Energy-Savings Survey: Detailed Findings

FMs have accomplished much in terms of energy-savings measures, but many more are identified that need to be done.

By Peter S. Kimmel, AIA, IFMA Fellow

This survey was a collaborative effort among FMLink, the U.S. Green Building Council (USGBC), BOMA International, and the Association for Facilities Engineering (AFE). It was done to assess energy-savings measures in commercial, industrial, government, academic, medical, and other types of non-residential facilities.

The survey asked respondents—facilities and property managers of both corporate-owned and leased space—to address energy-savings practices and products within a single building. The results of this survey will help companies identify their *best practices* for energy efficiency—which strategies worked well, which didn't, and why—as well as identify opportunities for cost effective energy efficiency upgrades.

This paper is divided into the following sections:

- Methodology used for the survey
- Overview of findings
- Existing situation: building descriptions and best practices
    - Building and geographic data
    - Energy-related building and system configurations
        - HVAC equipment and controls
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        - Roofing
        - Windows
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    - Energy performance measures, green certifications and leases
- Energy audits and energy savings experienced to-date
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- Plans to upgrade or improve energy savings
- What else can be done?

This contents of these *Detailed Findings* are presented in summary form in a separate report, *Energy-Savings Survey: Summary of Findings*.

Methodology Used for the Survey

The survey was developed by FMLink with support from each sponsoring organization as well as technical support from several members of the USGBC LEED for Existing Buildings Corresponding Committee (EBCC).

The survey was run online from August 28 – September 29, 2008. It was promoted through mailings to members and subscribers of each of the collaborating organizations, representing over 30,000 people. In addition, each organization promoted it through its own Web site. A total of 676 individuals responded to the survey; 268 of them completed all questions in the survey. The analysis focused on the responses of those who completed all the questions.

The survey respondents consumed more than 2.36 billion kWh of electricity during 2007, which is a very significant number, and certainly large enough from which to draw major conclusions. All fuel (electric, natural gas, propane, oil, chilled water, steam, solar) was converted into MMBtu, for comparison

purposes—a total of 6,496,000 MMBtu (energy used at the site, not energy consumed from the source, which is much greater) were consumed by the respondents.

> Each kWh consumed *at the site* is 3,415 equivalent BTUs of energy, but it takes 10,000 BTUs *at the source* to get the energy there, because of the inefficiency of electrical generation and utilities. When most others discuss about reducing carbon footprint, they referring to reduction at the source, not the site. So for each kWh reduction at the site, there will be approximately three times that amount at the source.

The survey took respondents an average of 30 minutes to complete, and required respondents to have access to their prior year's utility statements. The sponsoring organizations were hoping that because the subject matter was of so much interest to all, people would be willing to spend the time and effort necessary to participate. The high response rate indicated that these hopes were achieved.

Overview of Findings

The survey clearly identified how much the respondents have paid attention to energy conservation, especially in recent years. Part of this is reflected by the significant increase in energy audits performed over each of the past three years, exhibiting the increased need to find solutions.

There was little doubt that the realities of the current economy, coupled with most organizations' budgeting processes, have impacted how audit recommendations have been implemented. There was a clear trend in the increase in implementation of the low-cost, "low-hanging fruit" operational strategies, while fewer implemented major capital projects. Thus, there were many more who implemented operational changes using equipment or controls (sensors, timers, etc.) rather than major capital projects. Nonetheless, both types of upgrades resulted in significant energy savings.

The respondents also showed that they are more savvy than ever before. With only a few exceptions (usually those involving some of the more technical items typically recommended by professional engineers), improvements implemented by those who had audits were strikingly similar to those who did not have audits. This indicates that efforts made in recent years by professional associations have made an impact on how building professionals are prioritizing their objectives.

Not content to stop where they are, most respondents plan to implement many more energy-saving strategies over the next few years.

The survey also detected two interesting profiles of respondents:

a) **High- versus low-technical training.** While the survey indicated that most respondents are close to being as knowledgeable about many operational areas as professional engineers, there seem to be a few areas where they are not. We found that while the non-professional engineer group was equally likely to implement many of the most effective energy-savings solutions, it was less likely to implement those where more technical expertise was required.

b) **All-or-nothing approaches to energy savings**. For most of the findings, as the percentage of space with an energy-savings strategy increased (e.g., lighting sensors), there were fewer respondents who had implemented them. This is expected. However, in many cases, especially for those operational changes that were least costly to implement (e.g., lighting sensors), there was a noticeable uptick at the extremes where respondents had implemented the strategy for greater than 90% of their space.

   Those who are implementing solutions for nearly all their space may be an acknowledgement that some type of improvements require a facility-wide implementation strategy to be effective. The spike at the tails also may reflect the attitude of some organizations with a mindset to implement everything they can to save energy, while at the other extreme, a mindset not to spend anything.

Overall, the survey's results indicate that facilities managers are much more aware than ever before about energy-savings techniques. Continuing education and easily understandable solutions are always

needed and will continue to be effective. Energy audits and continuous re-commissioning seem to yield positive results and should be encouraged; but the real savings from energy audits result from the implementation of the results.

As more time passes and it becomes time to replace major capital expense items in buildings, such as HVAC and roofing systems, significantly more savings will be realized. For these savings to be maximized, the building professional may need more information and education.

Existing Situation: Building Descriptions and Best Practices

Building and Geographic Data

Geographic Data

Of the 268 buildings that completed the survey, 208 were from the United States, 9 were from the UK, and 8 each from Canada and India (See *Figure 1*).

Region	Number of Participants
North America	216
Asia	18
Europe	16
Africa	6
Australia	4
Atlantic Islands	4
Middle East	3
Central America	1
TOTAL	**268**

Figure 1. Geographical distribution of survey participants.

Building Age

The distribution of the building ages is very representative of generally available building data. 83% of all buildings are between 4 and 50 years old, with more in the 21-50 age bracket than in the 4-10 bracket. See *Figure 2*.

Number of Floors in Buildings

Most buildings (54%) were low-rise (2-5 floors). Only 7% of the buildings were taller than 20 stories, and 16% were single story. See *Figure 3*.

Building Size

The buildings were fairly evenly divided among five groupings: those under 50,000 sq. ft., those 51-125,000 sq. ft., those 126-250,000 sq. ft., those 251-600,000 sq. ft., and those greater than 600,000 sq. ft. See *Figure 4*.

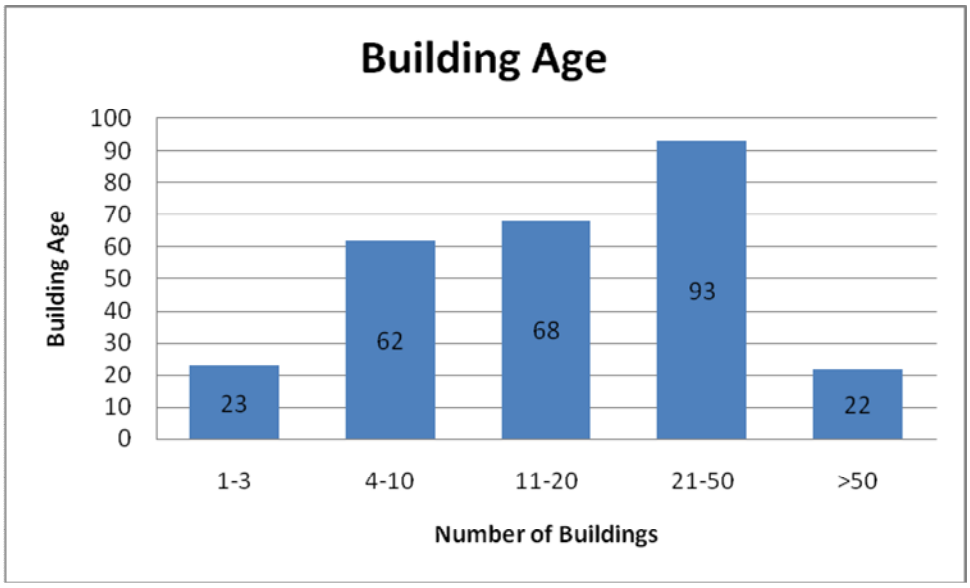

Figure 2. Age of buildings managed by the survey participants.

