DOE Leadership in Energy and Water Efficiency for Sustainable Federal Buildings

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Executive Summary

Executive Order 13123 directs federal agencies to develop sustainable building practices. In response, a number of agencies have adopted policies based on the US Green Building Council's "Leadership in Energy & Environmental Design" (LEED) Rating System. LEED provides both a *framework* of sustainable design features to consider and a *performance metric* by which the sustainability of the design product can be measured. The purpose of this White Paper is to review the range of sustainable construction policies adopted by federal and non-federal agencies, particularly those based on LEED. We outline several options for DOE to consider in formulating a "Secretarial Challenge" that would apply LEED to new DOE buildings.

Because energy and water efficiency are central elements of DOE's mission, we also present options for the Secretarial Challenge to place special emphasis on energy and water efficient design and performance assurance in new DOE buildings. This emphasis provides a leadership example to other public agencies. A Secretarial Challenge would also build on DOE's experience to date with applying LEED and other sustainable/energy-efficient design criteria to a few showcase buildings at several sites.[1] This would allow the best practices of the Department's own leading examples to become the norm for all future DOE construction.

Application of the LEED rating system varies significantly across federal agencies. The Departments of State and Veterans Affairs, for example, adopt specific items from the LEED project checklist without adopting the overall rating structure. Commerce and Interior have adopted LEED on a building-by-building basis, but have not established formal agency-wide policies. NASA has adopted the LEED structure, but has made LEED a desired goal rather than a project requirement. The Air Force has set specific performance level requirements using LEED, but has elected to "self certify" its projects rather than opt for full LEED certification. Finally, agencies such as GSA, EPA, and the Navy have adopted the entire LEED rating system, with specific target levels to be achieved by new construction projects. The Army has gone one step further, establishing additional criteria that build on the LEED system through a closely related Sustainable Project Rating Tool (SPiRiT). The Army now hopes to incorporate major elements of SPiRiT into future versions of LEED.

A number of state, county, municipal, and special-purpose agencies (for example, school districts) have also adopted LEED as a mechanism for establishing and monitoring sustainable construction practices. At least 10 states and 19 local governments have policies for new construction based on LEED, either in place or currently under consideration. Several of these state and local agencies have also developed additional criteria to supplement LEED with specific, often more stringent, requirements. Energy efficiency requirements are among those often included in "LEED Supplements."

LEED has also been very successful commercially, with over 1200 design projects registered as intending to achieve LEED certification. This commercial uptake strongly suggests that the market sees value in the LEED rating and certification system.

At least three recent studies have attempted to quantify the added first cost of LEED design and construction. These studies find that:

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[1] Even in the absence of an explicit policy, DOE facilities have already certified three LEED buildings and have another 12 registered with LEED, with the intent of future certification. Of the certified buildings, 2 of the 3 achieved both targets recommended for the Secretarial Challenge: 4 energy performance points and a minimum of 3 water efficiency points. However, among the DOE buildings registered for LEED (and in various stages of design or construction), from the data submitted to date only 1 is definitely planning to achieve 4 energy performance points, while the others may achieve these LEED credits. Three of the 12 DOE projects definitely intend to earn the proposed minimum of 3 water efficiency points; the others may also earn 3 or more water credits.

- high levels of sustainable design can be achieved at low additional first cost — often less than 5% of the total construction cost;
- the first cost can sometimes be negative — when applied on a whole-building basis early in the design process, the "best practice" techniques that LEED emphasizes can result in a design and construction process with an even lower first-cost than the status quo;
- the life cycle benefits of sustainability, considering only those readily quantifiable, regularly offset the higher initial cost — particularly with regard to improved energy performance; and
- additional hard-to-quantify benefits like improved occupant health and productivity are roughly estimated to be an order of magnitude larger than the readily measurable direct cost savings (energy, water, building maintenance, etc.).

Overall, the design and construction of sustainable buildings is becoming increasingly common throughout the US. Numerous public and private entities have determined that the benefits of sustainable construction, using LEED as a performance metric, outweigh the additional first costs for energy-efficient and sustainable design, construction, and LEED certification.

We provide a framework for DOE to consider three options for a Secretarial Challenge goal for sustainable DOE facilities. The low option would essentially match what several other federal agencies are already doing, while the high level would set a significant new standard of sustainable and energy-efficient performance for the federal sector — one that would be practical and cost-effective to achieve provided that DOE is prepared to furnish strong, consistent leadership. Within each level, we consider three main components of sustainable performance:

(1) a target level of LEED performance (e.g., Certified, Silver, or Gold),

(2) an additional component of energy performance leadership that extends beyond the minimum LEED energy requirements and also emphasizes efficient water use, and

(3) added steps for performance assurance, to ensure that sustainable design and construction intent translates into real buildings that operate in a high-performance, sustainable way.

