Reduced energy consumption (4.60)
- 2nd: Reduced water consumption (4.58)
- 3rd: Cost of environmental fines for the lack of regulatory compliance (3.93)
- 4th: Avoided generating capacity costs to the utility (3.88)

One respondent noted that most of these evaluation metrics only become relevant if they are legislatively required.

Responses to Supplementary Questions (14–31)

The survey posed 18 supplementary questions in an effort to collect site-specific data relevant to the quantification of non-energy benefits and barriers to the measurement of non-energy benefits. The number of responses to these questions was limited.

For any question asking for quantitative data and receiving five or more responses, the range of responses and the median are reported in the table below.

Question Number	Responses: Range	Responses: Median
14: Maintenance budget per square foot (8 responses)*	$.21 - $17.65	$2.19
15: Total square footage managed (10 responses)	74,000-80 million	1.166 million
16: Internal staff maintenance budget/square feet (5 responses)	$.31 - $4.37	$2.77
17: Area (sq. ft.) managed/per maintenance staff person (7 responses)	5000 – 120,000	59,000
18: Capital budget allocated (9 responses)	0% - $100%	22.5%
19: Annual maintenance complaints (5 responses)	0 – 17,500	750
20: Total number of building occupants (9 responses)	300 – 360,000	6,000
21: number of square feet per occupant (7 responses)	200 - 1,126	400
24: Percent annual maintenance budget spent on corrective/reactive maintenance (8 responses)	10 – 80%	62.5%
29: Percent of EPC project funded with capital dollars (9 responses)	0 – 100%	10%
30: Number of years of M&V data (8 responses)	0 – 10 years	1

Received 8 responses; however only 7 of these responses provided annual maintenance budget and total square feet managed (Question 15), both numbers of which were needed to calculate the median response.

The following supplementary questions either had less than five responses or did not request specific quantitative building data.

Question 22: What is the average number of annual sick days per worker?

- Number of responses: 3
- Range of answers given: 4 - 6

Question 23: What is the annual number of voluntary worker resignations?

- Number of responses: 1
- Range of answers given: 2

Question 25: Can you identify any specific building system that has a potentially large negative impact on employee health, productivity or morale?

- Number of responses: 21
- 12 yes (57%)

- 9 no (43%)

Question 26: If you answered yes to the previous question, what is that building system?

- Number of responses: 12
- 10 HVAC; 3 lighting (1 person identified both HVAC and lighting)
- Would imply ventilation or thermal is more important than lighting

Question 27: Do you currently track indoor air comfort and air quality complaints?

- Number of responses: 19
- 11 yes (58%)
- 8 no (42%)

Question 28: Do you survey building occupants annually as to IAQ, comfort, and lighting?

- Number of responses: 19
- 4 yes (21%)
- 15 no (79%)

Question 31: What is your average yearly percentage of annual energy savings goals achieved per your M&V plan (in %)?

- Number of responses: 4
- 9 – 78%
- *(Author's Note: Respondents appeared to be confused about organizational energy savings goals versus project savings goals as measured by an M&V plan.)*

Putting the Survey in Perspective

In reviewing the survey data, the single most significant barrier to the quantification of non-energy benefits is the existing level of data collection and the belief that the difficulties inherent in the measurement of individual variables made the process as a whole problematic. However, the establishment of avoided operation and maintenance costs was clearly identified as the most commonly quantified non-energy benefit of energy performance contracting projects. Because there is already a data collection process in place as part of the ESCO model of energy efficiency resource delivery, these benefits are regularly counted and measured as part of the economic evaluation of current energy savings performance contracts.

Operations and Maintenance (O&M) Savings

Reductions in operations and maintenance (O&M) costs arise due to installation of new high-efficiency equipment. However, the baseline issues associated with the measurement of operations and maintenance cost savings are not directly linked to the amount of energy and water consumption savings. Tracking O&M savings typically requires multiple baselines (e.g., internal labor, external maintenance contracts, commodities, replacement equipment, training costs and amount of comfort complaints). The substitution of new equipment, services and systems with higher productivity requires long-term tracking of O&M costs in order to measure these non-energy benefits.

