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Energy Star, LEED,

and Commercial Buildings

How these two initiatives are helping to raise the bar in facility design and operation by targeting the energy and environmental efficiency of commercial buildings

Typical commercial buildings use nearly one-third of the non-renewable energy consumed annually on our planet.[1] The Energy Information Administration[2] estimates that energy bills for the approximately 67 billion sq ft of commercial space in the United States total $82 billion annually. Experts predict that, around the globe, we will erect as many buildings over the next 50 years as we have over the last 5,000.[3]

Research shows that new commercial construction can achieve 50-percent energy savings using an integrated design approach and carefully implemented energy-performance strategies.[4] In recent years, several initiatives targeting energy use and promoting energy efficiency have emerged. The two most prominent are Energy Star (*www.energystar.gov*) and Leadership in Energy and Environmental Design (LEED) (*www.usgbc.org/LEED*), which are helping set in motion a shift in thinking about energy and resource consumption and indoor environmental quality.

ENERGY STAR

Introduced by the U.S. Environmental Protection Agency (EPA) in 1992 as a voluntary labeling program for energy-efficient computers, Energy Star—described by the EPA as a partnership between organizations, businesses, consumers, and government—has been expanded to cover new homes, most of the buildings sector, residential heating and cooling equipment, major appliances, office equipment, lighting, and consumer electronics.

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In 1999, the EPA introduced the Energy Star Label for Buildings, a set of performance standards that adjusts a building's energy use and compares it to that of similar buildings nationwide. Buildings that perform in the top 25 percent and conform to industry standards for temperature and humidity, illumination, outside-air ventilation, and the control of indoor-air pollutants are eligible to earn the Energy Star label.

The EPA estimates that, through 2002, Americans, with the help of Energy Star, saved more than 100 billion KWH of electricity, prevented more than 20 million metric tons of carbon equivalents of greenhouse-gas emissions, and saved more than $7 billion. Roughly half of those benefits were the result of people using Energy Star-qualifying products in their homes and at work, while the other half were from organizations adopting superior energy-management practices.

LEED

LEED is a voluntary, points-based, national standard for developing high-performance buildings—that is, buildings that benefit from a more-integrated, better-planned design process. Think of LEED as a framework for informed, educated design, as well as a quality-control mechanism. LEED evaluates "greenness" in five categories: Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, and Indoor Environmental Quality.

LEED-NC is the rating system for new construction and major renovation projects. LEED-EB, the rating system for existing buildings and system improvements, is in the pilot phase and expected to be available this year. The goal of LEED-EB is to help building owners operate their buildings in a sustainable way year after year.

In the Energy & Atmosphere category, prerequisites include fundamental building-systems commissioning and minimum energy performance. The latter is defined as meeting ASHRAE/IESNA Standard 90.1-1999, *Energy Standard for Buildings Except Low-Rise Residential Buildings*, or the local energy code, whichever is more stringent. Whether owners decide to go beyond the LEED prerequisite is up to them. The first 53 LEED-certified buildings were an average 30 percent above code in terms of energy efficiency.[5] The designers of some of the buildings opted not to pursue energy efficiency and instead focused on other LEED categories.

INITIATIVES COMPARED

A summary of Energy Star and LEED is presented in Table 1. Basically, LEED helps define what constitutes a green building, while Energy Star primarily is concerned with energy performance. Each initiative has tools related to both the new- and existing-buildings markets, and both have building-certification programs that are relatively new to the marketplace.

Both Energy Star and LEED require adherence to American Society of Heat-

	Energy Star Label	LEED-NC	LEED-EB
Year program established	1999	2000	2003
Benchmarking approach	Statistical analysis	Building characteristics	Statistical analysis and building characteristics
Buildings seeking certification	19,000	1,200	95 (pilot in progress)
Buildings achieving certification	1,400	100	Pilot in progress
Minimum score required	75	26	29
Maximum score achievable	100	69	74
Minimum building size, square feet	Generally 5,000	N/A	N/A
Certification levels	1	4	4
Energy-accounting method	Source consumption	Site energy cost	Site cost or source consumption
Registration cost per square foot	None	1.5 cent to 5 cents	1.5 cent to 5 cents
Certification good for	One year	Five years	One year

TABLE 1. A comparison of the Energy Star and LEED building-certification programs.

ing, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards; however, LEED is more comprehensive. A summary of HVACR and energy standards applicable to each program is presented in Table 2.

