GREENING EXISTING BUILDINGS WITH THE LEED RATING SYSTEM

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INTRODUCTION

When considering the current situation of the built environment it becomes readily apparent that the LEED for Existing Buildings Operations and Maintenance (LEED-EBOM) Rating System is the most important of all the LEED Rating Systems. Historically its adoption in the industry has lagged behind the better known LEED for New Construction Rating System. In the effort to create more efficient, healthy, and financially sound buildings, LEED-EBOM accounts for two significant classes of buildings: buildings certified under the LEED Rating Systems geared toward design and construction, and buildings not previously certified. LEED-EBOM is a tool to measure the impact of a building's operations and provide a means to track performance over time. This information allows stakeholders to make informed decisions about operating policies that support energy efficiency, reduced environmental impact, and comfortable spaces for the occupants of the building. This article presents statistics about the existing building stock, provides an overview of the LEED-EBOM Rating System, and offers examples of successful implementation strategies drawn from over a dozen projects certified through the LEED-EB Rating Systems.

GREENING EXISTING BUILDINGS

Green building practices seek to reduce building energy consumption, reduce environmental impact of buildings, and improve the quality of indoor spaces for building occupants. To encourage green building design and construction and provide a metric for the sustainability of buildings, the US Green Building Council developed the LEED Rating System. The LEED Rating System has been prominently adopted in the design and construction of new buildings, with 1,431 buildings certified under the LEED for New Construction (LEED-NC) Rating System by the end of 2008.[1] This amounts to 156 million gross square feet of space that has demonstrated green design and construction practices and received LEED certification.[2] While this is an astonishing number, it only represents 0.26% of the gross square footage of buildings in the US, and the LEED-NC system does not address sustainability in building operations. To fill this gap, the USGBC created LEED for Existing Buildings.

Existing buildings present an opportunity to make staggering gains of environmental, economic, and social importance, particularly in the areas of energy consumption, greenhouse gas emissions, waste disposal, and water use. While there has been considerable excitement over greening new construction, existing buildings account for almost all of the nation's estimated 4.5 million commercial properties,[3] and the efficiency of these buildings declines over time.[4] There was 74.8 billion square feet of existing commercial floor space in 2006.[5] On average, 1.5 billion square feet of existing buildings are demolished and five billion square feet of new buildings are added as "new construction" each year. However, an additional five billion square feet of existing buildings are renovated each year creating a great opportunity to improve the energy efficiency of the existing building stock.[6]

Some general trends within the Buildings Sector according to DOE's 2008 Building Energy Data Book (BEDB):

- Electric energy consumption is increasing (natural gas and petroleum energy consumption are declining).

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- The Commercial Sector consumed 36 percent of all electricity produced in the United States in 2006.
- Space heating, lighting, and space cooling are the top three energy end-uses and energy end-use expenditures. Water heating and electronics complete the top five end-uses.
- In 2006, lighting used 25 percent of primary energy attributed to the commercial sector. This is approximately twice the energy used for space cooling, the next closest end-use.
- Lighting accounts for 42 percent of a commercial building's cooling load.
- Carbon dioxide emissions by utilities generating, transmitting, and distributing electricity drives the Buildings Sector carbon dioxide emissions. Eighty percent of all carbon dioxide attributed to the Commercial Sector comes from electricity consumption. The carbon dioxide attributed to the U.S. Commercial Sector is roughly equivalent to all the carbon dioxide emitted by Australia, New Zealand, and South Korea combined.
- As much as 95 percent of buildings related construction waste is recyclable, and most materials are clean and unmixed.

The importance of focusing on existing buildings is also underscored by other initiatives:

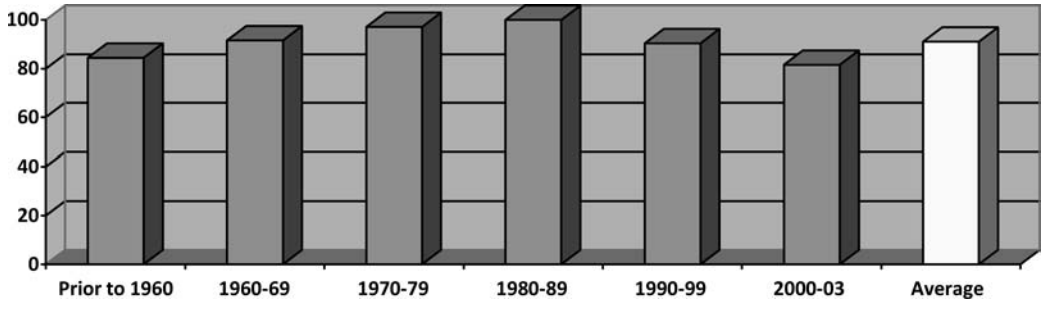
- The new Federal economic stimulus plan includes many important provisions for green building, green schools, and energy efficiency for existing buildings.[7]
- The Clinton Climate Initiative created the Energy Efficiency Building Retrofit Program in 2006 to facilitate the retrofitting of existing buildings. As reported by Cortese, the foundation recently announced partnerships with the city of Chicago and GE Real Estate to retrofit buildings in its portfolio.[8]
- The Cambridge Energy Alliance (CEA) in Cambridge, MA is one example of a city's effort to evaluate and revamp its existing building stock by helping residential and business customers to identify and arrange financing for all cost-effective efficiency and renewable measures.[9]

INTRODUCTION TO LEED-EB RATING SYSTEM

As the market began to embrace the original LEED Rating System and the USGBC continued to gain recognition as one of the leading organizations in the green building movement, there was a call for the USGBC to address the existing building market. Applying the LEED-NC program for buildings in operation did not make sense, since LEED-NC was developed with a focus on design and construction practices. Recognizing a demand for LEED certification for existing buildings, and the potential to green the existing building stock, the USGBC developed LEED for Existing Buildings.

The original LEED-EB Rating System, launched in January 2002 as a pilot program, was closely aligned with the LEED-NC Rating System. Credit categories were identical and many prerequisites

FIGURE 1. Energy consumption intensities (kBTU/sf) for commercial buildings, by building age. (Data from 2008 BEDB, Table 3.1.8)



from the NC system were carried over to the EB program, such as Erosion and Sedimentation Control, which do not apply to building operations.