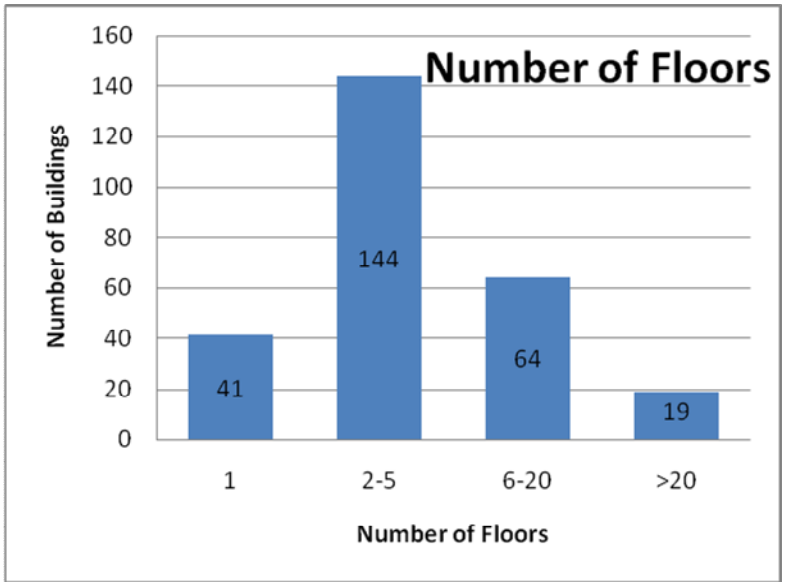

Figure 3. Number of floors in buildings managed by survey participants.

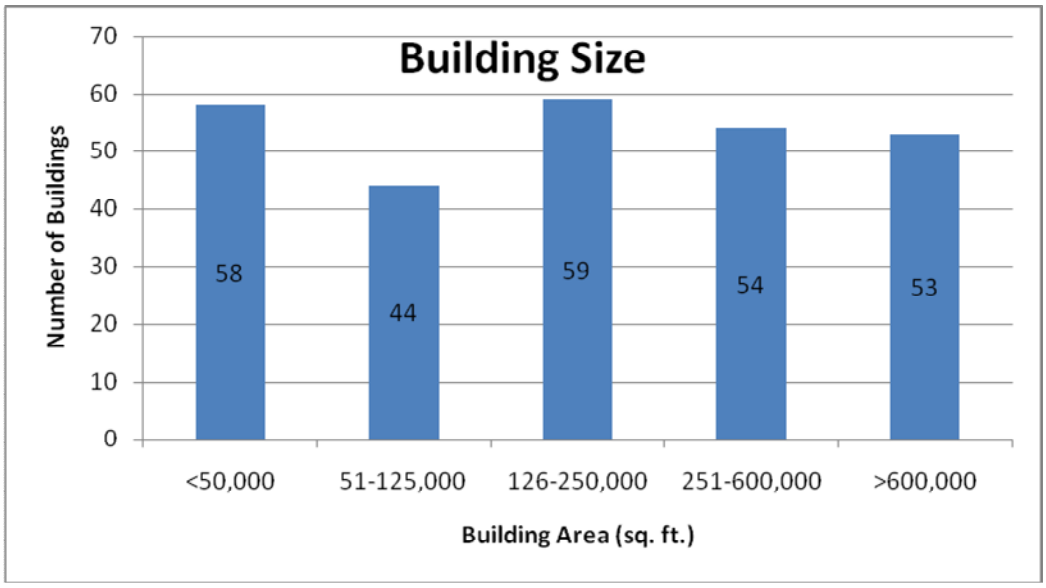

Figure 4. Sizes of buildings managed by survey participants.

Building Types

The types of buildings were very representative of the types of buildings that exist. Most (53%) were office buildings, followed by manufacturing facilities, medical or hospital, educational, and then research or lab. There were less than ten of each other building type. See *Figure 5*.

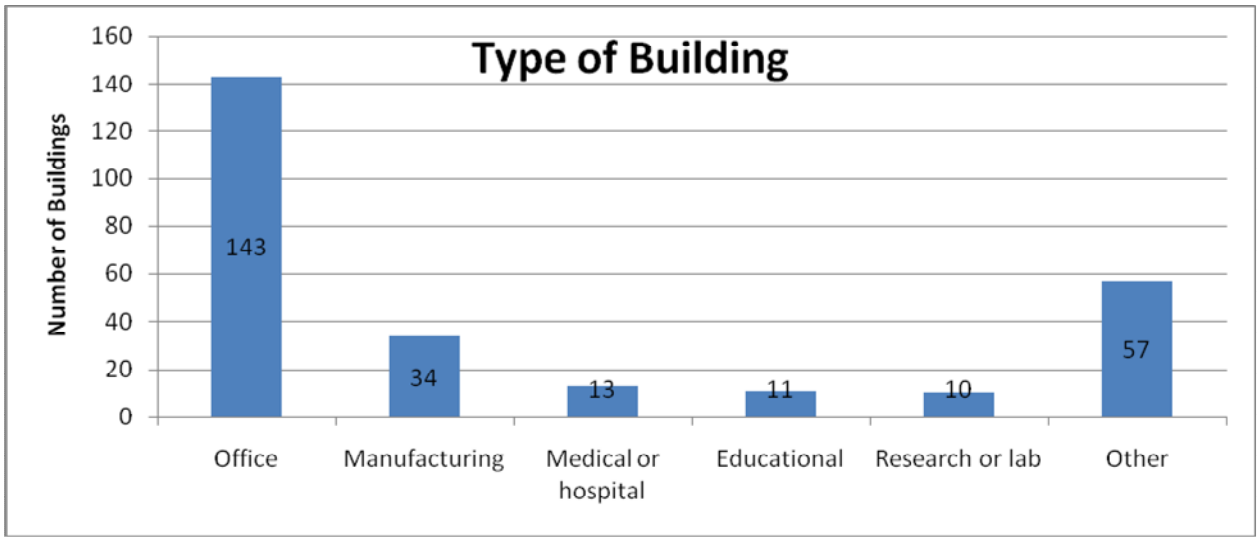

Figure 5. Types of buildings managed by survey participants.

Building Climate

The buildings represented a wide variety of climates; climate was measures by one of the methods used by EPA, where each climate is defined in terms of its Temperature and Humidity. 26% were in a Mixed Humid climate (e.g., Washington, DC, Philadelphia, New York), 17% from Cool Humid (e.g., Toronto, Pittsburgh, Chicago, Boston). The next largest representation, with less than 10% each, were Very Hot,

Humid (e.g., Singapore, Rio de Janeiro, Mumbai, Miami, Honolulu), Hot, Humid (e.g., Houston), Warm, Humid (e.g., Tokyo, Seoul, Milan, Dallas, Atlanta, Buenos Aires, Brisbane), and Mixed, Marine (e.g., Sydney, Seattle, Paris, Melbourne, Berlin). All others were 5% or less.

Other Building and Participant Characteristics

74% owned their buildings. 34% of the total leased out part of their buildings (this includes some of the 26% who leased their buildings and then subleased a portion of that space).

78% of those who own their buildings were from the private sector; the remaining 22% of owned buildings were federal, state/province or local government facilities.

20 of the buildings (7.5%) were considered historic (a seemingly high number).

The respondents were members of a wide range of professional associations and organizations. Some people said they were members of multiple organizations:

- BOMA (75)
- IFMA (52)
- AFE (52)
- ASHRAE (47)
- ASGBC (46)
- AEE (33)
- All others (12 or less each organization)

Energy-Related Building and System Configurations

Energy Sources

Respondents identified the primary sources for several types of energy usage. The most frequent responses for each type of energy usage:

- Space Heating (37% electric, 37% natural gas, 14% hot water)
- Air conditioning (67% electric, 30% chilled water)
- Hot water (43% electric, 38% natural gas)
- Lighting, plug loads and process loads (each was >90% electric)

Other than natural ventilation, less than 5% are using any alternative energy savings strategies such as solar, wind, biomass, and geothermal.