In collecting O&M baseline data and verifying O&M savings, it is important for the customer to value only those O&M savings benefits that can be proved to the customer with clearly understood data that supports the valuation. Where there is disagreement as to the appropriate valuation methodology or the quality of the data used to establish the valuation, the savings can always be audited by a third party. Transparency in verifying the savings is critical and where O&M savings are being claimed, there should be some form of documentation of the quantified benefits. Credibility is a direct function of solid empirical data that serves as evidence of the value of all non-energy benefit claims.

A 2005 Lawrence Berkeley National Laboratory (LBNL) study of the performance contracting market revealed some interesting data on the important role that O&M savings play in many projects. As the next table shows, over half (55%) of the federal market projects in the LBNL study sample report O&M savings, whereas other market segments report such savings between 26% and 38% of the time. Federal customers appear considerably more likely to include operational savings in project economics. O&M savings were reported much more frequently than other types of non-energy savings in all market segments.

Market Segment	O&M Savings	Other Non-energy Savings
Federal government	55%	13%
K-12 schools	38%	7%
Universities/colleges	28%	7%
State/local government	26%	7%
Health/hospitals	26%	4%

For those projects that reported non-energy savings, which are predominantly O&M savings, a comparison of the relative magnitude of these savings among market segments is provided in the next

table. While federal projects tend to include non-energy savings more frequently than other market segments, when included, the savings account for a lower share of overall project savings compared to most other markets.

Market Segment	Non-energy Savings Median Share of Project Savings
Federal government	14%
K-12 schools	27%
Universities/colleges	10%
State/local government	34%
Health/hospitals	21%

SOURCE: Public and Institutional Markets for ESCO Services: Comparing Program, Practices, and Performance

Federal government projects tend to be large projects that require a high level of savings to amortize the project cost. This has motivated more facility decision-makers in the federal market segment to try to account for O&M savings available to pay for project costs.

In the K-12 market segment, the value of energy savings tends to be relatively low compared to other market segments because the energy use per square foot of schools tends to be lower than that for other public facilities. As a result, there is typically a larger share of total project savings coming from O&M savings in the K-12 market segment that is used to amortize project costs.

Universities and colleges tend to be more conservative in their valuation of O&M savings because of the technical sophistication of their O&M staff. As a result, it is not as common for O&M savings to be recognized or included by this particular market for determining project costs savings.

State and local governments are the least likely of the different market segments to count non-energy benefits; however, when they do count these benefits, they account for the largest share of total project savings of all the market segments discussed above.

Avoided Utility System Costs

Avoided utility system costs are clearly real. Utilities routinely perform cost of service studies and are required to estimate the cost of avoided transmission, distribution and generation capacity, as well as line losses. These engineering and economic data are readily available from utilities or public utility commissions. Energy and demand savings at the building level can be used as well in straightforward engineering and economic calculations to estimate the value of avoided utility system costs. While these estimates of value are fairly straightforward, the ability to actually monetize them depends upon whether the utility offers specific incentives recognizing the value of these avoided utility system costs.

The market mechanisms to monetize the value of these savings are unevenly developed in different regions of the country. The funding for utility incentive programs has been variable over time and across regions in the United States, but a significant number of energy efficiency programs, including many using third-party delivered energy performance contracts, have been able to capture and monetize some of the value of these avoided utility system costs. Utility DSM incentive programs have generally recognized the value of energy efficiency as a resource by providing incentives to large customers for kW or kWh savings. For utilities that have active demand response or load-shedding programs in place,

there are real opportunities to capture some avoided utility system costs generated by these programs. While utilities reward participants in energy efficiency and demand response programs with incentives to participate, the calculation of these incentives does not typically value all of the elements of the avoided utility system costs. This creates a lost opportunity, particularly for large customers, to derive the full economic value created for the utility by the customer's load-shedding activities over time. If the full range of utility system cost reductions was to be monetized, they might represent as much as 30% of the value of annual energy savings.

Emissions Reduction Market

The avoided emissions market is probably the least developed market for monetizing non-energy benefits, although in some regions of the country it is possible to sell emissions credits into exchanges or through bilateral agreements in order to monetize the value of those emission reductions.