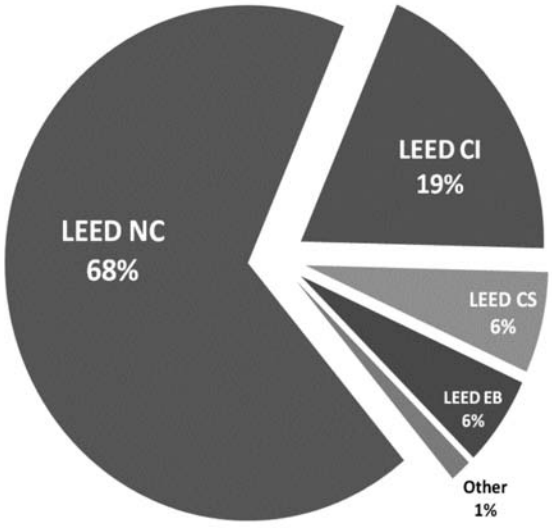
Recent changes to the LEED-EB Rating System bring requirements into alignment with building operating procedures. These changes include reducing the number of prerequisites, increasing the focus on activities under the control of the facility manager, and including more options to achieve credits in water efficiency, energy performance, building commissioning, and green cleaning.[10] The key selling points of LEED-EB are:

- Improve management of energy and water consumption and reduce operating costs.
- Procure environmentally preferable materials and manage solid waste.
- Improve the indoor environment and occupant comfort.
- Document operational procedures within the organization and communicate to building staff.
- Track performance to encourage consistent implementation of procedures.

The latest version, LEED for Existing Buildings: Operations & Maintenance or LEED-EBOM, also supports tracking performance after the initial certification is achieved, since a building must recertify at least once every five years to remain current. For the recertification, documentation must be provided showing performance since the last certification for each credit and to continue to meet the requirements of the program. Consistent documenting and monitoring of performance by the facility manager is essential to ensure the recertification is not in jeopardy. The documentation also provides a ready source of data for stakeholder inquiries into building management policies and procedures.

A look at recent registrations (the first step for LEED projects to become certified) shows that since the introduction of the revised LEED for Existing Buildings Rating System in October 2007[11], LEED-EBOM registrations have expanded their LEED market share to 16% of all registered projects compared to 50% of projects registering under LEED-NC.[12] Prior to October 2007, LEED-EB and LEED-NC projects accounted for 7% and 65% of registered projects, respectively, which closely aligns with the ratio of certified projects shown in Figure 2.[13] At the end of 2008, only 120 buildings had achieved LEED certification under the existing buildings system, representing one tenth of the success of the LEED-NC program.

FIGURE 2. LEED certifications by rating system. (New Construction (NC), Commercial Interiors (CI), Core & Shell (CS), Existing Buildings (EB))



Projects that register with the USGBC have a project page set up on the LEED Online portal and project teams get access to the prerequisite and credit letter templates, which include many of the calculations required for the project. Even if a project is not ready to seek certification, registering the project and gaining access to LEED Online to monitor and track performance can be a useful tool in improving facility operations.

Another development that has encouraged more registrations under LEED-EBOM is the LEED Portfolio program. The Portfolio program is geared toward building owners with multiple buildings that have common management or function. The program has outlined four categories that encompass this type of portfolio owner: Campus setting–Repetitive Buildings; Campus Setting–Different Buildings; Multiple Sites–Repetitive Buildings; and Multiple Sites–Different Buildings.

STRUCTURE OF LEED-EBOM

LEED-EBOM has two unique features when compared to other LEED rating systems: the performance period and a recertification. The performance period is defined in the LEED-EBOM Reference Guide as the "continuous, unbroken time during which sustainable operations performance is being measured." LEED-EBOM gives the facility owner the opportunity to earn an initial certification, and then also recertify the building over a longer time period. For the initial certification, the performance period must be at least three months (although one credit does require at least one year of data). The recertification performance period can range from one to five years at the applicant's discretion, but it must start when the initial certification performance period ends. If a new credit is pursued in the recertification, the requirements of the initial certification apply to that credit. A project is not required to seek recertification, but the intent of the rating system is to provide ongoing tracking and monitoring of performance, which by definition promotes recertification.

The LEED-EBOM Rating System, like all the LEED Rating Systems, is divided into five credit categories that cover a full range of building characteristics: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, and Indoor Environmental Quality. Additionally, the rating system includes a set of Innovation in Operations credits for recognizing exemplary performance against the metrics of the LEED credits or for recognition of an element of the building operations that is not covered by the LEED credits. Each of the credit categories is similar in scope and focus to the corresponding credit categories of the other LEED Rating Systems. The key difference of the LEED-EBOM Rating System is that the focus of the credits is on ongoing operations, not designing and constructing a project. Due to the consensus approach used by the USGBC to develop the LEED programs, the prerequisites and credits are industry-accepted best practices that can be used as a guideline to create a sustainable facility operations plan. Prerequisites and credits are structured around the concept of creating facility operating plans and policies, then tracking ongoing performance against those plans. The key for a facility owner pursuing certification is to identify the credits that support the owner's sustainability goals and provide the best value. The LEED Rating System can be viewed as a set of best practices for buildings. LEED-NC addresses design and construction strategies, but does not attempt to address building operations and maintenance (O&M). LEED-EBOM only addresses buildings in operation, and does not include sustainable strategies for design and construction. Despite this shift in focus, the credit categories are the same and many LEED-EBOM credits align with credits from LEED-NC.

Sustainable Sites: The environmental impact of a building is highly dependent on its location, and the location of existing buildings is already determined. However, policies can be developed to incorporate the best practices from the Sustainable Sites credit category and minimize the environmental impacts of building operations on a given site. These best practices address occupant transportation (e.g., employee commuting and fleet vehicles), grounds and landscape management (e.g., fertilization and integrated pest management), and reflectivity of roof and hardscape surfaces to address the urban heat island effect.

Water Efficiency: Under LEED-EBOM, the Water Efficiency credit category encourages retrofitting or replacing existing plumbing fixtures to achieve water reductions in existing buildings. Reducing water use in buildings will assist in conserving clean water resources and reduce energy use attributable to hot water heating and wastewater treatment.

Energy and Atmosphere: Further reductions in energy use can be achieved by retro-commissioning existing buildings. The Energy and Atmosphere credit category is structured around a building energy audit and energy use assessment to benchmark against other similar buildings. Implementing a monitoring and tracking program for building performance will also assist building management in identifying operating problems as they arise, preventing system failures and expensive emergency repairs. Measuring and documenting energy use also creates a compelling case for implementing energy efficiency improvements.

Materials and Resources: A general trend in LEED-EBOM is creating and documenting policies for best practices. Environmentally preferable pur-

chasing (EPP), solid waste management, and green cleaning policies under the Materials and Resources credit category are good examples. Developing policies and uploading supporting documentation that indicates follow-through sets the organization on track to reducing waste and environmental impact.