Table S-1. Policy Options for DOE Consideration

LEED-NC Level		Additional Performance Requirements	Performance Assurance Measures
I	Certified	15% above ASHRAE 90.1-1999†; 2 Water Efficiency points	Building utility meters
II	**Silver**	**30% above ASHRAE 90.1-1999; 3 Water Efficiency points**	**LEED credit EA3 (Additional Commissioning); Interval meters for electricity**
III	Gold	30% improved performance for total building load†; 4 Water Efficiency points	EA3 plus LEED credit EA5 (M&V); Sub-metering of significant end-uses

†For laboratory buildings, special energy performance provisions are recommended – see text and Appendix B.

Using this framework, we conclude with a recommendation that DOE consider the medium level of policy options (displayed in bold in the table above) for the Secretarial Challenge goal and develop a roadmap for implementing the Challenge.

Introduction

This paper provides background information on policies for sustainable construction of new buildings. Specifically, it details the use of the US Green Building Council's Leadership in Energy & Environmental Design Green Building Rating System for New Construction[2] (LEED-NC) as a design standard adopted by a variety of actors, including federal, state, and municipal government agencies throughout the US. The paper also provides information about specific strengths and weaknesses in using LEED-NC to deliver high-performance sustainable buildings, suggests options that can augment LEED-NC, and discusses economic costs and benefits of these sustainable construction policy options.

The purpose of this paper is to inform consideration of a DOE policy on the sustainable construction of new DOE buildings. We argue that three elements are necessary for such a policy:

(1) a *metric* that defines sustainability, against which DOE design and construction practices can be measured;

(2) an *energy and water performance* component that creates a clear standard of life-cycle cost-effective design, construction, and operations practice; and

(3) a *performance assurance* component that provides a positive feedback loop between sustainable design intent and actual building design, construction, and operational performance.

The information provided here may be used to formulate a Secretarial Challenge goal for DOE Offices and programs, including the DOE National Laboratories, to help DOE design, build, and operate its new facilities in a cost-effective, high-performance, and sustainable manner.

Steps in preparing this White Paper included:

- Compilation of the goals and policies established by other federal agencies, as well as selected state and municipal agencies, concerning sustainable design for their own facilities, especially policies and practices based on LEED criteria.
- Assessment, through literature review and selected interviews, of these agencies' experience with implementing sustainability policies, including an overview of sustainability costs and benefits for actual projects.
- Development of Challenge goal options for consideration by DOE that are:
    - bounded by the range of goals already established by federal, state, and local agencies;
    - designed to demonstrate DOE leadership in the energy and water efficiency aspects of sustainable design; and
    - structured in ways that are likely to be seen as effective and achievable by the DOE community.
- Circulation of the White Paper to DOE personnel for critical review, and adaptation of the White Paper content to reflect this input.

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[2] The current version (v2.1) of the LEED-NC rating system can be found on the US Green Building Council's Web site at: http://www.usgbc.org/Docs/LEEDdocs/LEED_RS_v2-1.pdf

The Policy Environment for Sustainable Construction

In 1999, President Clinton issued Executive Order 13123 - "Greening the Government Through Efficient Energy Management." A component of this Executive Order directs agencies to develop sustainable building practices. Specifically, Section 403(d), "Sustainable Building Design," requires:

> "DOD and GSA, in consultation with DOE and EPA, shall develop sustainable design principles. Agencies shall apply such principles to the siting, design, and construction of new facilities."

The initial response to this requirement was the sponsorship by several federal agencies of the Whole Building Design Guide (WBDG) website (http://www.wbdg.org), which is managed by the National Institute of Building Sciences. The WBDG site provides a wealth of technical information and reference sources on sustainability, aimed at both federal and non-federal project managers and building designers; however, while offering general guidance on sustainability principles, the site does not provide specific performance goals or requirements for federal construction, nor specific metrics to measure progress toward these goals.

A number of federal agencies have set such goals and requirements for their own construction programs (OFEE 2003; DOE/FEMP 2004). DOD and GSA, the agencies designated as sustainability leads in EO 13123, have adopted criteria for their own use based on LEED-NC. LEED-NC offers a specific set of metrics to measure the achievement of sustainable design principles – at least at the design stage.[3] There are two main benefits to using LEED:

(1) it provides a standardized framework for measuring the successful adoption of sustainable design and construction practices; and

(2) it is a product that has been successful in the commercial sector and as a result is becoming a known quantity with architects and engineers.

Federal and non-federal government agencies have been among the most active users of LEED in its first few years, with public buildings accounting for about half of all buildings that have completed the LEED-NC certification process.[4] By comparison, government buildings make up roughly 10% of total new construction each year.