LEED has incorporated elements of Energy Star into its rating systems. Compliance with EPA rules and regulations is required to satisfy one LEED prerequisite and achieve five LEED credits in the Sustainable Sites and Indoor Environmental Quality categories. In the Sustainable Sites category, designers have the option of using Energy Star-labeled roofing products to achieve Credit 7.2, *Exterior Design to Reduce Heat Islands*.

The programs are fundamentally different in that Energy Star is performance-based, using the benchmarking technique of statistical analysis to compare energy-use intensities relative to the national population of buildings. LEED-NC, on the other hand, uses a points-based system that assigns a rating according to building characteristics. LEED-EB, like Energy Star, is performance-based, but it goes beyond Energy Star to address whole-building cleaning/maintenance issues, including chemicals, indoor-air quality, energy and water efficiency, recycling, exterior maintenance, and system upgrades. The Energy Star Label for Buildings is incorporated into the LEED-EB scoring system as an option for satisfying LEED Energy & Atmosphere Credit 1, *Optimize Energy Performance*.

Another fundamental difference between the two initiatives concerns the measurement of energy efficiency. Energy Star uses source energy as the basis for benchmarking. A conversion factor (obtained from the 1999 Commercial Buildings Energy Consumption Survey[2] data set)

Energy Star	LEED
ANSI/ASHRAE Standard 52.1-1992, *Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter*	ANSI/ASHRAE Standard 52.2-1999, *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*
ASHRAE Standard 55-1992, *Thermal Environmental Conditions for Human Occupancy*	ASHRAE Standard 55-1992, *Thermal Environmental Conditions for Human Occupancy*
ASHRAE Standard 62-1999, *Ventilation for Acceptable Indoor Air Quality*	ASHRAE Standard 62-1999, *Ventilation for Acceptable Indoor Air Quality*
"IESNA Lighting Handbook"	ASHRAE/IESNA Standard 90.1-1999, *Energy Standard for Buildings Except Low-Rise Residential Buildings*
	ASHRAE Standard 129-1997, *Measuring Air-Change Effectiveness*

TABLE 2. HVACR and energy standards applicable to Energy Star, LEED.

is used to obtain source energy consumption from site-energy-consumption data. In contrast, LEED-NC uses site energy cost (ASHRAE/IESNA Standard 90.1 methodology). LEED-EB essentially combines the two approaches, offering the option of achieving points for site-energy-cost benchmarking or direct application of the Energy Star benchmarking tool Portfolio Manager. (For more information on these two energy-accounting methods, see the sidebar "Site and Source Energy.")

Site and Source Energy

The two methodologies for assessing building energy consumption are site energy and source energy. Site energy is the energy consumed at a building location. Source energy is equal to site energy plus the energy used to generate, transmit, and distribute energy to a building.

Although site energy is the more familiar convention for assessing building energy consumption, it is useful only when comparing buildings with the same fuel type. When comparing buildings with different fuel types, the air emissions and prices of which can vary drastically, source energy is a far more accurate indicator of energy, environmental, and economic performance.

Energy Star uses source energy in benchmarking building energy performance. On-site power generation and the use of on-site renewable-energy sources offset the need to generate source energy. Buildings that utilize these energy-reducing strategies use less source energy, which is accounted for fully in Energy Star performance ratings. Additionally, this convention is fuel-neutral—no building is at an advantage or disadvantage based on its fuel type.

LEED awards energy-efficiency points based on the reduction of energy costs—not merely energy consumption—through the use of the ASHRAE/IESNA Standard 90.1 Energy Cost Budget Method. This is important because energy costs are based on utility-rate structures, which are a major, if not the primary, driver of energy solutions in buildings today. On the downside, this approach fails to include the source-energy component, thus missing the bigger picture of energy *and* environmental efficiency.