HVAC Equipment And Controls

Figure 6 depicts the primary HVAC systems and component in place in the respondents' buildings. Each was named by at least 10% of the respondents (respondents were allowed to select multiple items).

Localized Ventilation Controls. Most respondents did not have *localized ventilation controls* (53%), while only 18% did not have individual temperature controls (some may have interpreted an adjustable thermostat in their general office space as "localized."

Off-hour Controls. Nearly two-thirds of the respondents had *off-hour controls* for their HVAC system, while only 20% had off-hour controls for fan motors greater than ¾ horsepower.

43% of the respondents said that all their air supply and exhaust hoods, vents, and ventilators are equipped with *dampers* to close automatically when spaces served are not in use (47% were not equipped, and the rest did not know). We were a bit surprised that so many respondents had buildings that were equipped with such dampers.

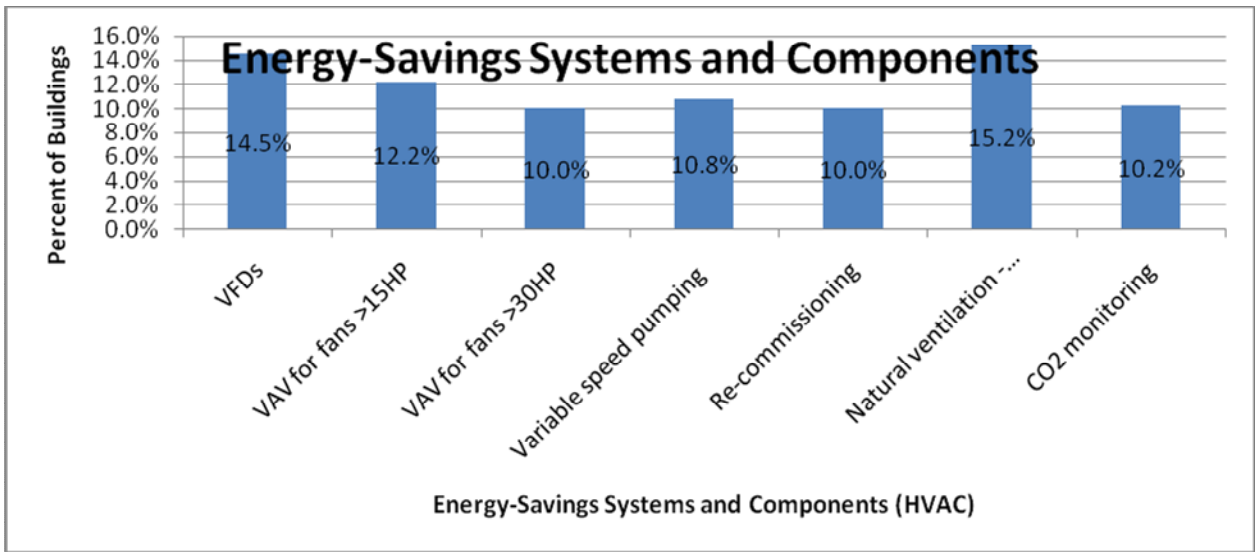

Figure 6. Energy-savings systems used by survey participants (participants were allowed to select more than one system; only systems used by at least 10% of the participants are shown).

Building Automation Systems (BAS). More than three quarters of the buildings greater than 50,000 sq. ft. had *building automation systems*. 87% of those with more than 600,000 sq. ft. had BAS. We could not identify a reason for why the remaining 13% of those with large buildings did not have a BAS—there was no correlation to building age or whether a building was historic; thus, this may be an example of an opportunity for significant improvement. It should be noted that most who experienced a greater-than-5% energy savings over the past two years had implemented a BAS.

> Of those who have a BAS, 98% use it for A/C, 87% for space heating, 67% for ventilation schedules and results, 65% for chilled water, 52% for interior lighting, 51% for exterior lighting, 44% for electrical consumption and demand per hour, 43% for O/S air control and CO_2 monitoring, 42% for electrical consumption of HVAC and chilled water systems, and 37% for continuous re-commissioning and demand (to ensure good performance).
>
> Upon examination of the large buildings without BAS, we found that these buildings consistently followed the least amount of best practices; e.g., only one-third had a Building Operating Plan, none had re-commissioning, and only half had an energy audit in the past 5 years. In other words, they had generally ignored many of the commonly accepted energy best practices.

HVAC Filters. A large number (59%) did not know the *MERV rating* for their HVAC filters (the higher the MERV rating, the more efficient the filter is). Of those who did know, 32% claimed a MERV rating of less than 9 (very inefficient), 38% were 9-12, 26% were 13-16 (very efficient), and 4% had a MERV rating greater than 16. There is usually a direct relationship between the MERV rating and the cost of the filter.

HVAC Policies and Procedures. 91% of all respondents said that they follow the preventive maintenance programs for all HVAC equipment, as recommended by manufacturers.

When asked which standards are followed for their HVAC system, 50% said they either did not know of or did not follow a standard. 33% followed either the ASHRAE 90.0 2001 or 2004 standard (a few more for the 2004 one), and 15% mentioned ENERGY STAR. More education would clearly benefit the facilities manager in this area, as well as that of MERV ratings.

Half of the respondents report having a policy of procuring only ENERGY STAR Rated devices when they exist. One-third said they don't have such a policy, and the remainder said they don't know. Again, more education would help here, especially, as will be shown below, there is a relation between having such a policy and realized energy savings.

CO_2 monitoring for outside air makeup control by a building automation system was identified as an area where more education is required. This is often in the bailiwick of professional engineers.

Building Operating Plan. 68% said they have a *building operating plan* that describes how the building is to be operated and maintained; slightly less than an additional 12% said they intend to implement such a plan in the next 12 months (this would leave only 20% without a plan).

Most plans (58% of those with plans) were developed in-house (versus professionally developed). The following were included in their plan by at least 88% of the respondents:

- Occupancy schedule.
- Equipment run-time schedule.
- Design set-points for all HVAC equipment (by day of the week for 72%).

The following was included in 67% of the plans:

- Design lighting levels throughout the building.

Training Programs. 41% of the building operating plans included a *professionally-developed energy-strategies staff education program*. Less than 12% of the respondents said they plan to implement such a plan in the next 12 months. This means that in one year, nearly half of the buildings still would not have a professionally-developed staff education program.

For those who had such education programs, the following sources were identified as the program or developer of these programs:

- Outside consultant (38%).
- EPA ENERGY STAR (36%).
- BOMA Energy Efficiency Program (BEEP) (18%).
- USGBC (8%).

Though available only in the United States, ENERGY STAR's training programs are delivered via Webinar and are often free of charge. Energy efficiency training provided by industry associations, including those of BOMA, also did not appear to be utilized often by the respondent group—another surprising result, given that these programs often share best practices and case studies developed by industry peers; many of these programs are often offered at no charge or for a nominal fee, and can even be done as a Webinar so one does not have to leave their site.

Lighting

Nearly all light was from *overhead fixtures* (>80%); the rest were from task and ambient. When asked about their primary lamp types for overhead fixtures, most stated T8 fluorescent. See *Figure 7*.

78% per the respondents had *electronic ballasts* in at least 80% off their space, and another 11% in at least 60% of their space. Although there clearly are many more electronic ballasts than magnetic ones, there still are a large number of the latter; because nearly all have a high percentage of their space with electronic ballasts, we conjecture that most are not in the primary office spaces.