The LEED rating system provides both a framework of sustainable design features to consider and a performance metric by which the sustainability of the design product can be measured. The system combines a set of minimum requirements with a flexible system of points, or "credits," to provide design flexibility based on the client's priorities and the specific opportunities or constraints of each site and facility. The LEED-NC rating for new construction offers a total of 69 possible credits, divided into five building characteristic categories and one design innovation category:

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[3] A separate LEED rating system for existing buildings, LEED-EB, is now in development. It is designed mainly to apply to improved operation and retrofit of existing buildings, rather than as a tool for following a new building after the design stage to assure that the sustainable design intent is actually achieved throughout construction and long-term operation of the building.

[4] As of this writing, 84 buildings have completed the LEED certification process (under Version 2, with an additional 19, including pilot projects, certified under LEED Version 1). Of those, 10 (12%) are federal, 25 (30%) are state or local, 17 (20%) are institutional (e.g. universities), and the remaining 32 (38%) are either commercial or undetermined. In total, nearly 2/3 (62%) of the buildings that have completed the certification process have been non-commercial buildings.

- Sustainable Sites (14)
- Water Efficiency (5)
- Energy & Atmosphere (17)
- Materials & Resources (13)
- Indoor Environmental Quality (15)
- Innovation & Design (5)

LEED performance is rated at four levels: Certified[5] (26-32 points), Silver (33-38), Gold (39-51), and Platinum (52-69), depending on the number of credits achieved by the facility during its design stage. An important component of the LEED system is certification of the design by a third party, which helps to assure that the policy intent is accurately reflected in the building design.

Appendix B presents an analysis of both LEED-certified and LEED-registered buildings, discussing which energy and water LEED credits have been achieved or targeted in these buildings.

Federal Agency Policies Using LEED

Eleven federal agencies have made some level of commitment to sustainable building practices using the LEED rating system. These agencies are summarized in Table 1.

Table 1. LEED Policies in Federal Agencies[6]

Agency	LEED Goal	Goal Notes	USGBC-certified projects (LEED v1 or v2)
Commerce – National Weather Service	Silver	"Shall strive for minimum of LEED Silver"	1 Certified (v2); 1 Silver (v 2)
Defense - Pentagon	None		2 Certified (v2)
Defense - Air Force	Certified	Required by FY '09, self-certified	1 Bronze (v1)
Defense – Army	Gold*	*SPiRiT, not LEED; Required by FY 06[7]	
Defense – Navy	Certified	Required now	1 Certified (v1)
Energy	None		2 Silver (v2); 1 Certified (v2)
EPA	Silver	Required by 2005	1 Gold (v1), 1 Gold (v2)
GSA	Certified	Required now, Silver recommended	3 Certified (v2)
Interior	None	"Incorporating" LEED criteria, no goal	2 Certified (v2)
NASA	Silver	Silver is baseline goal, Gold recommended where cost-effective	
State	None	LEED elements written into RFPs & design guides	
Transportation – Federal Aviation Administration	None		1 Gold (v2)

There are four forms of policy commitment by federal agencies to using LEED, ranging from informal use of LEED elements as a general guide or checklist to specific requirements that new buildings achieve a defined LEED rating level:

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[5] Unfortunately, it is easy to confuse the terminology of LEED certification (meaning the design review process) with the LEED-NC performance level of Certified. To minimize confusion, in this report the performance level will always be capitalized, while the process will always be written in lower-case type.

[6] In addition to the agencies listed, we searched Websites for nine other agencies but could find no published references to existing policies for sustainable new construction or for the use of LEED ratings.

[7] The Army began requiring SPiRiT for all new construction beginning in FY '02, with an initial requirement of SPiRiT Bronze. From FY '03-FY '05, "showcase" projects were selected and required to meet SPiRiT Gold. In FY '06, all projects are required to meet SPiRiT Gold. FY '02 and '03 projects are currently under construction.

(1) use of LEED materials on an ad hoc basis but with no stated LEED policy;

(2) use of LEED ratings as a "desired goal" for new construction;

(3) use of LEED as a goal, with the intent to require compliance in the future; and

(4) agency-wide requirements that new construction projects comply with LEED (with either third-party or self-certification.)

An example of the first type is the Department of State, which is writing LEED criteria into its RFPs and design guidelines for overseas construction (e.g., embassies and consulates). Even absent a whole-building or systems approach to sustainability, this *ad hoc* method can provide some level of attention to sustainable design features. The drawback is that, by focusing only on individual components, such projects may not achieve the synergies possible when a sustainable design concept is adopted early in the design process and applied to the project as a whole. A selective approach toward sustainable building practices makes it difficult to reach an optimal level of energy efficiency, in particular. For example, a component-based design criterion might specify a high-efficiency chiller for building cooling but fail to account for the significant benefits from energy-efficient building envelope, lighting, and HVAC distribution system features which could significantly reduce the size of the chiller needed – and thus its first cost.