The assignment of the value of avoided emissions is highly dependent on the rules adopted to regulate emissions in various jurisdictions, but the potential value of monetized emissions ranges from 3-30% of the value of annual energy savings. [1] Perhaps one of the key challenges to monetizing emissions reductions is the determination of the ownership of emissions reductions. Emissions produced on-site by a coal or fossil fuel fired boiler are considered to be direct emissions reductions and are owned by the entity producing the emissions. On the other hand, power demand reductions produce emissions reductions, but are currently claimed by the electric utility that asserts ownership of those emission credits. Absent the involvement of a third party emissions reduction bank, the utility is unlikely to allow the facility owner to directly monetize those credits. Currently, this is only true in a minority of jurisdictions in the United States. However, 31 states, representing 70% of the country's population, have signed a new climate registry to measure, track, verify and publicly report the greenhouse gas emissions by major industries. This registry is a likely precursor to market-based regulations to reduce greenhouse gas emissions.

Emissions reductions are currently being estimated and calculated by a number of ESCO project participants, even though most of them cannot currently monetize the value of those emissions reductions. Accounting for these avoided costs raises many of the same data collection challenges highlighted below which can be summarized as the trade-off between the cost of data collection and the value of the benefit. However, most estimates of the value of emissions reductions by ESCOs are actually lower than they should be for the following reasons:

- Energy reductions at the building level also reduce utility line losses and reduce the emissions that are associated with those line losses. They are not normally counted as avoided emissions, but they should be.

- Water efficiency reductions are often very large for university, military and public housing clients, and since water production requires a significant amount of energy, there are significant avoided air emissions due to water efficiency projects, which are often not counted (i.e., .18 pounds of CO_2 per thousand gallons of water savings).

- A further complexity is that most emissions reductions factors are calculated on some sort of average generation resource base. These emissions reductions factors may not account for

[1] California Utility Commission and the U.S. EPA. SOURCE: Personal Correspondence with Donald Gilligan, NAESCO

dirtier marginal emissions that are avoided by some energy efficiency projects particularly those projects that reduce or eliminate peak load.

Avoided Environmental Compliance Savings

Avoided environmental compliance savings are sometimes a significant driver of some energy performance contracting projects because of the air quality standards that apply, especially to older coal-fired facilities. In some cases, these environmental compliance costs run into the millions of dollars and could become the primary basis for economically justifying an energy performance contract. These costs can be monetized in the form of avoided cost calculations and can equal or exceed the value of annual energy savings.

Health and Productivity Benefits

Measuring the economic value produced by energy efficiency projects on indoor environmental quality is more complex. Energy efficiency projects may improve thermal comfort, lighting, acoustics and ventilation. Measuring these physical parameters is relatively straightforward; however, measuring the impact of these changes on productivity and health is much more complicated. Privacy and liability issues may be barriers to tracking these non-energy benefits.

Improvements in indoor environmental quality are typically a secondary effect of the energy efficiency project. If the owner's goal was to improve employee health and productivity, he might be more motivated to substitute a direct investment in a preventative wellness screening and lifestyle for wellness education program, which arguably might have a more direct and cost-effective impact on worker health and productivity than the more indirect approach of improvements indoor environmental quality.

In general, the most difficult non-energy benefits to quantify are the effects of energy efficient infrastructure upgrades on building occupant health and productivity improvements. These benefits are perhaps the least credible to decision makers, but potentially could be very significant if avoided sick days, individual and corporate medical costs, and productivity increases could be measured with some exactitude. While it is possible that the magnitude of building occupant health and productivity benefits actually exceeds the economic value of annual energy savings, the problem of quantification is daunting. Specifically, some of the quantification challenges include the degree to which the data on human health and productivity can be directly attributed to changes to the building indoor environment. Establishing the appropriate reporting period for measuring these changes requires funding of long-term studies. For instance, public health studies utilizing control groups are needed to produce credible, quantitative claims about the economic value of health and productivity gains.

The sheer number of variables that affect the health and productivity of building occupants confounds the measurement challenge. There are many types of respiratory illnesses and it is a very diffuse category of illness to use as data to measure health improvements. Survey responses may not be a useful modality to provide credible data about occupant health and productivity. They may, however, provide some value as a gauge of market perceptions of health and productivity issues.

Perhaps one of the most significant catalysts to the interest in measuring health improvements of building occupants is the rising cost of health care insurance premiums borne by state and local governments. Per employee annual costs of health care to municipalities covered by *City Weekly* has

almost doubled since the year 2000. Building codes establish minimum health, safety and security performance criteria. Non-energy benefits related to health and productivity seek to measure incremental improvements over code requirements. There is a growing interest of employers in identifying credible strategies to improve overall worker health, thus reducing aggregate health costs, such as lower health insurance premium payments and the dollar cost of sick days and forfeited worker productivity.