59% of the respondents have *occupancy sensors* in their general office space, which shows great strides over the past decade. It also implies that the other 41% of the respondents are in the position of improving their electric consumption by adding occupancy sensors in their general office space. One third of those who had sensors had them in less than 10% of their general office space, so there is room for improvement there as well. Because of the relatively low cost of implementing sensors, this points to another opportunity for education and outreach to increase awareness on low-cost options

Another 20% had sensors in less than 10% of their general office space. As expected, as the percentage of space with sensors increased, there were less people who had sensors in those larger amounts of space. However, there was a slight *increase* for those who had over 90% of their space with sensors. Although there are not enough data to corroborate this finding, it indicates that there may be some facilities and building managers who want to take care of as much of their space as they can. See *Figure 8*.

This trend repeats itself, and even more pronounced, when looking at the results for the percentages of rest rooms, conference rooms and individual offices with sensors (see *Figure 9*). When the results for the general office space are combined with this trend for sensors in the other spaces, the results are quite compelling: for many people, there seems to be a mentality of treating all or none of one's spaces with sensors.

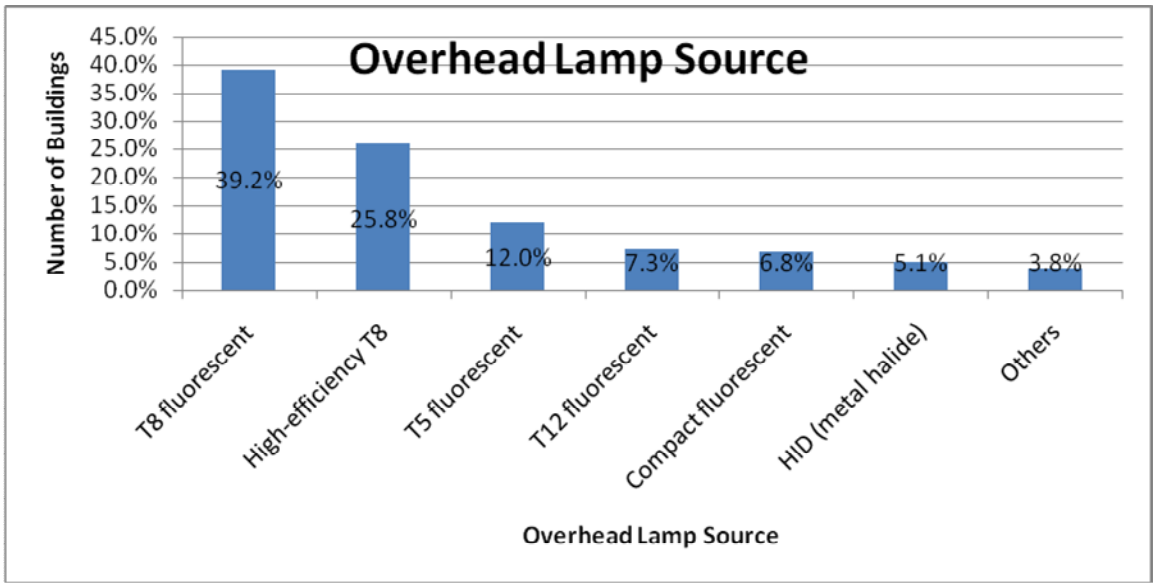

Figure 7. Overhead lamp sources used by the survey participants. There now are nearly as many using energy-efficient fluorescents as the less efficient bulbs.

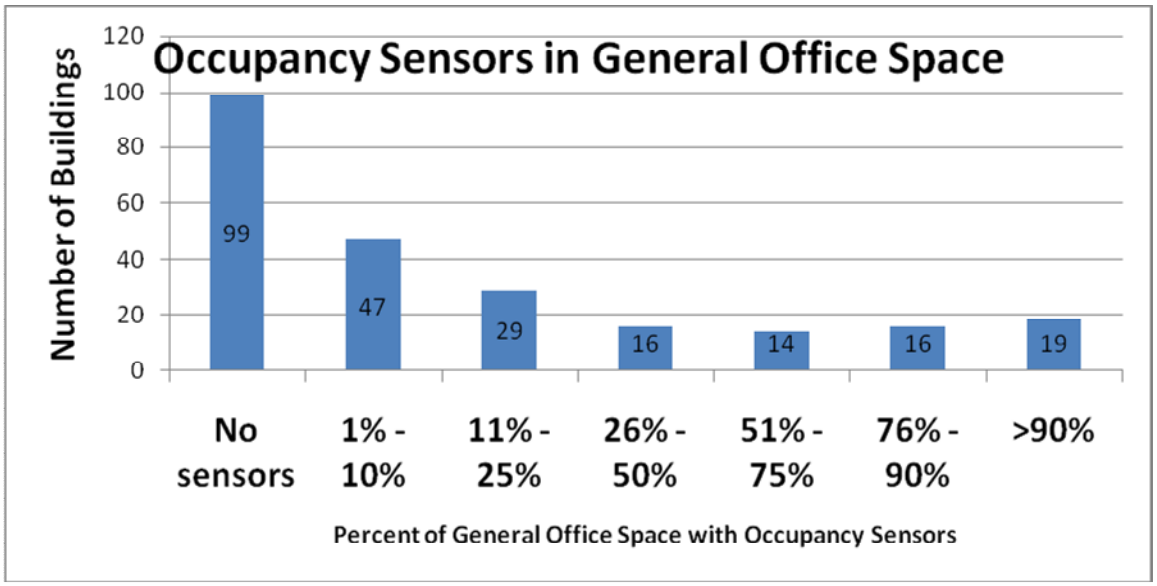

Figure 8. Use of occupancy sensors in general office space by survey participants..Notice that there is a downward slope from left to right, and then a slight upward slope for those with more than 75% of their space having sensors. See the text for an explanation.

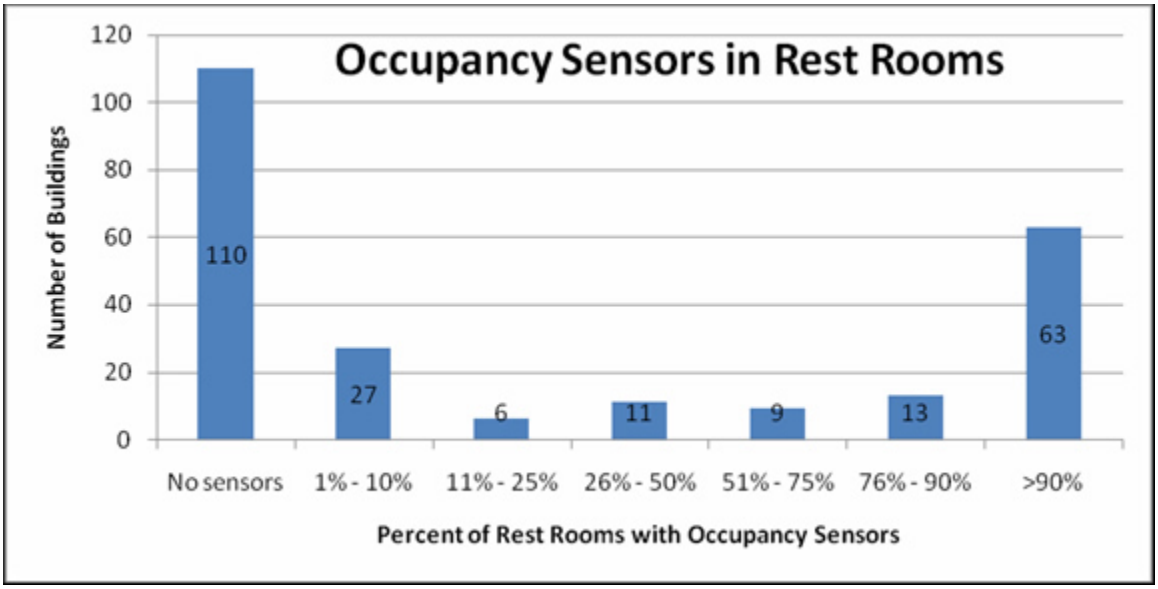

Figure 9. Use of occupancy sensors in general rest rooms. The curve on the above chart is more pronounced than on that for the conference rooms. This shows that fewer buildings have sensors in their restrooms as the percentage of restrooms with sensors increases for each building. Note the steep increase in the number of buildings with a high percentage of restrooms with sensors at the right side of this chart, indicating that there are many facilities that try to implement some energy savings initiatives to the fullest extent possible. Occupancy sensors are indicative of the low-hanging fruit—one of the least costly energy-savings measures that one can implement.