Another example of the limited, selective use of LEED is the Department of Interior. While LEED is referenced in the Department's 2001 Energy Conservation Action Report, the policy guidance is vague, saying only that Interior "will incorporate [LEED] as a self-assessing system." An example of this policy in practice is the National Park Service, which recommends use of the LEED checklist during design. In theory, this means that Park Service designers and contractors could use a holistic approach, but this may be difficult in practice unless the full LEED rating system is also used to provide a clear-cut metric for success.

The second type of LEED application recognizes the benefits of a system-level approach and uses USGBC's Green Building Rating System to provide a comprehensive framework for sustainable design, but the choice to use LEED is made at the facility or sub-agency level. Examples include the National Weather Service within the Department of Commerce and the DOE National Laboratories. Both entities are currently building LEED-certified buildings, but not in response to an agency-wide policy recommending or requiring LEED. (The National Weather Service does have a policy for all of its buildings, but Commerce does not.)

NASA has taken the step of providing a general goal for sustainable design throughout the agency, but as a suggested target rather than a requirement that all construction projects meet this goal – at least for the time being. To some extent, this may represent a cautious first step on a path to eventual adoption of a LEED requirement. This "test and see" approach allows the agency's technical and management personnel to become familiar with the technical and procedural requirements of LEED compliance, and more comfortable with the incremental benefits and costs involved. A number of agencies that now fully embrace LEED for new construction have followed this route in the past. NASA recommends a relatively high level of performance for all new buildings (LEED Silver), and also has a goal of LEED Gold whenever this is cost-effective. However, for now there is no firm requirement that NASA construction projects meet either target.

Beyond this second tier of LEED applications (i.e., recommended but not required), a few agencies such as the Air Force have announced their intent to meet LEED standards at a specific date in the future. (The Air Force will begin in FY 2009 to require the LEED Certified level for all construction, though a subset of "showcase facilities" are required to reach these goals now.) A delayed effective date may have the advantage of allowing agency staff and contractors sufficient lead time to prepare for the smooth and cost-effective application of LEED, for projects just now entering the planning pipeline. The EPA has taken a similar approach, although its LEED target level is one step higher and its effective date sooner (LEED Silver beginning in 2005). EPA has also shown that the anticipation of future policy implementation can inspire voluntary improvements even in the near term: that agency has already certified two new laboratories for LEED Gold.

Two additional features of EPA's experience bear mention. First, EPA has had success in certifying laboratory facilities. As we will discuss in the section on DOE's construction environment, laboratories are a significant fraction of DOE's anticipated construction. EPA's experience with LEED in certifying laboratories is therefore particularly applicable to DOE's planned laboratory projects. Second, in its policy goals, EPA emphasizes its own environmentally preferable products program and the linkage between that program and the Materials and Resources section of LEED. In this way, **EPA integrates its agency activities into policy goals for its own facilities**, establishing a leadership position with regard to Materials and Resources. DOE has an opportunity to provide similar leadership with respect to the Energy & Atmosphere and the Water Efficiency sections of LEED.

The last group of agencies are currently requiring LEED compliance at various levels, for all new construction. Examples include GSA, the Army, and the Navy, all of which currently require LEED compliance (or a roughly similar level of performance in the case of Army's SPiRiT rating) for new facility construction:

- The Navy requires LEED certification.
- GSA requires LEED Certification but recommends LEED Silver as a design goal.
- The Army requires a Gold rating using its own SPiRiT rating system (based on LEED)[8]

The Army in fact started with a target compliance level of SPiRiT Bronze in 2001, but found that it could exceed this level very cost-effectively and has raised its target twice, first to SPiRiT Silver in February of 2003 then to Gold two months later. In the memo outlining the increase from Bronze to Silver, the Army wrote:

> "This goal [SPiRiT Bronze] was established with the assumption that most projects can achieve the Bronze level without additional cost if some basic SDD [Sustainable Design and Development] principles such as integrated design and planning and design charrettes are adopted. USACE [Army Corps of Engineers] districts have gained valuable SDD experience since we adopted this policy and virtually all Army MILCON projects have achieved Bronze level within budget. …Army leadership has recognized the success in implementing SDD and has asked USACE to achieve a higher level of SDD." (Army, February 2003)

GSA has also had success in meeting its goal and is now considering raising the GSA requirement to Silver. This would replace the current policy of requiring LEED Certified while recommending LEED Silver for new GSA buildings.

These federal sector LEED goals are relatively new; indeed, the LEED-NC process itself is still rather new—USGBC introduced LEED v1 in 2000. Relatively few buildings have completed the design, construction, and certification process; however, in addition to certified buildings, USGBC also keeps a list of "registered" buildings – buildings planning on seeking a LEED rating but not yet complete. There

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[8] Specific performance comparisons between LEED and SPiRiT are complicated and depend to some extent on the project, but SPiRiT Gold appears to be a high target for sustainable, roughly comparable to LEED Silver (see Appendix A).

are currently over 1,200 registered buildings in the USGBC database. Table 2 below provides a partial list of federal buildings in the USGBC registered buildings database. The table is incomplete because it contains only those federal buildings that: (a) chose to make their information publicly available, (b) provided significant data in the database, and (c) were identifiably federal buildings based on agency or keyword search of the USGBC database. A table containing additional data elements is available in Appendix B.