Indoor Environmental Quality: This category of credits promotes a healthy and productive indoor environment through the elimination of sources of pollutants; improving ventilation and filtration to control the remaining pollutants; monitoring and tracking indoor air quality; and creating conditions to promote occupant comfort.

These five LEED credit categories form a comprehensive (though not intended to be complete) set of best practices for building operations. Even if a building was not designed and constructed to be LEED certified, the LEED-EBOM Rating System provides an opportunity for the building to be operated sustainably. Considering the entire lifespan of a building, building operations represents a significant opportunity to reduce impact—and arguably a greater impact than design and construction.

Sustainable Sites (SS)

When it comes to issues regarding the site, the initial impression is often that existing buildings have limited options because the site has already been selected and the building is already designed and situated. But, the focus of LEED-EBOM is on operations and maintenance, not necessarily on design. There are many opportunities to operate and maintain a site in ways that protect and enhance the site and surrounding ecosystem. The Sustainable Sites category allows for actions to be taken among a range of issues, including landscaping, pest management, erosion control, transportation programs, heat island reduction, and light pollution. These credits provide a chance to restore the existing site and implement policies and practices that will ensure its protection during future additions and alterations.

Sustainable Sites credit 1 rewards existing buildings that were previously certified under LEED for New Construction, LEED for Schools, or LEED for Core & Shell (when at least 75% of the floor area has also been certified for Commercial Interiors). LEED-EBOM is expected to award 4 points for this credit under the LEED 2009 point system, providing buildings with a jumpstart toward the 40 points required for Certification.[14]

Sustainable Sites credits 2 and 3 encompass a wide range of standard exterior maintenance activities. Both credits require having plans in place that feature low-impact site maintenance practices and products that reduce chemical use, water waste, air pollution, and site runoff. Buildings can earn points for composting landscape waste, planting native species, and replacing gas-powered equipment with electric-powered alternatives.

Sustainable Sites credits 2 and 3 both involve coordination with grounds staff and third party contractors. Because of the growing popularity of the LEED-EB rating system, contractors are already offering LEED-compatible services that comply with the credit requirements. Many contractors will even supply the required documentation. Building owners and property managers should review their existing service contracts, discuss LEED requirements with their contractors, and identify areas for negotiations. If services are not already being performed, language can be added to contracts upon renewal or changed mid-term, often at no cost.

It is not uncommon for some LEED requirements to essentially become industry standards. Integrated Pest Management (IPM), for example, is one LEED-required practice that has become fairly standard and is almost always being performed at a facility to some degree. While many existing IPM programs account for preventive pest control measures and more targeted application of less toxic chemicals, LEED-EBOM also requires a communication plan to alert building occupants in advance of when chemicals are going to be applied on-site.

Credit 4 in the Sustainable Sites category seeks to reduce single-occupant commuting and the many environmental problems associated with "conventional" automotive transportation. Because of the enormity of pollution and land development impacts from transportation, reductions made under this credit can earn significant points toward certification—as many as 15 points—depending on the level of reductions.

The intent is to promote behaviors that reduce the use of single-occupant, conventionally-powered vehicles. There can be an advantage for existing buildings that are already located close to well-established

TABLE 1. Summary of combined transportation strategies for SSc4.

Strategy	Summary
Public transportation access via shuttle	Public transportation was available in the area but located a 1/4-mile outside the distance required by LEED. The facility was able to address this by offering a cab/van shuttle service to local public transportation stops.
Onsite bike storage	Secure bike storage and changing/shower facilities are available to occupants.
Preferred parking for alternative fuel vehicles	The facility implemented a preferred parking program for vehicles listed under the EPA Smartway Elite category on the EPA Green Vehicle Guide. The initial commitment allocated 3% of the parking capacity, but the policy allows for expansion without limit as interest and demand grows. Green tags and reserved parking signs are used, as shown in Figure 3. The facility staff advertised the program to building occupants and within the first month received several inquiries from people in the process of purchasing cars who wanted to use the information from the program to help them pick a vehicle.
Preferred parking for carpool vehicles	Similar to the program for alternative fuel vehicles, carpool vehicles are also eligible for preferred parking. 5% of the parking capacity is committed for carpools, and carpools get to park in the garage or choose a spot in the parking lot. Additionally, the company guarantees a ride home to carpoolers if needed.

public transportation systems, but the LEED system allows for a range of approaches that are applicable to any building, including telecommuting, compressed work weeks, carpooling, distributing discounted passes, back-up ride services, and various alternative-fuel vehicles strategies.

One utility company leveraged existing programs that implemented a combination of transportation strategies while earning LEED certification at their corporate headquarters. This combined strategy is summarized in Table 1.

Water Efficiency (WE)

The Water Efficiency category of credits seeks to decrease the use of potable water associated with buildings for both interior and exterior water consuming activities. The credits promote efficiency through the use of water-efficient fixtures, landscaping practices, and operations. They also promote the understanding of where water is being used in a facility through metering and submetering. The Water Efficiency category obviously has the benefit of reducing the consumption of water, which is critical in many areas of the country. It may appear to much of the population in temperate zones of the country that water resources are not an issue; however, there are 36 states anticipating local, regional, or statewide water shortages by 2013.[15] Reducing potable water consumption also has the benefit of reducing the energy, cost, and burden on the infrastructure for water distribution, water treatment, sewage conveyance, and sewage treatment. American public water supply and treatment facilities consume about 56 billion kilowatt-hours (kWh) per year.[16]

The water efficiency category of credits includes a prerequisite (WEP1) that a building meet a minimum level of performance against an industry recognized benchmark. Performance above the minimum level of efficiency is rewarded with up to 5 points through a credit (WEC2). The reference standard for the water efficiency credits are the Uniform

FIGURE 3. Reserved parking sign for alternative fuel vehicle.

Plumbing Code (2006) and International Plumbing Code (2006). However, recognizing that most existing buildings were built prior to the current codes being in place, the benchmark for minimum performance is to consume no more than 120% to 160% of the code requirements, depending on the age of the plumbing system and how recently any modifications were made. For each 10% below that benchmark that the building actually performs, the facility is eligible for a credit, up to 30%. For a project registered with the USGBC, the baseline calculation is accomplished through the credit template on the project's LEED Online site. The required information includes the number of plumbing fixtures and the number of building occupants. It is important to keep the number of occupants consistent across the LEED credits. The actual performance numbers are used from metered water data and sub-metered data.