Most respondents do not have *daylight sensors* in their general office space (76%, with another 8% having daylight sensors in less than 10% of their general office space). This trend has clearly not yet started to take root.

Of those who do not have daylight sensors in their general office space, most (60%) do not have *timers* either. Of those with timers, 20% do not synchronize their lights with the times of the cleaning crew shifts, 49% keep the lights on until the crew is scheduled to leave, and 31% have the lights go off after hours, on again when the crew arrives, and then off again.

22% have *lighting sensors in their parking areas*.

Lighting Policies and Procedures. Only 5% have occupant training manuals available to their employees. 15% have energy-related requirements for all new lighting purchases.

Roofing

37% of the respondents had asphalt-based roofing (built-up, modified, etc.), the most common roof-type among participants.

Green Roofing Systems. Less than 1% of the respondents have a green roof. 87% said they either don't plan to get one, or if they did, it would be at least five years away. This is not surprising given the long life expectancy of roofs, the cost to replace, and the relatively longer pay-back period associated with green roofs, especially in today's economy.

This also points to an area where public policy could be used to incentivize roof replacements—typically a major capital expenditure. In 2007, during the 110th Session of Congress, the Realistic Roofing Tax Treatment Act of 2007 was introduced in the U.S. House of Representatives and would reduce the depreciation recovery period for roof systems from 39 years to 20 years. No action was taken but it is expected to be introduced again when the 111th Session convenes in 2009.

Nearly half the respondents (44%) said they know very little about green roofs, and 47% said they were somewhat familiar; 9% were very familiar. This is an area where education would be of great value.

Reflective Roofing Systems. 46% have a reflective roof, and another 35% don't plan to get one; another 13% said they won't get one for at least five years (probably when their roof would be replaced). 51% said they know very little about cool roofing systems, and another 40% said they were somewhat familiar. Again, some education here would be useful.

Photovoltaic Roofing Systems. 7% have photovoltaic integrated roofs; 74% don't have solar and don't plan to get one; 12% said they won't be getting one for at least five years.

Windows

Tinting and Insulation. Most respondents (53%) said their windows are either tinted or insulated, and the rest 47% have both tinted and insulated windows.

Operable windows. 70% of the respondents said less than 20% of their windows were operable.

Window Coverings. 56% said they have neither mechanically-operated coverings nor insulated shades or drapes. 26% have insulated, manually-operated shades or drapes. Less than 1% have mechanically operated coverings triggered by sensors or timers. The remaining respondents (17%) have mechanically operated coverings, but no sensors or timers.

Fuel Consumption

Most fuel consumption was electric. The survey respondents consumed over 2.36 billion kWh of electricity during 2007, which is a very significant number, and certainly large enough from which to draw major conclusions. The buildings from the United States represented 94.5% of the total electricity consumed.

All fuel (electric, natural gas, propane, oil, chilled water, steam, solar) was converted into MMBtu, for comparison purposes. The USA consumed 68,890,000 MMBtu (68,890,000,000,000), while the global database consumed 6,496,000 MM Btu. So the USA represented 91.4% of the total fuel consumed in the survey.

Note that buildings where there may have been apparent errors that would have skewed the database significantly were removed from the above calculations, but remained in all other portions of the survey that did not use fuel consumption data. Examples of such buildings included buildings where the respondent may not have noticed our use of "000" with numbers provided. We also removed anomalies such as data from a cruise ship, which consumed 381 million gallons of oil (more than the rest of the database combined).

Within the USA, usage was highest for electricity, natural gas and steam in Cool Humid to Subarctic states, as expected. Propane use was concentrated in Warm Humid to Mixed Marine states, which includes states where there is not a significant availability of natural gas.

Unfortunately, because the square feet were reported by ranges—ideal for determining differences between small-medium-large buildings for other analyses—we could not make comparisons on a per-square-foot basis for fuel consumption purposes, so that analysis is not included in this survey.

Alternative energy sources—payback. The payback for use of solar energy is faster than we expected—thirteen out of eighteen who had implemented solar panels expected payback in less than nine years. We believe that this is probably because of influence of tax incentives, which help defray

some of the up-front costs. The wind power payback is about the same as solar, according to the respondents.

Energy Performance Measures, Green Certifications and Leases

Energy performance measures. 30% of the respondents from the USA use EPA's Portfolio Manager to track energy performance (this program is not available outside of the USA). The rest use customized internal measures.

Green certifications. 9% of the buildings had some form of green certification (mostly ENERGY STAR® or LEED). However, a majority said they plan to obtain such certification in the future. A variety of reasons were offered for not obtaining such certification (see *Figure 10*). The most common reasons were that the respondents said they saw "little value in the designation", followed by "too expensive" and "little management support."

Additional education, especially of the "management" may be beneficial here; there also would be value in finding ways to bring down the actual and perceived costs of obtaining certification; for example, if those who certify buildings could generate statistics that demonstrate that those who achieve certification realize an average of an "x" percent reduction in utility costs, and that this far exceeds the cost of obtaining certification, that would be helpful. It also would be helpful for the development of tools to help one through the certification process so that there could be a reduction in the time required by outside consultants and engineers, this could reduce the cost of certification.

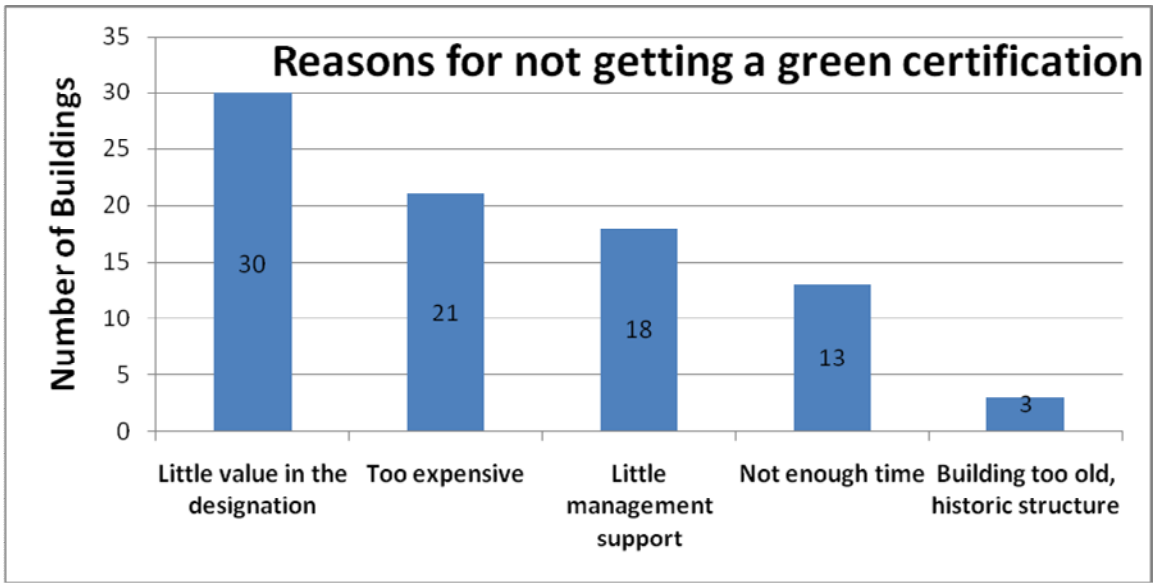

Figure 10. Reasons for not getting a green certification. Notice that in most cases, the reason is not that the building is unable to obtain certification due to its age or historic nature. All remaining reasons may be able to be reduced through more education of the facilities managers by those who offer certification.

Green leases. Of the one-third of the respondents who lease out parts of their buildings, 55% do provide an operations manual with good energy management practices to their tenants. The 45% who do not provide such a manual said they are not planning to have one in the next year.