STRATEGIES FOR SUCCESS

Although there is no single path to Energy Star certification, a 2001 EPA study identified common characteristics of Energy Star buildings. For instance, of the first 729 buildings to achieve Energy Star certification, 99 percent perform regular operations and maintenance, 85 percent utilize an energy-management system, and 50 percent use motion sensors for lighting systems. A strong organizational commitment to energy efficiency is another hallmark of Energy Star buildings.

The Energy Star Buildings Manual[6] recommends the following integrated approach to improving energy performance in existing buildings:

• Recommission—periodically examine equipment, systems, and maintenance procedures, and compare them with design intent and current operational needs.

• Install energy-efficient lighting systems and controls that improve light quality and reduce heat gain.

• Purchase Energy Star-labeled office equipment, install window films, and add insulation or a reflective roof coating to reduce the energy consumption of supplemental-load sources.

• Properly size fan systems, adding variable-speed drives and converting to variable-air-volume operation.

• Replace chlorofluorocarbon chillers with energy-efficient models to meet reduced cooling loads, and upgrade boilers and other central-plant systems to energy-efficiency standards.

The EPA estimates that the savings from an integrated approach to energy-efficient upgrades can be 35 percent or greater.

Energy Star's New Building Design Guidance is a Web-based initiative consisting of recommended actions at each stage of the design process. The recommendations focus on energy issues and encourage an integrated design approach. The process starts with setting goals and ends with achieving the Energy Star Label for Buildings.

Target Finder, Energy Star's Web-based energy-performance calculator, helps set an energy-use target early in the process. Progress can be measured by comparing simulated energy consumption to the target. Energy strategies are incorporated as an integral part of the design and can be compared to industry benchmarks.

As mentioned previously, LEED considers all elements of the design, construction, and operation of new and existing buildings. The goals and benefits of this whole-building approach are:

• Reduced energy use.

• Reduced operation and maintenance costs.

• Reduced environmental impact.

• Increased occupant comfort.

• Improved indoor environmental quality and occupant health.

• Increased employee productivity.

• Increased property value.

These goals and benefits can be achieved by:

• Instituting a refined design process that meets the needs of integrated design, energy efficiency, and environmental stewardship. (See the sidebar "An Approach to Green-Building Design.")

• Educating clients on the benefits of energy and environmental efficiency. Well-documented case studies, as well as design tools/resources, can go far in aiding this effort. Three good places to start researching are the Energy Star Website, the U.S. Green Building Council (USGBC) Website (*www.usgbc.org*), and the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Website (*www.eere.energy.gov/buildings/highperformance*).

• Leading by example—adopting energy- and environmentally efficient practices within one's own organization.

When designing a building, consider that establishing green-design goals early is key to maximizing integration and energy and environmental efficiency.

Lastly, resist the urge to think of Energy Star and LEED as awards to hang on your wall. Instead, think of them as guides providing tools and resources to help raise the bar in energy and environmental design. They are not designed to do our thinking for us, but assist us in making more-informed decisions.

COSTS AND BENEFITS

The EPA estimates that every dollar invested in an energy-efficient upgrade can produce $2 to $3 in increased asset value. The New Buildings Institute (*www.newbuildings.org*) says that while it often is economical to retrofit buildings for greater energy efficiency, it always is cheaper to make them more efficient at the time they are designed and constructed.

There is a widespread perception that green buildings cost significantly more than traditional ones. For instance, a half-dozen California developers interviewed in 2001 estimated that green buildings are 10- to 15-percent more expensive.[7] But recent data indicate that such estimates are a bit high.

High-efficiency lighting systems generally cost more; however, their high return on investment makes them attractive. Mechanical systems, especially those with fairly elaborate controls and high equipment

An Approach to Green-Building Design

Following is a summary of PCD Engineering Services' approach to green design:

PROCESS

• Set performance goals through the early involvement of all stakeholders.

TEAM

• Create an interdisciplinary team with an integrated, collaborative approach.