By reviewing and auditing the plumbing fixtures in a building, there are often easy methods to increase water efficiency with a low capital cost. The water efficiency prerequisite has to be met for a building to be certified, so an early review of the credit is warranted. A high-rise commercial office project that earned a LEED-EB v2.0[17] Gold certification began the audit process, and it was quickly determined that the existing plumbing fixtures did not meet the minimum prerequisite requirements. The building was built in 1984 and no changes to the plumbing fixtures had been performed. An evaluation of the fixtures revealed several opportunities including adding aerators to the faucets, modifying the orifice plates for the urinal flushometers, and replacing flushometers on the toilet fixtures. This facility had energy audits and had done efficiency upgrade work in the past, but had not reviewed water efficiency opportunities. By making these changes, the water consumption decreased approximately 40% and the performance went from not meeting the LEED prerequisite to meeting the prerequisite, earning 2 credits, and surpassing the credit requirements by enough that the project earned an innovation credit.

Potable water use for landscaping/irrigation and cooling tower make-up water is also addressed in the Water Efficiency category (WEC3 and WEC4, respectively.) The landscaping water use credit also ties in very closely to the Sustainable Sites Credit 3 that addresses a landscape management plan. Planting and landscaping decisions may influence the requirements and need for irrigation systems.

The Water Efficiency category also promotes giving facility operators and managers the ability to track water consumption within a building (WEC1). Simply put, you cannot manage what you do not measure. A facility is eligible for a credit if there is a whole building water meter that is monitored and tracked on a regular basis, including monthly and annual summaries. Most facilities have a building water meter; however, many do not have a regular monitoring and tracking system in place. Municipalities often provide quarterly water statements. However, this interval does not provide close enough monitoring to catch a problem in a timely fashion.

Another credit is available if the facility has the ability to submeter one of several typical major uses in the building such as irrigation, cooling tower make-up water, or the indoor fixtures. Submetering must also be monitored and tracked on an ongoing basis. The project sited above met these two objectives. The chief engineer had set up a system to read and record the meter readings on a daily log sheet and chart the monthly numbers. The daily records allowed the building engineers to monitor usage and enabled them to catch a spike in consumption that was caused by a leaking valve in the cooling tower system. This issue was identified quickly and resolved. The monthly records allow historical comparison as the seasons change in a year and year-to-year. The chief engineer has a decidedly low-tech, but extremely effective method for monitoring the monthly consumption. The monthly consumption figures are plotted by hand on an 11 × 17 inch sheet of graph paper and posted to a bulletin board in his office by two thumb tacks at the top of the page. Each year a new sheet is placed on top of the stack, so it is easy to flip through the charts and compare the current month to past years. This system has been used since the building was built in 1984, and three years of data is stored on the bulletin board, while the older years are filed. The key here is that the metering is in place, there is a disciplined method of monitoring the data, the data is summarized on a regular basis, and posted in a manner that is easy to access and use. One of the benefits of the LEED-EBOM program is that it provides an opportunity to recognize the good work the facility staff is already doing.

Energy & Atmosphere (EA)

The Energy & Atmosphere category of credits decrease the emissions associated with energy production through energy-efficient design and operation, refrigerant management, and renewable energy generation. Energy efficiency holds the most cost effective method of reducing emissions, since less energy consumption results in fewer emissions. Renewable generation methods greatly reduce emissions associated with energy generation. Refrigerant fluids are addressed to reduce the harmful effects of greenhouse gases. Existing Building Commissioning is a recommended method to identify energy efficiency opportunities, and also survey the building systems for other operating problems.

Energy & Atmosphere credits 2.1, 2.2, and 2.3, the series of Existing Building Commissioning credits, represent a three-step process: 1) Investigation and Analysis, 2) Implementation, and 3) Ongoing Commissioning. The investigation and analysis builds upon the energy assessment performed for EA Prerequisite 1 and provides two paths for the project team to pursue: a commissioning process (Option A) or an energy audit (Option B).

Selecting Option A or Option B under the Investigation and Analysis (EAc2.1) is a key decision and must be made strategically in consultation with the building owner, management, and contracted members of the team to ensure alignment with overall project goals, and that documentation requirements are met for the LEED submittal process.

The intent for Energy & Atmosphere credit 2.1 has three key components:

1. Develop an understanding of system operation.
2. Identify measures to optimize performance.
3. Develop a plan to optimize performance.

Though no physical changes to the building are taking place to complete the Investigation and Analysis, physical monitoring through portable data logging and spot measurements are required based upon the performance improvement measures identified for the building. Manual functional performance testing (FPTs) may also be required under Option A (commissioning), depending on the building and energy saving measures identified. Both options to complete the Investigation and Analysis require a site assessment and an energy use breakdown. Both options also require an energy use breakdown by system, based on ASHRAE Procedures for Commercial Building Energy Audits. The breakdown goes beyond system level, identifying major components consuming energy (i.e., space heating, pumps, computer/data center). The remaining documentation depends on which compliance path is selected.

The compliance path for Option B (energy audit) expands upon the ASHRAE Level I Energy Audit, with notable additions including:[18]

- List all possible modifications to equipment and operations that would save energy.
- Short list of modifications deemed practical by the owner, describing:
  - Cost of implementation.
  - Energy costs savings.
  - Impact on energy index.
  - Potential interaction impacts with other building systems or modifications.
  - Estimated impact on operations and maintenance.
  - Summary of energy savings if all modifications are implemented.
- List of modifications not pursued, with reasoning.
- Identification of the measurement and verification (M&V) required to evaluate the effectiveness of the practical modifications once implemented.
- Identification of capital-intensive modifications that may require a Level III assessment (i.e., energy modeling) to determine feasibility.

Performance measurement is a core component of the Investigation and Analysis. Measuring performance may range from spot checks of light levels to data logging and/or trending temperatures over a two-week period, depending on the energy-saving measure under consideration. Collecting actual data reduces uncertainty in calculating cost savings; however, data collection efforts must be developed with the rough order of magnitude of savings in mind.

The energy audit approach under Option B truly focuses on energy efficiency, but for a building that has significant operating problems, such as poor indoor air quality, a more comprehensive approach may be needed. Under Option A, the project team develops a master list of "all operating problems that

affect occupants' comfort and energy use." Cost savings and potential interactions are evaluated, similar to Option B. In contrast to Option B, data collection is used to diagnose the operating problems identified in the master list of findings. To diagnose operating problems in the building, the service provider must be competent in building commissioning.