Table 2. Federal Buildings Registered With USGBC

Agency	Building Type	Minimum LEED Level	Agency	Building Type	Minimum LEED Level
CDC	Lab	Certified+	DOE-NREL	Lab	n/a
DHS	Office	Gold+	DOE-ORNL	Assembly/Mixed	Silver+
DOD	Office	n/a	DOE-Sandia	Lab	Silver+
DOD	Other	n/a	DOE-Sandia	Lab/Cleanroom	Certified+
DOD	Recreation	n/a	EPA	Office	n/a
DOD-Air Force	Multifamily	n/a	FAA	Other	Gold
DOD-Air Force	n/a	n/a	GSA	Courthouse	n/a
DOD-Air Force	n/a	n/a	GSA	Courthouse	Gold+
DOD-Air Force	n/a	n/a	GSA	Courthouse	n/a
DOD-Air Force	Office	n/a	GSA	Courthouse	n/a
DOD-Air Force	Other	n/a	GSA	Courthouse	n/a
DOD-Air Force	Other	n/a	GSA	Courthouse	n/a
DOD-Air Force	Other	n/a	GSA	Courthouse	Certified+
DOD-Navy	Industrial	n/a	GSA	Courthouse	n/a
DOD-Navy	Multifamily	Certified+	GSA	Office	Gold+
DOD-Navy	Multifamily	Certified+	GSA	Office	n/a
DOD-Navy	Multifamily	Certified+	GSA	Office	n/a
DOD-Navy	Multifamily	Certified+	GSA	Office	n/a
DOD-Navy	Multifamily	n/a	GSA	Office	n/a
DOD-Navy	n/a	n/a	GSA	Office	n/a
DOD-Navy	Office	Silver+	GSA	Office	n/a
DOD-Navy	Office	Silver	GSA	Office	Certified+
DOD-Navy	Office	Certified+	GSA	Office	Silver+
DOD-Navy	Office/School	n/a	GSA	Office	n/a
DOD-Navy	Recreation	Certified+	GSA	Other	Certified
DOD-Navy	School	Silver+	GSA	School	Certified+
DOD-Navy	School	n/a	GSA	School	n/a
DOE-ANL	Industrial	n/a	Interior	Office	Certified+
DOE-ANL	Lab	Certified+	Interior	Office	Silver
DOE-BNL	Lab/Office	Certified+	NASA	Multifamily	n/a
DOE-BPA	Office/Indus.	n/a	NASA	Office	n/a
DOE-INEEL	Lab/Office	n/a	NASA	Recreation	n/a
DOE-LBNL	Lab/Office	Silver	NASA	School	n/a
DOE-LBNL	Office	n/a	NOAA	Lab	n/a
DOE-NETL	School	Certified+			

As the table shows, a number of federal buildings are "in the pipeline" and can be expected to be certified within the coming years.

Finally, we have spoken with policy makers within a number of these agencies. All of them report that there have been no significant complaints from the field offices about these policies. The lack of complaint is not necessarily synonymous with universal compliance with these policies, of course, but it does appear as though they are being adopted without substantial difficulty to date. In the future, additional insights on agencies' experience with implementing LEED might be obtained by interviewing project managers and other field personnel, to complement the view of agencies' headquarters staff.

State and Local Policies

States and municipal governments have also been adopters of LEED, with some pushing the performance envelope by mandating that some of the LEED credits be achieved by all projects, or/and adding specific requirements for features not covered by LEED (see Tables 3 and 4). These "LEED-supplemental" policies, once tested by a few pioneering agencies, may also prove a fertile source of new ideas for future refinements to strengthen the overall LEED rating system. If DOE were to take a leadership position in supplementing LEED with specific energy performance and water efficiency provisions, other federal and non-federal agencies might follow the same path, making it more likely that future versions of LEED will also incorporate stronger energy provisions.

Table 3. LEED Policies in State Agencies

States:	Policy
California	Executive Order requires, "Designing, constructing and operating all new and renovated state-owned facilities paid for with state funds as "LEED Silver" or higher certified buildings"
Connecticut	Legislation introduced requiring LEED Certification of capital projects.
Illinois	Capital Development Board is considering requiring LEED Certification for public projects
Maine	Considering Executive Order directing all new or expanding state buildings to incorporate LEED guidelines provided that standards can be met on a cost-effective basis.
Maryland	Executive Order requiring all capital projects over 5,000 gsf to earn LEED Certification. Legislation introduced to codify this policy.
Massachusetts	Considering LEED adoption for all state projects.
New Jersey	Executive Order requiring all new school designs to incorporate LEED guidelines. The New Jersey Economic Schools Construction Corporation is encouraging the use of LEED but not requiring certification of new projects built under its $12 billion public school construction program.
New York	Executive order "encourages" LEED certification for state projects; NYSERDA offers incentives for design teams of any New York State building that achieves a LEED rating.
Pennsylvania	Draft bill under consideration would require LEED certification for state projects.
Washington	Legislation under consideration would require LEED for state projects.