66% said they don't have a green lease (a lease with legal language to facilitate ongoing implementation of sustainable building practices), nor are they planning to have one in the next year. However, we do expect this to grow dramatically over the next ten years—green leases are relatively new, and just now

are beginning to be more widely used for new leases and renewals. As more existing leases come up for renewal, it is logical to expect to see green elements added.

Energy Audits and Energy Savings Experienced To-Date

Energy Audits

73% of all buildings greater than 50,000 sq. ft. have had an energy audit. Conversely, 63% of those under 25,000 sq. ft. did not have an audit. See F*igure 11*.

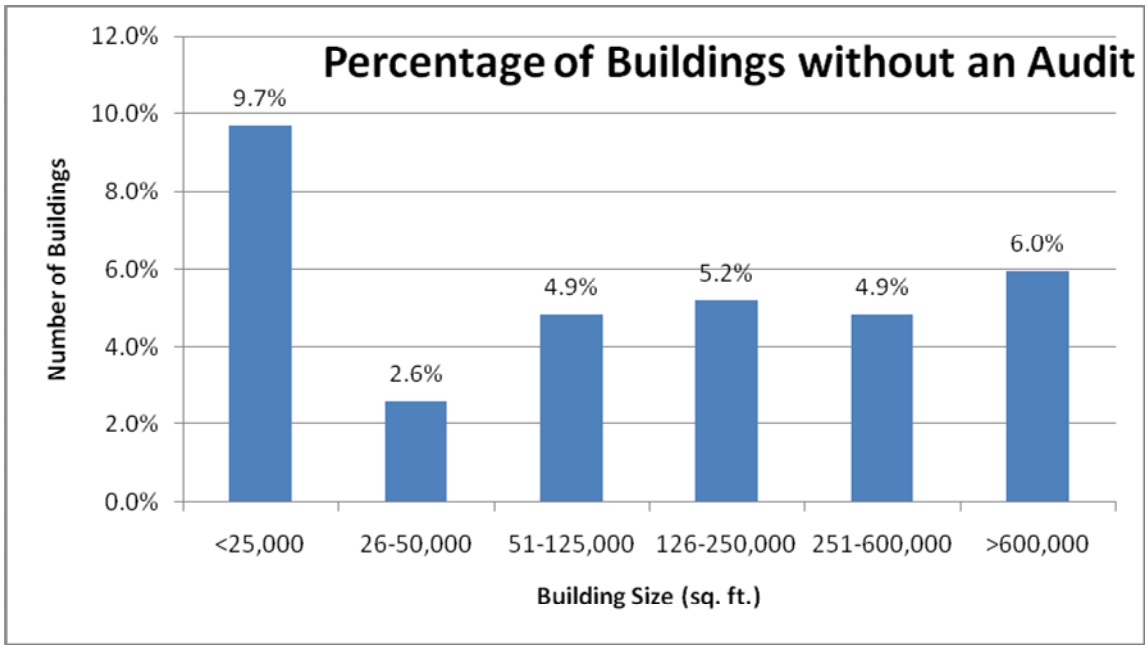

Figure 11. The above chart identifies the distribution of the 33% of the buildings surveyed that have not have an audit performed. The chart shows that the distribution is fairly flat for each building size, except that those with less than 25,000 sq. ft. are much less liklely to have had an audit.

86% of the audits were done in the past 5 years, and 64% in the past three years; 30% were completed in the past year (see *Figure 12*)—clearly a result of the recent importance of sustainability and the increased cost of fuel. With the strong trend of their being more energy audits over each of the past three years, these numbers are very encouraging.

Slightly more audits were conducted by engineering firms (36%) than by utility companies (24%) or by internal staff (30%). The remaining 10% of the audits were conducted by a variety of other methods.

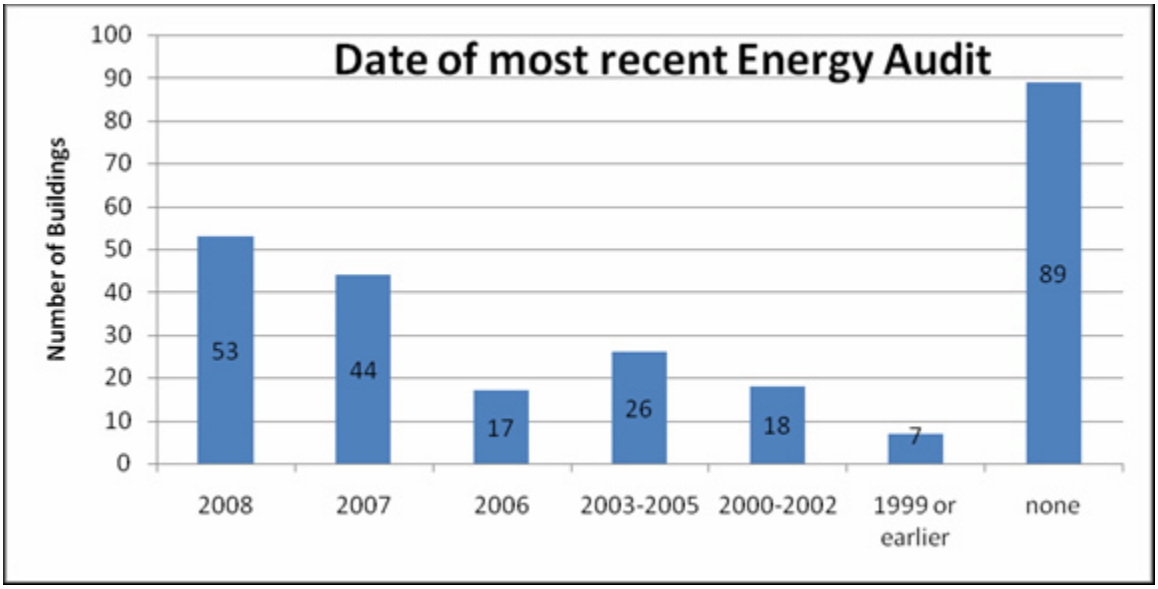

Figure 12. The above chart shows that there has been a clear trend of more audits in the most recent years.

Energy Audit Recommendations. Respondents were asked to name a maximum of five recommendations made by their audits.

The most mentioned recommendations were lighting upgrades (with more than 45% for respondents with buildings greater than 50,000 sq. ft.), and HVAC upgrade/replacement (chiller, air handling unit, boiler, pumps, outside air), which were mentioned by 34%. For those with buildings smaller than 50,000 sq. ft., weatherstripping and insulation were frequently mentioned. See *Figure 13*.

> The area of energy audits represents another area where public policy could play a positive role by offering tax deduction or rebate programs to help with the out of pocket costs of an energy audit. Several local BOMA associations are working cooperatively with their utilities to bring energy audit programs – at a reduced rate – to their members as part of their overall demand reduction programs.

Savings To-Date and Techniques Used to Achieve Savings

Overall, the respondents averaged energy savings of 5-10% over the past two years. 57% of those measured their savings through the money expended on utilities, energy consumed or ENERGY STAR score. An additional 23% used some form of internal analysis. There were more respondents who measured their savings through the money expended than the actual energy consumed, perhaps because those numbers may be easier to track from existing company records.

The overwhelming majority of those who saved energy identified the cause as operational changes using equipment or controls (sensors, timers, etc.)—76% selected this as the #1 or #2 cause. Many fewer identified major capital projects (41%)—we surmise that this is because fewer people made such changes, in large part because of their significantly higher costs. 42% identified operational changes from occupant behavior or tenant occupation, but one-third of these selected this as the #1 reason. 35% identified minor repairs or corrective maintenance.

Those who have had an energy audit seemed to have slightly better energy performance than those without. Those who did not undergo an energy audit experienced an energy reduction of 7%, while those who have had an energy audit had just under 9% savings. Based on the responses received, there is a possibility that the reason for the small difference is that it takes time to implement some of the

recommendations (especially those that are major capital projects), and they may not have been done yet; there were not enough data to draw valid conclusions and we recommend that future research focus on the measurement of savings from implementing audit recommendations.