The commissioning agent works with building management and the building controls operator to articulate the building systems through their sequence of operations. This process can be compared to functional performance testing in commissioning new construction projects. Through these tests, the commissioning agent is able to diagnose problems with hardware (i.e., HVAC fans or dampers) and software (i.e., system controls sequencing). This physical investigation by the commissioning agent supports the development of a retro-commissioning plan to be implemented in EA Credit 2.2. The master list of findings documents all problems and proposed solutions, with estimated cost impacts from energy use and maintenance procedures.

A key difference between Option A and Option B is how actual performance data are utilized. In Option A, the commissioning agent uses the performance data to diagnose system problems and propose solutions for retro-commissioning. In Option B, the engineer uses performance data to refine the cost estimates developed for the energy saving measures. Other differences are illustrated in Table 2.

EPA's Energy Star Portfolio Manager provides the scale for measuring a building's relative energy efficiency in several credits under the Energy & Atmosphere category. Buildings must receive an energy performance rating of at least 69 and earn 2 points towards certification. Higher ratings yield more points; an EPA Energy Star® rating of 71 receives 1 point, 73 receives 2 points, and so on. The maximum number of points achievable under the credit is 18 points with an Energy Star® rating of 95. Recognizing that not every type of building falls within the Energy Star® database, the LEED rating system does offer several alternate compliance paths for this credit. The key element is to identify a comparable benchmark against which to compare facility performance.

To operate a building efficiently, many newer buildings have a building automation system (BAS). The BAS is a software program installed on a computer that communicates to devices distributed throughout the building and adjusts system operation to maintain a comfortable environment. Sensors provide feedback to the BAS, which then adjusts the central air handling units, chillers, and boilers

TABLE 2. Differences between Option A and B.

Credit Intent	Option A: Commissioning	Option B: Energy Audit
Develop an understanding of system operation.	Site assessment: interviews and equipment inventory	
	Energy use breakdown by system and major components	
Identify measures to optimize performance.	Develop a master list of all problems relating to energy use and occupant comfort and proposed solution for retrocommissioning, using data and functional performance testing to diagnose the problem.	Develop a comprehensive list of all problems impacting energy use (expand list from EA Prereq 1), then create a short list of practical measures based on owner's priorities.
	Perform cost-benefit analysis on measures to correct owner's priority operating problems, based on findings from EA Prereq 1.	Based on operating data collected, calculate the energy savings and impacts for the owner's priority measures.
Develop a plan to optimize performance.	Work with owner to outline a plan for implementing improvements through a capital improvement plan or a retro-commissioning plan.	Work with owner to outline a plan for implementing priority measures.
		Identify M&V required to quantify savings after implementation.

accordingly to optimize energy use. A functioning BAS in the building yields one point under EA credit 3.1 when a performance measurement plan is documented.

EA credits 3.2 and 3.3 require system-level metering provided for 40% and 80% of the energy consumed in the building, respectively. For a typical office building, installing submeters for the mechanical and lighting systems will include at least 40% of building energy consumption (see Figure 4). However, to provide submetering for 80% of building energy consumption may require metering power distribution to outlets to account for office equipment and miscellaneous loads. Computers, printers, and copiers become more significant energy consumers in buildings with high performance mechanical systems since the load distribution has shifted (see Figure 5).

Reducing building energy use also makes it easier for project teams to achieve 6 points under EA credit 4. This credit requires renewable energy generation by installing systems on-site or purchasing green power certificates for produced renewable energy to be generated off-site. Up to 6 points are awarded based on the percentage of renewable energy generated for the project. For a 50,000 sf office building to achieve all four of these points (assuming 100 kBTU/sf/year, which is equivalent to 5,000,000 kBTU per year, or 1,465,416 kWh per year), a generation system must be installed to provide 175,850 kWh per year. This capacity could be obtained through installing approximately one hundred (100) 1-kW two-way tracking solar photovoltaic units. However, the energy yield from the system is dependent on weather, latitude, and shade from trees or surrounding buildings. A budget of $650,000 to $800,000 would be required for installing the two-way tracking units in this example.

Under the off-site compliance path, 100% of building energy consumption would have to be offset with green power certificates, totaling $14,654 per year. Documentation requirements for the credit require a commitment to at least three years of purchasing green power certificates. Upon purchase, the certificates are "retired," meaning the environmental benefit has been used to offset the energy used by the building. The certificates are not allowed to be resold—this would eliminate any environmental benefit to purchasing the certificates, since the offset is passed to the purchaser.

There are many potential variations on this credit, including solar thermal systems, wind turbines, or systems using biofuels. Generating capacity can also be reduced, though fewer points are achieved. Using the previous example for a 50,000 sf office building:

Purchasing green power certificates represents a lower cost method to achieve the credits. However, when considering the financial metrics, installing

FIGURE 4.

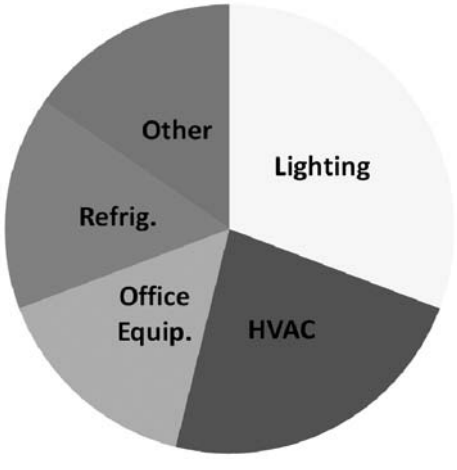


FIGURE 5.

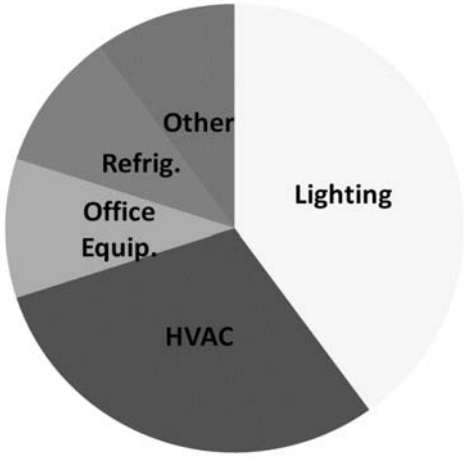


TABLE 3. Example renewable energy options.