Table 4. LEED Policies in Municipalities

Municipalities:	Policy
Arlington, MA	Requires all new buildings and major renovation projects to achieve LEED Silver.
Austin, TX	Requires LEED Certification of all public projects over 5,000 gsf
Berkeley, CA	Requires municipal buildings to achieve LEED Certified. Council required the city staff to propose within 6 months: (a) the minimum building size for this standard, and (b) a deadline to increase this standard to LEED Silver
Boulder, CO	All new or significantly renovated city facilities are built to LEED Silver
Bowie, MD	Requires all municipal projects to follow green building criteria and to use LEED guidelines on a project by project basis
Chicago, IL	Goal of LEED Certified for all new public buildings
Dallas, TX	Issued a resolution requiring all new city buildings larger than 10,000 square feet to have at least LEED Silver certification.
Eugene, OR	All new construction, additions, and/or remodels encompassing over 5,000 gsf of building area shall achieve the equivalent of LEED Certified. A higher equivalent rating should be sought where practicable. In addition, all City buildings and facilities shall be operated and maintained in a sustainable manner using LEED-EB as a guide.
Kansas City, MO	Requires that all new city buildings be designed to meet LEED Silver at a minimum.
King County, WA	Executive Order requires all new public construction projects to seek LEED certification and encourages the application of LEED criteria to building retrofits and tenant improvements. A local LEED application guide is currently under development.
Los Angeles, CA	On April 19, 2002, the Los Angeles City Council voted to require LEED certification for all public works construction projects 7,500 gsf or larger. As of July 2003, all building projects funded by the City of LA are required to be LEED certified.
Los Angeles Community College District	In March 2002, LEED certification of new construction projects was approved as part of the $1.6 billion bond proposition funding building projects on the nine campuses of the LA Community College District.
Omaha, NE	All new Metropolitan Community College construction projects and sites must meet LEED certification.
Portland, OR	Requires LEED certification of all public projects (new and major retrofits) and has developed a Portland LEED supplement.
Sacramento, CA	Goal of LEED Silver for new public buildings over 5,000 gsf.
San Diego, CA	Requires LEED Silver for new construction and major renovation of public buildings over 5,000 gsf.
San Jose, CA	Requires LEED Certification of all municipal projects over 10,000 gsf.
San Mateo County, CA	Requires new projects and additions built by the County and greater than 5,000 sq. ft. to achieve LEED certification at the highest practicable rating level. Smaller projects are encouraged to follow LEED standards but are not required to submit documentation for certification.
Santa Monica, CA	Requires LEED Silver for all new city projects
Seattle, WA	Requires LEED Silver certification of all city owned projects over 5,000 gsf.

DOE Policies

In addition to the government-wide requirements of Executive Order 13123, DOE has established its own guidance on sustainable construction through Order 430.2A, "Departmental Energy and Utilities Management," with the general requirement that sustainable design principles be applied to new construction of DOE facilities. Any new DOE building with an area of greater than 10,000 gross square feet, or with estimated energy use of 500 million Btu or greater, must submit certification to FEMP at the end of Title II design. The certification must demonstrate that the design meets federal performance standards for energy efficiency, and that the design "incorporates sustainable design principles."

Federal performance standards for energy efficiency are found in 10 CFR 434, "Energy Code for New Federal Commercial and Multi-Family High Rise Residential Buildings" and 10 CFR 435, "Energy Conservation Voluntary Performance Standards for New Buildings; Mandatory for Federal Buildings."

In addition, buildings must be operated in accordance with 10 CFR 436, "Federal Energy Management and Planning Programs," Subpart F, "Guidelines for General Operations Plans."

Finally, various Executive Orders and Federal Acquisition Regulations require DOE, along with other agencies, to specify and purchase equipment and building products with some component of sustainability, including energy- and water-efficient products, recycled content, environmental preferable, and bio-based products.

LEED Projects Within DOE

Three projects at DOE-related facilities have been completed using the LEED design process and certified by the US Green Building Council. They are the Central Supply Facility for Argonne National Laboratory, certified Silver under the LEED v2 criteria; the Ampere Annex for the Bonneville Power Administration, also certified Silver under LEED v2; and the East Campus Modernization project at Oak Ridge National Laboratory, which earned a LEED v2 Certified rating.