A Draft Research Plan Design

It is crucial to agree on well-defined metrics for establishing and valuing non-energy benefits. Some form of standardized data collection protocols will be essential to achieving credibility with customers, utilities, system operators, and regulators. Surprisingly there is a scarcity of actual measured energy use data in most of the existing databases on high performance buildings. It will be important to create a large enough database of operating projects sufficient to be able to aggregate the project data in order to be able to provide credible information on the amount of non-energy benefits created by energy efficiency retrofits and to establish a valuation protocol. Ideally, the end goal is to use this database as the basis for a conversation across a variety of stakeholders about what constitutes credible data for purposes of valuation of non-energy benefits. An effort to eventually incorporate the methodologies for measurement and verification of non-energy benefits into industry-wide protocols like the IPMVP would be a key objective both to educate stakeholders about non-energy benefits created by an energy efficiency retrofit and to provide a credible and transparent way to identify and value these non-energy benefits.

Perhaps the best approach would be to begin with the development of detailed case studies of energy performance contracting projects that have actually monetized non-energy benefits or collected enough detailed data to provide for credible estimates of those benefits and, if available, details about the valuation process.

Data to Be Collected by ESCOs and Project Owners and Provided to the Research Team

- Square footage
- Annual cost per square foot for maintenance
- Annual number of occupant complaints
- Average cost to respond to occupant complaints
- Utility system line loss percentage
- Marginal distribution capacity costs
- Marginal generation capacity costs
- Emissions rates per kwh
- Emissions rates per unit of on-site combustion fuel
- Number of building occupants
- Energy efficiency measures installed
- Date of energy project completion
- Amount and types of annual energy and water saving
- O&M costs for commodities, equipment downtime, external maintenance contracts
- Current level of maintenance services

The initial goal would be to develop a database with operating data from a minimum of 50 buildings based on the above NEB performance metrics and refine the set of performance measures based on the results of the initial data collection.

In addition, researchers should analyze the operating data from LEED certified existing building project pool using the above NEB performance metrics.

To build a persuasive case for health and productivity benefits, conduct controlled experiments focusing on single variables. (Example: initially focus on small ventilation zone sizes that deliver the best indoor air quality)

Conclusion

Skepticism about the credibility of claimed energy savings has been successfully addressed through the collection and verification of transparent energy consumption data and the existence of standard measurement and verification protocols vetted over time by thousands of building owners. However, that skepticism reappears when the discussion turns to the calculation of non-energy benefits. The creation of a well-defined, internationally recognized and standardized methodology for the measurement of these non-energy benefits will be necessary, just as it was for the measurement of energy consumption reduction. The development of a standardized measurement protocol for verifying energy savings helped to drive energy efficiency investment and grow the market for the widespread use of energy efficiency.

The ESCO industry may, once again, need to take the lead in developing standardized protocols that provide a simple and reliable valuation approach for measuring the non-energy benefits created in the course of the implementation of energy efficiency project. The first step, however, in the establishment of such a protocol is the collection of the empirical data. While this report highlights the collection challenges, the report also identifies the magnitude of savings currently not recognized, captured nor monetized as part of an energy efficiency retrofit. The opportunities to quantify the full value of energy efficiency resources are considerable and the creation of credible and transparent documentation of non-energy benefits could be an economic accelerant to the use of energy efficiency globally.

Policy Recommendations

The most quantifiable non-energy benefits of ESCO projects are:

- Operational and maintenance savings (10-30% of estimated energy savings)
- Load shedding, DSM/peak power savings (5-15% of estimated energy savings)
- Emissions trading (3-15% of estimated energy savings)
- Reduced cost of responding to occupant complaints (10% of estimated energy savings)

If non-energy benefits were fully and appropriately valued in ESCO projects, they could increase the total value of project savings by as much as 50% or more. This would imply that we are under investing in energy efficiency projects if we fail to properly value the non-energy benefits.