	On-Site Generation			Off-site: Purchase RECs Annually	
LEED Points	Annual Energy Generated (kWh/yr)	Capacity (kW)	Install Cost	Required Offset (kWh)	Annual Cost Premium
1	43,963	25	$175,000	366,354	$3,664
2	87,925	50	$350,000	732,708	$7,327
3	131,888	75	$525,000	1,099,062	$10,991
4	175,850	100	$700,000	1,465,416	$14,654

systems on-site to produce power represents a better investment. Despite on-site solar applications having a payback in this example of 40 years (at best), there is no payback to calculate for the purchase of green power certificates, since no investment is made. Purchasing green power certificates is paying a premium price for electricity and paying another company to install renewable energy generation systems.

Materials & Resources (MR)

The operations and maintenance of existing buildings are extremely resource-intensive and generate a large amount of waste. All of the prerequisites and credits in the Materials and Resources category deal with materials and resources that are either a) purchases for operations and maintenance, or b) discarded as waste. The overarching theme of the category is to purchase/use items that are considered more environmentally preferable and reduce the amount of waste leaving the facility to landfills or incinerators.

The Materials and Resources category has two policy prerequisites—one for purchasing (MRp1) and one for waste management (MRp2). As prerequisites, these must be written. Note that these prerequisites require policies only. Implementing the purchasing and waste policies and documenting levels of achievement earn points under the associated credits in this category. If applicable, adhering to the EPA's Environmentally Preferable Purchasing (EPP) guidelines can satisfy the MRp1 prerequisite and can be a simple approach to establishing a purchasing policy.[19]

There are many criteria used for defining environmentally preferable products, and the question of what is environmentally preferable is still unsettled and open to controversy.[20] LEED-EBOM splits purchasing into six categories: Ongoing consumables, Durable goods–electric, Durable goods–furniture, Facility alterations and additions, Mercury-containing lamps, and Food. Identifying green products within these categories can sometimes be a confusing and difficult task, but it is getting easier.

The LEED system has established various criteria within each category to guide product selection. Under LEED, for example, a product can be considered preferable if it contains at least 10% postconsumer recycled content or if it contains at least 50% materials that were harvested and processed within 500 miles of the site. Other criteria rely on products meeting certain certification or having eco-labels, but the range of products covered by these labeling programs can be very limited.[21] LEED specifically references Forest Stewardship Council for wood products, various Green Seal standards for paints and cleaners, ENERGY STAR® for durable goods, CRI Green Label Plus Carpet Testing Program for carpets, and a slew of labels for organic or local food. Arguments can be made to include other criteria if an applicant can provide adequate support.

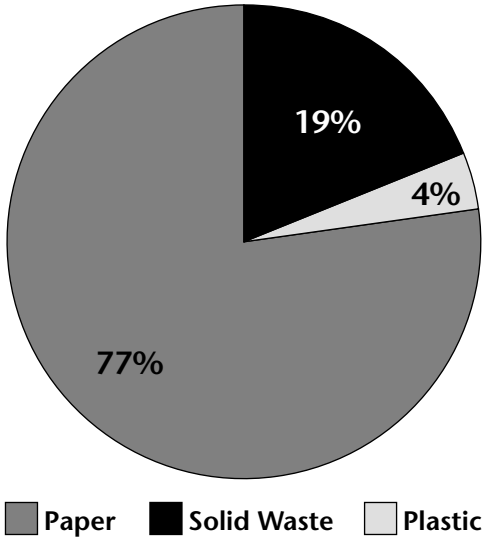
Documenting this credit involves close coordination with purchasing personnel. The type of purchasing structure—whether it is centralized or decentralized—can impact how this credit is approached and tracked. Colleges are notorious for decentralized decision making and purchasing, but they can operate under a consistent purchasing policy with select vendors. One Massachusetts state college campus has been able to work with their office supply company to track and report purchases

of ongoing consumables made across the campus by various departments. They have also set up a web site where people can see a list of green products that are available through that vendor and that will contribute toward the LEED certification.

Building owners are responsible for purchases that are under their direct control. In lease or rental situations, tenant purchases are not necessarily within the scope of these credits. Building owners/managers can be creative in how they approach tenant purchasing. Larger commercial properties have been known to include incentive language into lease agreements and provide tenant guidebooks that contain recommendations and resources that will help tenants meet the policy.

MRc6 awards 1 point for conducting a waste stream audit of the facility's ongoing consumables waste stream. This audit establishes a baseline of waste leaving the facility and is a good starting point for any waste-related initiatives. In fact, this was a prerequisite under the older LEED-EB system but is now being treated as a credit. The knowledge gained through a comprehensive waste audit can feed into improving recycling efforts (MRc7) or other waste reduction measures. Figure 6 shows the results of the waste stream audit for the Sebesta Blomberg Headquarters certification in 2006.

FIGURE 6. Waste Stream Audit Results.



Some waste haulers will provide this information to their clients. Work with your waste hauler to arrange an audit that includes a breakdown of your ongoing consumables waste stream, identifying the types of waste and their weight and volume.

Facilities pursuing LEED-EBOM certification often find that one of the greatest values comes in unexpected areas. The results typically come from the very fact that they are taking the time to go through a comprehensive audit process of the facility operations. Often the day-to-day activities of operating and maintaining a facility do not allow staff the time to review existing policies and procedures. In one example, the facility staff seeking certification of an office building was confident that their existing recycling program and infrastructure would easily allow it to achieve credits. Their recycling program had been in place for almost twelve years, and as far they were concerned it was working well. For LEED certification, they went through the process of reviewing the program, documenting the setup and layout and communication to employees, and compiling performance metrics. As they dug into their program, they found that many of the bins distributed in the building still had the original twelve-year-old labels stating that only white office paper could be recycled. Their current hauler accepted a much larger range of paper for recycling. The waste audit confirmed that more than just white paper was being recycled, but they were able to replace the labels and update employee communications on the program. Another benefit came from evaluating the locations of the recycling bins and placing them in areas used on a regular basis, such as key conference rooms where lunches are frequently served.

Another facility contracted with a hauler that performed off-site separation and recycling of any recyclable materials. The waste stream at the building was comingled, which provided ease of management by the facility team and ease of use by the office occupants. After evaluating the costs and volumes of their typical waste stream, the facility staff worked with the waste hauler to implement a new program to separate clean paper at the office. This resulted in lower costs for the program because the clean paper was more valuable for the hauler, and costs were less for off-site separation.

Indoor Environmental Quality (EQ)

The Indoor Environmental Quality category of credits creates a healthy and productive indoor environment eliminating pollutant sources, improving ventilation and filtration to control the remaining pollutants, monitoring and tracking IAQ to identify and resolve potential IAQ issues before they become major problems, and creating conditions to promote occupant comfort.