Two items are of interest with regard to these DOE projects:

- LEED Energy & Atmosphere points: The two LEED Silver buildings each achieved 4 energy performance points (i.e., 30% performance improvement beyond ASHRAE standards.) The ORNL building received 3 points. In addition, both the Argonne and Oak Ridge projects received LEED points for Additional Commissioning and Measurement and Verification. None of these projects received Renewable Energy or Green Power points.
- LEED Water Efficiency points: Both of DOE's LEED Silver buildings received 4 Water Efficiency points: 2 for non-potable use or no irrigation for landscaping, and 2 for a 30% reduction in interior water use. The ORNL building also received the 2 irrigation points.

In addition to these three certified projects, there are 12 other DOE projects listed in the USGBC database of LEED registered projects. While the data are less complete for these projects, a similar overview shows:

- LEED Energy & Atmosphere points: Of the six projects that provided energy performance goals, one was definitely planning to achieve 4 energy performance points (30% beyond ASHRAE) while the other five were considering achieving this level of performance (or better).
- Four of the projects (all of those reporting data in this category) definitely planned to achieve the Additional Commissioning LEED credit (the rest said "maybe").
- Five of the six projects reporting data on the Measurement & Verification LEED credit intended to achieve it (only 1 in 12 projects specifically excluded this credit).
- Two of the five projects reporting data planned to earn the Green Power credit, three were not, and the other 7 were still undecided.
- Six of the DOE projects reporting data were considering seeking Renewable Energy LEED points, while four had decided not to. Two provided no information.

Finally, there are also a number of activities underway at DOE sites to create site-level sustainability policies, design guidelines, etc. A recent example of this is the draft EFCOG template for construction guide specifications. (DOE/EEWG, 2004)

Overall, therefore, there are numerous sustainable construction activities taking place within DOE. In this context, the opportunity is ripe for a DOE policy action that can give unified direction and purpose to these various activities, recognizing the value of those projects that have already taken place and disseminating those practices as the new norm for sustainable construction throughout DOE.

Other Policy Considerations

In addition to the existing policies noted above, there are two emerging policy initiatives that may affect DOE's construction practices and complement a Secretarial Challenge for DOE leadership on energy and water efficiency within LEED. The first is legislative language that has been included in Congressional energy bills for the past two years. Senate Bill S.2095 Section 103 requires advanced metering in federal facilities[9], and Section 107 requires energy performance 30% above current ASHRAE 90.1 requirements. Section 107 also reaffirms commitment to sustainable construction practices in the federal sector. House Resolution H.R. 6 contains similar language.[10] These legislative elements have received strong bipartisan support and the specific provisions have been unchanged through several iterations of proposed energy legislation. This makes it more likely that these provisions for new federal construction will be included in the energy conservation sections of any energy bill that Congress may approve.

The second policy under development is a Memorandum of Understanding among several federal agencies currently using LEED. The MOU would supplement the requirements of LEED-NC with additional federal requirements, and may be one step along a path to a future Executive Order on Sustainable Federal Buildings. The draft MOU is being coordinated through the FEMP Interagency Sustainability Working Group, working closely with the Office of the Federal Environmental Executive (OFEE). One component being considered for this "LEED supplement" is an energy performance target of 20% above ASHRAE 90.1-1999. Water efficiency, indoor environmental quality, and materials and resource requirements are also being proposed, along with other sustainability provisions championed by the various participating agencies. DOE's announcement of the Secretarial Challenge could be instrumental in assuring that energy and water efficiency assume a primary role in any interagency policy agreement (or future Executive Order) to use and supplement LEED for new federal construction.

Finally, DOE buildings and planned construction are primarily a mix of office space, laboratories, and industrial process facilities. Any potential DOE construction policy must take this building mix into account. Laboratories, in particular, tend to be highly energy-intensive due to health- and safety-related ventilation requirements and a substantial amount of plug-in equipment. These intensive energy uses offer significant opportunities for improved efficiency in high-performance laboratories, as demonstrated through the EPA and DOE sponsored project on "Laboratories for the 21st Century" (Labs-21).[11]

As noted above, EPA has certified two laboratories at LEED Gold levels. Other laboratories have also been certified through LEED-NC, one at the Platinum level. In addition, over 100 laboratory construction projects have been registered for future certification under LEED-NC. This shows that it is possible to use the LEED-NC rating system in its present form to design and build sustainable, LEED-

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[9] FEMP's O&M program has a Web site dedicated to advanced metering issues in the federal sector, including discussion of this pending legislation. It can be found at:
http://www.eere.energy.gov/femp/technologies/om_advmetering.cfm

[10] For a summary of elements contained in the various House and Senate energy bills that have been introduced, see the Alliance to Save Energy's summation at:
http://www.ase.org/policy/EnergyBillsComparison_Mar_2004.pdf

[11] More information about Labs-21 is available at:
http://www.labs21century.gov

certified laboratory facilities. Appendix B includes a discussion of both LEED-certified and LEED-registered laboratories and ways to apply a DOE or federal policy to this specific building type.