For these benefits to be used in public and private decision-making, however, the following policy changes are critically needed:

Industry Trade Associations

- **Establish a centralized database with uniform data reporting standards.**

  Industry trade associations (such as NAESCO, Building Owners and Managers Association, International Facility Managers Association, ASHRAE, and the U.S. Green Building Council) should work together to coordinate data collection efforts related to the energy and non-energy benefits of energy efficiency projects. The lack of comparable data baselines for utility consumption, operations and maintenance costs per building type, per square foot, per building occupant, per hours of operation make it extremely difficult to quantify the range of benefits of ESCO actions. All public buildings, and thereafter, large private buildings should be mandated to submit annual updates on utility expenses at a very minimum, but ideally including the quantifiable non-energy benefits described above. A consistent approach to collecting and sharing data would aid aggregation, verification, and analysis so that performance standards could be clearly defined.

Government Agencies and Building Owners

- **Participate in utility demand response and utility rebate programs.**

  ESCO customers should make every effort to fully take advantage of utility incentive programs.

- **Promote the use of computerized maintenance management systems.**

  Complete a comparative field study on computerized maintenance management systems to develop recommendations for common measurements and reporting of utility, operations and maintenance costs. Use this field study to build the first generation of the centralized database with uniform data reporting standards.

- **Track the number and cost of responding to building occupant complaints as a primary measure of lost productive time.**

  While health and productivity may be difficult to track due to privacy and complexity issues, building complaint numbers, specific types of complaints, and response costs can be tracked uniformly across buildings. Establish the units and means of tracking complaints in the database, and mandate public sector compliance. Consider developing a survey to assess possible work time lost by building occupants linked to specific complaints (e.g., burnt out lights, too dark, too bright, too cold, too hot, too stuffy, air quality complaints, mold, system failures), to further quantify the benefits of preventative maintenance and high performance systems.

- **Work with Human Resource (HR) professionals to track most accessible and uniform health and productivity measures.**

  Since human cost-benefits can be ten to one hundred times more significant than energy cost-benefits, it is imperative that building owners begin the process of tracking the most accessible and uniformly recorded health and performance gains. Two indices related to indoor environmental quality that would potentially be improved by energy efficiency retrofits that could be collected in a pilot effort: respiratory health costs (asthma, allergies, colds, flu) in pharmaceuticals and medical attention; and tenant turnover rates and costs.

- **Conduct occupant building satisfaction online surveys.**

  On-line user satisfaction surveys can be easily administered to track user satisfaction with thermal conditions, air quality, lighting, and other environmental conditions as a building is improved through commissioning and renovations. User perception of health and productivity can also be assessed to see if overall trends improve with energy efficiency retrofits, and for possible correlation with measured health and productivity at task in buildings where this is available.

- **Switch from annual budgets to at least three-year budgets for utility, operation and maintenance costs.**

  This policy should be enacted immediately for all public buildings and strongly encouraged for privately owned buildings through State incentives, to ensure that energy efficiency projects can be evaluated using an appropriate economic timeframe. The inability to justify the proper analysis of energy retrofit investments due to the obsession with annual budget cycles is a serious deterrent to implementing energy efficiency projects.

ESCOs

- **Quantify the value of load shedding, utility system capacity savings and line loss savings from energy efficiency projects.**

  Establish standardized metrics - power plant by power plant - for energy, water and emission benefits of demand side management and peak load shedding, including line loss savings, from energy efficiency projects. Appropriate valuation of avoided utility system costs can accelerate policies and incentives for energy efficiency. The value of on-site power generation from a

range of fuel sources, with energy 'cascades' such as CHP or other multiplying benefits should be quantified in the same data base relative to energy, water and emissions.

- **Establish calculations for all emissions avoided by energy projects.**

  While power plant emissions will often be the most significant emissions costs for energy use, it is critical to quantify other contributions to emissions including line loss energy, water use energy, fuel source and transport energy, as well as waste management energy and emissions. Establish a 'cradle to cradle' calculation for all emissions avoided by energy projects.

- **Encourage continuous commissioning for large buildings.**

  The payback for commissioning is less than three years in energy savings alone, without attempting to quantify health, performance or even facilities management savings. Consider mandates for continuous commissioning of all public buildings and encouraging commissioning of private large buildings.

Many of these recommendations align closely with requirements for certain credits available through LEED-EB. There is an opportunity for government agencies and building owners to track these NEBs and help toward attainment of LEED or other certifications.