At the most basic level, building mechanical systems must provide a minimum amount of outdoor air to prevent indoor pollutants from accumulating and adversely affecting occupants. EA Prerequisite 1 addresses this need. To complete this prerequisite, the amount of outdoor air (OA) supply is measured at each air handling unit. This value, the OA flow rate (cfm), is documented for each air handling unit in a spreadsheet provided by LEED Online. This spreadsheet also structures the design calculations required to verify that the actual OA flow rate measured is sufficient, based on ASHRAE 62.1-2007 requirements.

Older mechanical systems in existing buildings may have trouble meeting the ASHRAE 62.1-2007 requirements due to original design capacity and current condition of equipment and air distribution systems. LEED-EBOM provides an alternative compliance path for this scenario, which requires a minimum of 10 cfm per person for OA supply. If mechanical systems cannot deliver at least 10 cfm of OA per occupant, the prerequisite is not awarded and the building cannot achieve LEED certification.

Other prerequisites focus on eliminating the sources of indoor pollutants, such as environmental tobacco smoke (ETS) and cleaning chemicals. Many cities and states are moving towards not allowing smoking in the workplace; however, the LEED prerequisite also includes keeping smoking areas at least 25 feet away from doors, operable windows, and air intakes. Smoking areas and policies can be a touchy subject for facility managers.

Several facilities that have identified the ETS prerequisite as one of the largest hurdles for LEED certification have found innovative ways to implement the smoking policy and meet the needs of all their constituents. At one facility, the existing outdoor smoking area was just outside the main entrance under the building overhang. The ashcans were the only indication that this was the smoking area, and the building's smoking policy only stipulated that smoking was not allowed in the building. Smokers congregated near the doorway, and anyone passing into the building generally had to pass through the smoking area. For years, the facility manager had been getting negative feedback from non-smokers, but was not comfortable making a change and did not want to further alienate the smokers. Armed with the guidelines laid out in the LEED-EB program and through the LEED-EB certification effort that was being promoted throughout the organization, the facility manager relocated the smoking area to a location away from the door, but still under a building overhang. He purchased tables and chairs and communicated the updated building ETS to the building occupants and posted signs outside the building. Then he held his breath, waiting for the reaction. What he found surprised him. Rather than viewing the change as negative, the smokers in the building appreciated the new smoking area and tables and chairs—he received positive feedback. The non-smokers also appreciated the relocation. This is a great example of creating a win-win situation.

Indoor Environmental Quality prerequisite 3 requires a green cleaning policy that addresses custodial practices for the duration of the performance period. A green cleaning program includes: policies, procedures, training, products, equipment, and ongoing assessments.

Many custodial services companies have embraced green cleaning and have incorporated these practices into their standard services. These companies frequently have a packet of information describing their green cleaning program or products that can be submitted as the documentation for the green cleaning prerequisites and credits. Figure 7 below illustrates a product brochure for a green cleaning chemical dispensing system that shows the Green Seal symbol and addresses ease of training, use, and disposal. The green cleaning credits (EQ 3.1 through 3.6) are among the easier credits to obtain and total 6 points towards LEED certification.

One project experienced an easy transition with their custodial service provider, but found that monitoring the custodial staff was required to complete

FIGURE 7. JohnsonDiversey's Ready-to-Dispense System Brochure (Image provided by JohnsonDiversey).

the transition to the green cleaning program. The switch to a green cleaning program was made with no additional cost. The new cleaning products were brought to the site, and training was conducted for the operating staff. However, a few weeks later the facility manager noticed some of the cleaning carts had the old cleaning products. Upon inquiry he found that the custodial staff themselves had brought the cleaning products back into the building. Basically, the staff had the opinion that the new cleaners couldn't be working because they didn't smell bad like the old ones! No pain, no gain seemed to be the attitude. The facility manager worked with the custodial company to conduct the training session again and remove the contraband from the cleaning carts. A month later, the facility manager checked in with the custodial workers and was pleased to find their opinions had changed. After working with them, they reported that the green cleaning products were working effectively, and they fully appreciated the reduction in exposure to fumes and chemicals. The new dispensing and dilution system reduced the number of spills and also reduced the overall amount of cleaning products being used. As with many organizations, a cultural shift with the cleaning staff was required, but by monitoring the situation and taking action, the facility manager was able to convert to a green cleaning program at no additional cost. This was the first green cleaning facility for the custodial service provider, so they took what was learned on this project and applied it to other facilities.

Reducing indoor pollutants, through eliminating or controlling their use, ensures a safe indoor environment for occupants. However, a safe indoor environment does not automatically mean a comfortable indoor environment. An occupant survey, under EQ credit 2.1, provides the end-user's perspective as it relates to building performance. Though this credit is only worth one point toward certification, the occupants' comfort is crucial to productivity and company performance.

Labor costs are on the order of eight times higher than building operations and maintenance costs. Modifying systems to improve occupant comfort may require an expense, yet minor improvements in employee productivity can offset this investment. Other credits that improve occupant comfort include individual lighting controls (one point plus exemplary performance) and either daylighting or window views (up to two points).

Implementing daylighting strategies can be compared to providing an office with a view. LEED

provides specific guidance to calculate the amount of spaces that receive adequate amounts of daylight to earn the credit, and the same is true for window views. Generally most facilities will not be able to modify the arrangement of their windows, but decisions on layout of interior spaces and partition walls can be influenced by the LEED requirements, particularly as renovations occur. One project seeking LEED certification was not able to earn the daylighting credit although initial review of the office layout and window geometries appeared that it would. Several years prior to the LEED certification effort, an energy retrofit project included the installation of a window film on the building to reduce HVAC costs. It was a successful project that contributed to the building's Energy Star® score, however, while calculating the daylighting factor, it was found the characteristics of the window film cut down on the amount of natural light that was entering the building. If maintaining the amount of natural light that was allowed into the building had been identified as a project goal, a film could have been selected to achieve that while still reducing HVAC loads. It is important to also note that the daylighting credit is not about having an active daylighting control system to reduce the amount of artificial light that is needed in the building. Any energy benefits from active daylighting control would be recognized under the Energy & Atmosphere credits.