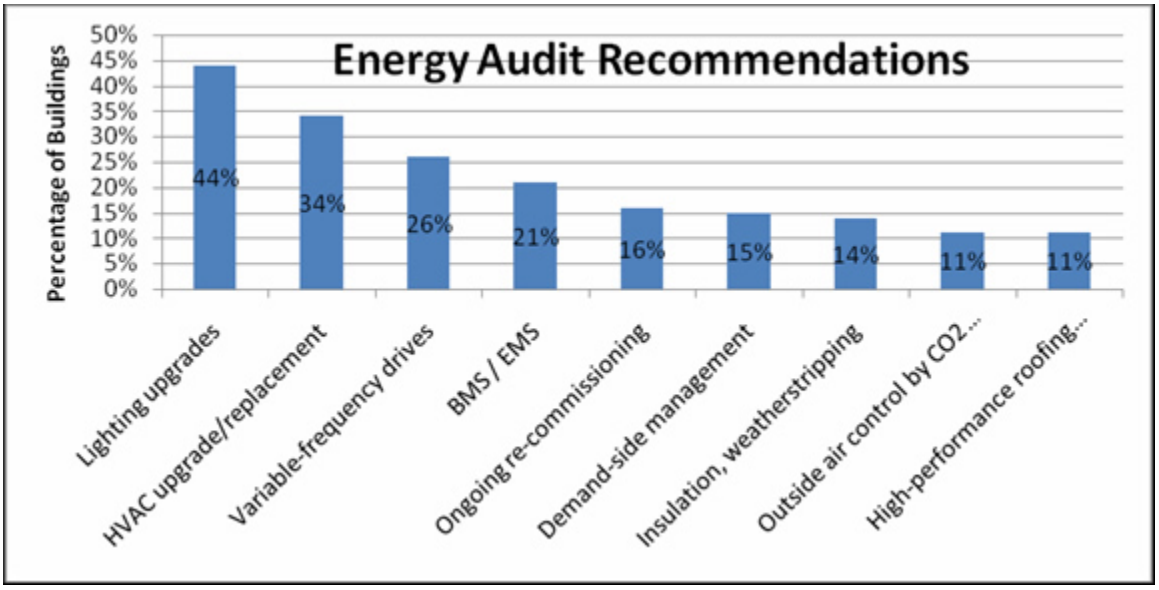

Figure 13. Note in the above chart that most of the energy audits' recommendations related to HVAC systems.

We then examined the percent improvement in energy savings and compared it to some of the buildings' attributes and energy-related policies of the respondents' companies. By studying the savings claimed over the past two years, we noted the largest differences in savings from the following:

Re-commissioning. Those who have undergone re-commissioning two or more times a year had significantly more energy savings over the past two years than others (see *Figure 14*). There also was a noticeable difference between those who did it once a year and the rest of the respondents (up to 20% improvement), but not for as many as those who re-commissioned twice a year. Those who re-commissioned less than once a year showed at least a 5% improvement in energy savings.

Other opportunities for energy savings. We identified several other areas for potential savings, where are identified in the paragraphs below as well as in *Figure 15*.

> **Building operating plan; building automation system (BAS).** Each of these shows some savings by their implementation, but no discernable trend in terms of how much savings one may have. What is clear, however, is that by not implementing such a system, there will be significantly less savings. The other items below clearly showed that one is much more likely to have savings once they are implemented than from a building operating plan or a BAS. Nonetheless, most who experienced a greater-than-5% energy savings over the past two years had implemented a BAS.
>
> **Recent energy audit (past three years).** This had the largest impact on savings. 87% of the companies who had an audit in the past three years experienced over a 20% savings, while only 41% of the companies with a 1-5% savings had an audit in the past three years. Because of the results in the previous section (which showed that the overall savings from those with energy audits were just slightly ahead of those without audits), this section's finding may be a result

stemming from those that have the greatest savings are more likely to implement many best practices (including energy audits), and not necessarily that the audits themselves lead to the savings.

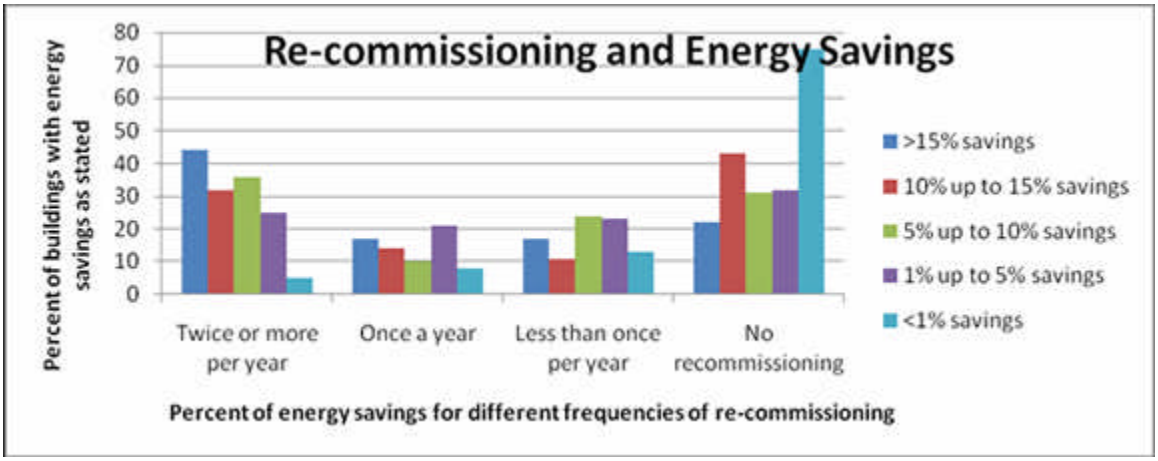

Figure 14. By looking at the buildings that have had re-commissioning at least twice a year there are clear indications that they are likely to have considerable energy savings (the height of each column trends downward from left to right). There were no such trends for re-commissioning when done once a year or less. When there was no re-commissioning the trend goes upwards to the right, indicating that one is less likely to experience energy savings. Note: The percentages of energy savings represent savings over the most recent two-year period.

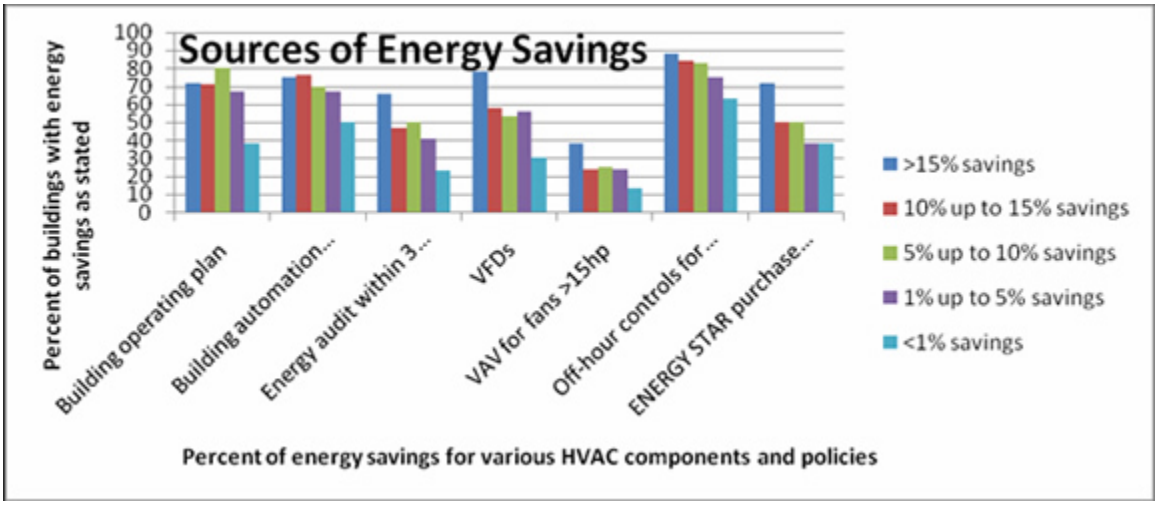

Figure 15. When looking at the first two sources in the above chart (building operating plan and BAS) one sees that the savings were flat for all but the last column, which was considerably lower than the others; this means that with these two sources, one is likely to have some savings but not necessarily a lot (and that without implementing these, there likely will be less savings). The remaining five sources have a downward trend, indicating that it is much more likely to have more savings as a result of their implementation. Note: The percentages of energy savings represent savings over the most recent two-year period.