DESIGN

• Orient the building to harvest "free" energy sources, including renewable energy and natural cooling/ventilation.

• Improve the building envelope to reduce mechanical-conditioning requirements and right-size equipment.

• Reduce internal loads. This relates to daylighting integration and the reduction of miscellaneous loads through the use of Energy Star-labeled equipment.

• Emphasize HVAC thermal comfort, indoor-air quality (IAQ), and efficiency.

SPECIFICATION AND CONSTRUCTION

• Specify locally and regionally manufactured materials.

• Specify materials that are free of carcinogens and toxic materials.

• Specify low-volatile-organic-compound and nontoxic finishes, paints, stains, and adhesives.

• Avoid chlorofluorocarbon (CFC) based refrigerants and the use of materials containing or produced with CFCs or hydrochlorofluorocarbons.

• Select materials with favorable life-cycle performance.

• Specify the use of materials with recycled content, and consider construction-waste management.

• Specify manufacturers committed to improving their environmental performance.

• Implement a construction IAQ-management plan.

OPERATION

• Verify that the design intent was achieved through commissioning, testing, and ongoing operation maintenance and monitoring.

efficiencies, may cost more, but owners have indicated that the reduced energy, operational, and churn costs far outweigh this premium.

In "The Costs and Financial Benefits of Green Buildings,"[8] a report to California's Sustainable Building Task Force, the average premium for green buildings is said to be slightly less than 2 percent, or $3 to $5 per square foot (Figure 1). The majority of this cost is attributed to increased architectural and engineering design time, modeling, and the time needed to institute sustainable building practices. (As design teams become more familiar with green design, this premium may shrink and even disappear.) High-performance designs may even cost less than traditional ones, primarily when buildings are tuned to reduce loads. Generally, the earlier green-building features are incorporated into the design process, the lower the cost. The report estimates that the financial benefits of green design in a LEED building are $50 to $70 per square foot—more than 10 times the additional cost associated with building green. These benefits are derived in part from lower energy, water, and operation-and-maintenance costs; less waste; reduced emissions; and increased productivity and health.

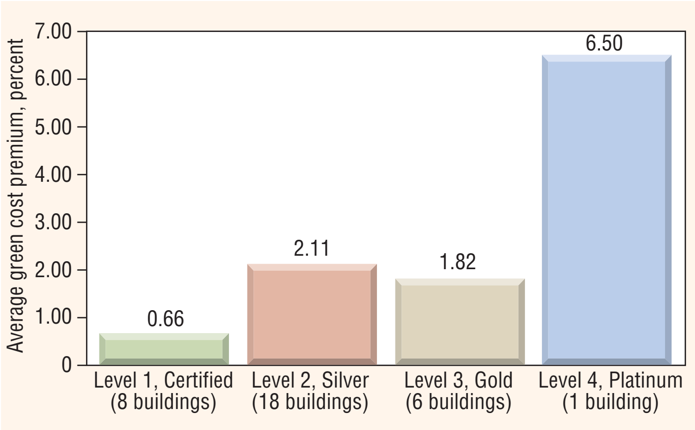

FIGURE 1. Average cost premium vs. level of green certification for offices and schools.