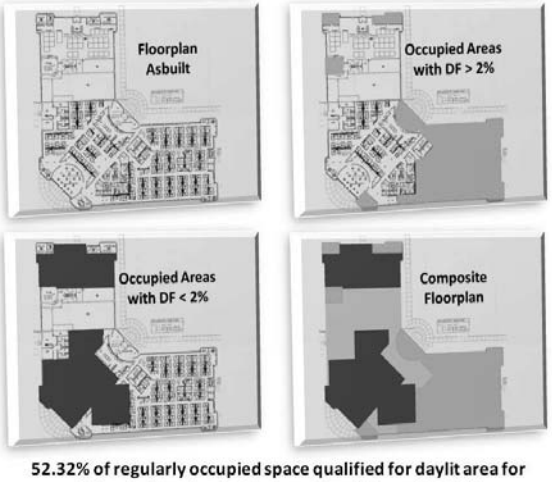
For the LEED certification of Sebesta Blomberg's Headquarters, the team initially anticipated the daylighting credits would be easily achieved due to the open floor plan and a consistent application of glazing as shown in Figure 8. However, after performing the calculations, the team found that many spaces did not meet the 2% threshold for daylight despite the layout and building elevations (see Figure 9). The building still received all available points for daylighting, with 52% of net occupied area receiving at least 2% daylight factor.

Innovation in Operations (IO)

The Innovation in Operations (IO) credit category provides an opportunity for a project to be recognized for exemplary performance against the metrics of the other LEED credits or for recognition of an element of building operations not covered by the other LEED credits. Elements of several of the innovation credits that were used by projects under the earlier versions of LEED-EB have been included in the latest version. One project that achieved a Gold certification under LEED-EB v2.0 was a non-profit foodbank that had an organic farm associated with it, for which an innovation point was applied for and received. Now LEED-EBOM includes a credit for having a Sustainable Purchasing Policy for food purchases that include food from an organic farm. Another facility participated in a computer reuse program that donated usable computers to schools

FIGURE 8.

FIGURE 9.



52.32% of regularly occupied space qualified for daylit area for Sebesta Blomberg's Headquarters in Roseville, MN

in need of computers, and a credit for an electronics recycling program is now included in the LEED-EBOM program.

It is also interesting to note that projects seeking certification under the other LEED rating systems are using credits from the LEED-EBOM rating as innovation points. For example, projects that develop and commit to implement a green cleaning program have been awarded innovation points under the LEED-NC rating system.

LESSONS LEARNED AND SHARED

One of the strengths of the LEED-EBOM Rating System is that due to its focus on operations and maintenance it can be applied across a wide range of facilities. Buildings certified under the program range from relatively new office buildings to old renovated mill buildings to a non-profit foodbank. The motivations and goals of each project team are unique, but it is a critical part of the certification process to set goals early so decisions can be made to support them. Projects we have been involved with have been driven from the top down, where the CEO is the project's biggest champion, as well as from the bottom up, where a core group of committed people push to change an organization from within. Some projects have used a LEED-EB certification to qualify for grant funding to support sustainability projects. Other projects have used utility funding for energy efficiency projects to help meet the LEED-EB energy goals.

The LEED-EBOM program is used in two similar, but subtly different ways. Some project teams use LEED-EBOM to make changes to facility operations and then seek initial certification at high level; others use the certification effort to measure existing operations and certify at a low level initially, then make changes over time and recertify at a higher level. The former may take longer for the initial certification, but meet the project goals. The timing of the selection of the performance period will be influenced by the project goals.

The key is to find credits that fit the organizational culture. It is natural that project teams seeking certification get caught up in the desire to obtain the maximum number of points, but it is important to set goals for the process and keep sight on the goals.

Project teams have to accept that some of the credits are not a good fit for the facility or organization and move on to focus on items that are a good fit. They also benefit from looking across the credit categories to identify where there may be overlapping credit requirements that help speed up the certification and documentation process. The best place to start is by reviewing the prerequisites. The prerequisites should be analyzed early to make appropriate changes as needed. By sitting down with the key players of the facility operations team and someone knowledgeable of the LEED-EBOM rating system, a gap analysis can be done relatively quickly. Advice to those embarking on the LEED journey for the first time: Remember to focus on the intent of the credit.

As mentioned throughout this paper, many current service providers may already be collecting the information you need for LEED documentation, or can provide upon request (i.e., green cleaning, waste haulers, landscaping). Make contact with your service providers, inform them you are pursuing LEED certification, and bring them in as a participant to the process. Most likely, they will want to help you and jump at the opportunity to develop the client relationship. If they have not worked with LEED before but show interest, don't write them off for lack of experience—work with them to advance your goals for sustainable operations.

Prior to investing too much time and effort in a LEED-EBOM certification process, make sure prerequisites can be satisfied. This is especially critical for the Optimize Energy Performance prerequisite to achieve an Energy Star rating in Portfolio Manager of at least 69. Improving building energy efficiency is one of the best opportunities for reducing operating costs in LEED-EBOM but may require significant efforts or an outside consultant.

It may be helpful on other prerequisites and credits to bring in an external service provider to perform tasks for some credits, for example existing building commissioning. When requesting this service, make a formal written request for proposal (RFP) to ensure the contractor will complete each element required for achieving the LEED credit. Many credits require multiple documents and analyses, all of which must be completed to be awarded the points. If a document is missing, points are in jeopardy. The

LEED documentation process requires strong coordination, organization and broad technical skills across multiple types of building systems—consider hiring a LEED facilitator to apply tested tools for managing the process for LEED certification.

When using outside consultants, engage building staff to the greatest extent possible in meetings and activities performed by the external service providers. Instructing building staff to provide assistance to the contractor is a great training opportunity for building engineers and operators.

The most successful LEED-EBOM projects are the ones that engage an entire organization and do not rely on the efforts of a few individuals. It generally takes a team to keep a facility running on a day-to-day basis, and as such it makes sense that the team should be involved in the certification effort. Dividing the credits amongst the team and assigning "champions" to complete the individual credits is the most effective way to complete the process.

The LEED Rating System is continually being evaluated and modified to address feedback from users implementing projects. A balance must be found between rigor and usability. Making the program too rigorous and documentation too onerous creates the risk that the market will reject the rating system as too cumbersome. Yet making the Rating System less rigorous with little documentation for review may lessen its credibility and the projects certified under it. This balance is best determined by the users of the Rating System, and this is why it is critically important for the membership of the USGBC to actively participate in the Rating System updates.

Everyone loves to be first. Most owners and project teams seek the status of being involved with "Firsts" of some type: first LEED-EB certification at this level; first LEED-EB certification at that level; first LEED-EB certification in that state; first of this building type to be LEED-EB certified at this level; etc. With the market uptake of the LEED-EBOM Rating System, the opportunity to be first is quickly passing. However, the real estate market is increasingly recognizing the benefits of a LEED certification and getting serious about reducing all of our buildings' impact on the environment. With a little creativity, a first can be found for any project. And, after all, who wouldn't want their facility to be as healthy, efficient, and cost effective as it can be.

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