Variable frequency drives (VFDs). VFDs seemed to separate those who experienced large savings from those who achieved moderate savings. Over three-quarters of those who experienced greater than 15% savings had VFDs, while less than 60% of those with less than 15% savings had VFDs.

Variable air volume (VAV) fans >15hp. Savings were indicated here as well, although not as pronounced as in the other areas in this section.

ENERGY STAR procurement rules. Those who had ENERGY STAR procurement rules saved much more energy than those without (65% of those who saved greater than 15% had ENERGY STAR procurement rules, while only 39% of those in the 1-5% grouping had them. While the rules themselves may not save that much energy, it is likely that those that have such rules have many other sound energy management practices in place.

Lighting sensors. There were indications that those with sensors in the rest rooms experienced savings (55% of those in the top savings group had sensors, while only 23% in the bottom group had them). Savings were less pronounced for those with sensors in their general office space (20% down to 11%).

Another interesting finding is that those in the best performing group (>10% improvement) consistently had more of the above sound building attributes and practices across the board than those in the worst performing group (<1% improvement).

Other energy-savings best practices. The practices listed below were also examined in the survey, but no discernable correlation could be detected with regard to experienced energy savings (this could be because there are so many variables that unless a trend becomes very pronounced, it won't be detected; there also may be too few instances of those with or without such practices to be able to draw any significant conclusions, and further research may be warranted).

Therefore, we caution the reader not to place too much importance in the best practices that are listed below—some of them may very well be a source of major energy savings. But for purposes of this study, the best practices listed prior to this paragraph showed definitive, significant trends, so we are confident that their implementation will lead to significant energy savings.

Best practices studied that did not show a significant correlation with energy-savings in this survey (read the previous paragraph to see how to interpret this list):

- Professionally developed strategies—staff education program.
- Outside air CO_2 monitoring by a building automation system.
- EPA's Portfolio Manager to track energy performance.
- Green certifications.
- Air supply and exhaust hoods, vents, and ventilators are equipped with dampers to close automatically when spaces served are not in use.
- Reflective roof.
- Mechanically operated or insulated shades.

Plans to Upgrade or Improve Energy Savings

HVAC

When asked which HVAC areas will be upgraded, installed, replaced or implemented over the next year, no item was named by more than 37% of the respondents. Responses included:

- Minor repairs or corrective maintenance – 37%
- HVAC equipment – 30%
- VFDs – 23%
- Ongoing re-commissioning – 21%

The high number for minor repairs and corrective maintenance reflects the awareness of the relationship between properly-running equipment and energy efficiency. The high number for HVAC equipment may reflect those waiting for equipment to require replacement before it is replaced (because of its high capital cost), and each year, this number will grow until most replace their equipment.

Items not on the top-priority list include building automation controls (14%) and CO_2 monitoring for outside air (10%).

Interestingly, for most HVAC areas, those who have not done an audit follow a very similar profile to those who have conducted an audit, in terms of what they plan to do over the next 12 months. This speaks well of the knowledge of today's building professionals. However, audits can have value in terms of providing one with payback information, which can help prioritize the implementation of the various HVAC improvements.

One of the few areas where there was a discernable difference between those who have had an audit versus those who did not was with the idea of CO_2 monitoring. Nearly twice as many building professionals with audits plan to implement CO_2 monitoring as those who did not have an audit. CO_2 monitoring is considered one of the areas where an engineering background may be useful.

Another encouraging result is that 19% of those surveyed plan to implement solar technology in the next 12 months, and another 6% plan to harness wind power.

Lighting

In terms of lighting improvements, "no item" scored over 11% (replace T8 fluorescents with high-efficiency T8s). Most of the other improvements, such as installing sensors, were mentioned by 6-10% of the respondents. In the case of the low score for lighting, this may be because many have already implemented it, and the rest don't intend to do so.

Roofing

As stated above, although just over half the respondents do not have a reflective roofing system. Of those who don't one-quarter said it would be at least five years until they do so, and the other three-quarters said they don't plan to get one at all.

The largest concern of re-roofing projects was cost, followed by disruption of business activities.

There still are many people who feel they do not know a lot about reflective and green roofs (see the results above). However, when asked about the top benefits expected from replacing a roof, energy savings is overtaking the weatherproofing (leak stopping) rationale, and we believe that with more education, perhaps coupled with government incentives, there may be some acceleration of the replacement of built-up roofing systems with reflective and green roofs.

What else can be done?

This study clearly identifies what steps facilities and property managers can take to decrease the energy consumption of their buildings. But there are additional steps than can be taken by others, including associations, organizations, universities, governments and utility companies. These cover ideas for future research, education of facilities and property managers, tools to assist facilities and property managers in identifying actions they can take, and the provision of incentives to help building owners implement some of the energy-savings ideas, especially those that relate to capital improvements.

Future research. This survey identified those best practices that are most likely to save energy; more intensive research must be done to identify specific savings attained from each of them. Second, while this study looked at the energy-savings achieved by those who had completed an energy audit, we did not focus on identifying which recommendations from the audit were actually implemented, and then relate those to the actual savings. Third, as more buildings achieve various green certifications, there should be more data available to correlate those savings to each type of certification. Some of this

research may be done by the associations and organizations in the field, while much may be done by universities; some funding by the associations and even governments would be a tremendous value.

Education of facilities and property managers. Many building professionals rely on associations and organizations in the field to provide them with information to keep them on top of what they can do to save energy. These include identification of tools that are available (e.g., EPA's Portfolio Manager, ENERGY STAR, BOMA Energy Efficiency Program, etc.), the development of detailed how-to guides (e.g., obtain green certification, employee training programs, etc.), and the explanation of technical concepts (e.g., CO2 monitoring, the costs involved in obtaining a green certification, determination of when to replace a major system such as a roof or HVAC system, etc.).

Tools to assist facilities and property managers. There are many types of tools that would be helpful to building professionals. One would be the development of employee training programs and other how-to guides from the previous paragraph. Another would be tools to allow building professionals to benchmark their energy consumption, which would enable them to measure the effectiveness of implementing various best practices. Some of these tools may be developed by organizations and associations in the field, while others may be done by private sector companies. In the case of the latter, it would be helpful for some of the organizations and associations to identify their existence to the building professionals.

Incentives for building owners. Many capital improvements are just too expensive to implement, especially in this economy, unless the existing system requires replacement. Yet some of the largest potential savings may be produced from these types of improvements (e.g., HVAC systems, sources of alternative energy, roofing systems). Concerted efforts can be made by government and utility companies to provide incentives to building professionals to implement these improvements. Each professional organization in the field needs to step up efforts to encourage this to happen.

The survey was designed and conducted by Peter S. Kimmel, AIA, IFMA Fellow, Publisher of FMLink and a former facilities manager in both the private and public sectors. Each contributing organization (USGBC, BOMA, AFE) provided input and expertise, both in the development and analysis of the survey.

In addition, very special thanks are made to Tom Dietsche, USGBC Research Manager, who organized and spearheaded many of the EBCC efforts, and Charles Anders Hall, PE, CEM, LEED AP of Excel E Solutions, who spent countless hours reviewing and suggesting questions for the survey, and then crunching many of the numbers used for the analysis of the results. Without the efforts of these two individuals, the survey and the results presented above would not have been possible.

The survey was generously sponsored by three organizations who have made a major commitment to reducing our carbon footprint: McQuay International, Performance Roof Systems, and Philips Lighting.