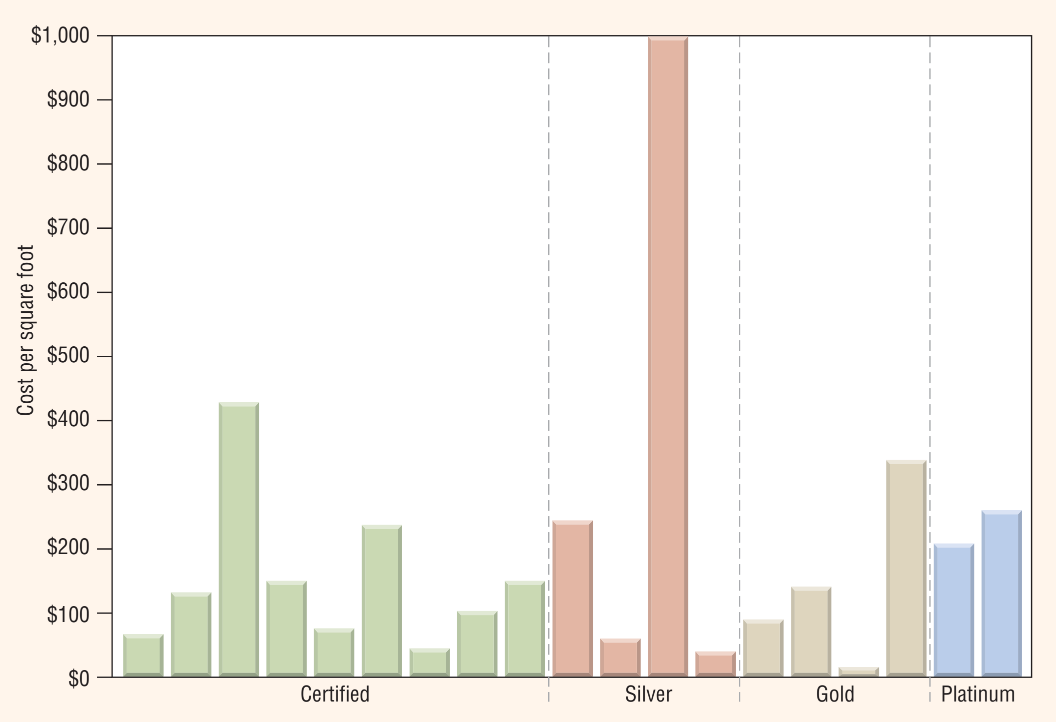

FIGURE 2. Preliminary cost data from 19 LEED-certified buildings (from USGBC Vice President Nigel Howard's "Cost of Green" presentation).

Figure 2 presents preliminary data from 19 LEED-certified projects. The data indicate that costs do not necessarily go up as facility design becomes more integrated and higher-performing.

Lastly, consider that design/construction accounts for only 15 percent of the life-cycle cost of a building. So, a 5-percent increase in first cost is less than 1 percent over the life of a building.

ADDITIONAL CONSIDERATIONS

If energy efficiency is a building owner's primary goal, he or she may wish to pursue Energy Star certification and become an Energy Star partner. If other aspects of a project, such as sustainability and/or building materials, are the primary focus, then LEED certification probably will be more desirable. To ensure a green building is a high energy performer, an owner may choose to pursue both.

CONCLUSION

Experience has shown that you do not have to have state-of-the-art systems to have an energy-efficient building as defined by Energy Star, and a sustainable building as defined by LEED will not necessarily be a high performer with regard to energy efficiency. But the tools and resources of both organizations can help improve how buildings are designed and operated.

NOTES

1) USGBC. (2001). *LEED reference guide, version 2.0*. Washington, DC: U.S. Green Building Council.

2) From the 1999 "Commercial Buildings Energy Consumption Survey," Energy Information Administration, U.S. Department of Energy, available at *www.eia.doe.gov/emeu/cbecs*.

3) Gregory, B. (2002, May 2). The future bodes well for green development. *Seattle Daily Journal of Commerce*, *www.djc.com/news/en/11132992.html*.

4) From the U.S. EPA's "New Building Design Guidance and Target Finder," available at *www.energystar.gov/ia/business/building_design/NBD&TF_final.pdf*.

5) LEED Advanced Training Workshop, held Oct. 9, 2003, in Denver.

6) Available at *www.energystar.gov/ia/business/Introduction.pdf*.

7) Berman, A. (2001). *Green buildings: sustainable profits from sustainable development* (unpublished report, Tilden Consulting). Available from the author (*adam@isabellafreedman.org*).

8) Capital E Group. (2003, October). *The costs and financial benefits of green buildings*, available at *www.scsa.ca.gov/costs_financials.pdf*.

Coming to Cleveland July 20-23: the Engineering Green Buildings conference, hosted by HPAC Engineering. *For more information, go to the Engineering Green Buildings "microsite" at* www.engineeringgreenbuildings.com.