Final Recommendation

A follow-up research project should be undertaken based on the recommendations above. Such research should be focused on state and federal government office buildings because most of these types of buildings:

- Have owners who should take the opportunity and be responsible for providing leadership in the market transformation to more sustainable buildings
- Are individually metered
- Have higher occupancy (number of persons per square foot) than other building types
- Usually have significant deferred maintenance
- Have long-term stable occupancy
- Are similar to private office buildings (in terms of size and number of persons per square foot)

List of Sources

Cleaner Energy, Greener Profits: Fuel Cells of Cost-Effective Distributed Energy Resources. Joel N. Swisher, Ph.D, P.E. Snow Mass, CO: Rocky Mountain Institute. 2002

Fact Sheet on Air Quality Environmental Defense. November 2002

Benchmarking Air Emissions of the 100 Largest Electric Power Producers in the U.S. Table 1, 2006 Emissions Data. www.nrdc.org

Planning and Reporting for Operations and Maintenance in Federal Energy Savings Performance Contracts. Prepared by Operations and Maintenance Working Group, approved by Federal ESPC Steering Committee. February 2007

Field Performance Reviews of Green and Sustainable Buildings. Catherine Turner. White Salmon, WA: New Buildings Institute. Presented at the 2007 IEPEC, Chicago IL. August 2007

Energy Reductions through Practical Scheduled Maintenance: Final Report. National Center for Energy Management and Building Technology. Report #061102. Michael Chimack, Jonathan Aardsma and Davor Novosel. Joint Research Project with the University of Chicago (Illinois). 2006

Moving Toward Transparency and Disclosure in the Energy Performance of Green Buildings Adam Hinge, Donald Winston, and Byron Stigge. Presented at the 2006 ACEEE Summer Study on Energy Efficiency in Buildings

Tracking the Benefits of Retro-Commissioning: An Integrated Measurement and Verification Approach. David Jump, Kris Kinney, Matt Denny, and Raoul Abesamis. Presented at the National Conference on Building Commissioning. April 2006

Indoor Environmental Quality, Energy Usage and Occupant Perception in Commercial Office Buildings. D. Novosel and L.D. Stetzenbach. National Center for Energy Management and Building Technology. Modified January 5, 2006

Green Value: Green Buildings, Growing Assets. Edited by Ross Davies. 2005

Commissioning Energy Performance Contracts. George Malek and Al Ficcardi. Presented at the National Conference on Building Commissioning. May 2005

The Cost and Benefits of Commissioning LEED-NC ™ Building. Peter C. D'Antonio. Presented at the National Conference on Building Commissioning. May 2007

Persistence Tracking in a Retro-Commissioning Program. By Mike Eardley. Presented at the National Conference on Building Commissioning. May 2007

Practical M&V for Re-Commissioning Projects. By Russ Chitwood., Jim Bradford and Chenggang Liu. Presented at the National Conference on Building Commissioning. May 2007

Commercial Commissioning Research and Development: Summary of Interview Results. California Commissioning Collaborative. Prepared by PECI. April 2007

Small is Profitable: The Hidden Economical Benefits of Making Electrical Resources the Right Size. Amory B. Lovins, E. Kyle Datta, Thomas Filer, Karl R. Rabago, Joel N. Swisher, Andre Lehmann, and Ken Wicker. Snow Mass, CO: Rocky Mountain Institute. 2002

Implementation of Continuous Commissioning in the Texas Lone-Star Program (Can you Achieve 150% of Estimate Retrofit Savings) "Revisited". David E. Claridge, Mingsheng Liu, Yeqiao Zhu, Mustafa Abbas, Aamer Athar, Jeff Haberel.

Monitoring Base Commissioning: Early Results from a Portfolio of University Campus Projects. Karl Brown and Mike Anderson. Presented at the National Conference on Building Commissioning. April 2006

Canadian Healthy Workplace Criteria. National Quality Institute in partnership with Health Canada. For more information, contact www.nqi.ca. October 2005

"Facility Factor: Can Buildings Boost Productivity?" David Kozlowski, ed. *Building Operating Management*. August 2004

Public and Institutional Markets for ESCO Services; Comparing Program, Practices and Performance. LBNL 55002. Nicole Harper, Charles Goldman, Jennifer McWilliams, Dave Birr, and Kate McMordie-Stoughton. March 2005

*"*How IEQ Affects Health, Productivity", *ASHRAE Journal*. William J. Fisk.

"Re-analysis Summary: Daylighting in Schools, Additional Analysis", *Summary Prepared by New Buildings Institute on behalf of the California Energy Commission*, PIER Program. Full report prepared by Heschong Mahone Group. Lisa Heschong, author. February 14, 2001.