Two specific issues about the applicability of LEED-NC to laboratory spaces require additional discussion. The first concerns the design requirements of LEED-NC. LEED-NC requires the use of ASHRAE 90.1-1999 as a design prerequisite. Two common features of laboratories—100% outside air supply and fume hoods—are addressed by ASHRAE 90.1-1999:

1) 100% outside air supply is covered by Section 6.3.6.1 – Exhaust Air Energy Recovery, which requires:

> Individual fan systems that have both a design supply air capacity of 5000 cfm or greater and have a minimum outside air supply of 70% or greater of the design supply air quantity shall have an energy recovery system with at least 50% recovery effectiveness. Fifty percent energy recovery effectiveness shall mean a change in the enthalpy of the outdoor air supply equal to 50% of the difference between the outdoor air and return air at design conditions. Provision shall be made to bypass or control the heat recovery system to permit air economizer operation as required by 6.3.1.1. (ASHRAE 90.1-1999, p. 45)

2) One exception to 6.3.6.1 is laboratory systems meeting Section 6.3.7.2; i.e., laboratories with fume hoods. Section 6.3.7.2 – Fume Hoods requires:

> Buildings with fume hood systems having a total exhaust rate greater than 15,000 cfm shall include at least one of the following features:
>
> (a) Variable air volume hood exhaust and room supply systems capable of reducing exhaust and makeup air volume to 50% or less of design values.
>
> (b) Direct makeup (auxiliary) air supply equal to at least 75% of the exhaust rate, heated no warmer than 2°F below room set point, cooled to no cooler than 3°F above room set point, no humidification added, and no simultaneous heating and cooling used for dehumidification control.
>
> (c) Heat recovery systems to precondition makeup air from fume hood exhaust in accordance with 6.3.6.1 (Exhaust Air Energy Recovery) without using any exception. (*Ibid*, p.45)

Since LEED-NC requires ASHRAE 90.1-1999 compliance as a prerequisite, all laboratory buildings aiming for certification under LEED-NC must comply with these ASHRAE prescriptive design requirements.

While ASHRAE 90.1-1999 allows for the use of auxiliary air fume hood design (part b above), laboratory design best practices suggest that this method should not be used. According to a draft Labs-21 Best Practices Guide on fume hoods, design negatives include:

- The researcher is close to the supply air discharge and may become uncomfortably cold or hot.
- Makeup air velocity introduces another directional component near the face of the hood that may create turbulence in the breathing zone. (This problem can be verified by ASHRAE-110 containment testing.)
- Supplementary tempering of incoming air may be needed, which makes this a costly alternative and minimizes the energy conservation benefit.
- A design that incorporates the internal delivery of auxiliary air can pressurize the hood and result in the loss of containment.

- Auxiliary (fume hood makeup air) does not flow through the laboratory space, does not purge or ventilate the room, and cannot be considered as part of the room air change requirements.

Designers of DOE laboratory facilities are therefore encouraged to follow the Labs-21 guidelines and use options (a) or (c) in the ASHRAE 90.1-1999 fume hood requirements.

The second issue of LEED-NC applicability to laboratory buildings concerns the calculation of laboratory building energy performance for the purpose of receiving LEED Credit EA1: Optimize Energy Performance. Energy performance beyond ASHRAE requirements is calculated for *ASHRAE-regulated loads*. The issue of what is considered a regulated load under ASHRAE 90.1-1999 versus what is considered a "non-regulated" load is ambiguous for some components common to laboratories. USGBC has provided the following guidance in a Credit Interpretation Request ruling to clarify exactly what should be modeled when determining laboratory building energy performance for LEED-NC credit:

> 9/20/2001 - Ruling
>
> Specialized loads found in laboratory spaces are a form of commercial energy use, or process energy. For the purposes of LEED, the energy required to operate special ventilation equipment such as fume hoods and HEPA filters, as well as load associated with 100% outside air, should be considered "non-regulated" energy components. This energy use is excluded from the numerator and denominator of Equation 1 as described in the June 2001 version of the LEED Reference Guide (p.128).

Because of this exclusion from the savings calculations for the EA1 Credit, LEED-NC does not reward the use of best-practice, high-performance laboratory-specific design features. USGBC has recognized this limitation and taken two actions in response. As an immediate response, LEED-NC allows good laboratory-specific energy performance design features, including improvements in the efficiency of fume hoods and other laboratory equipment, to be considered for LEED credit points under the Innovation & Design Process section. As a longer-term solution, USGBC is developing an Application Guide for Laboratories (LEED-AGL, also known as "LEED for Labs") to allow the LEED-NC system to take these unique laboratory design considerations into account. Until a new LEED rating system for laboratories is approved,[12] the Labs-21 Environmental Performance Criteria (EPC) can help inform design decisions for new laboratory buildings.[13] EPC is based on the LEED-NC framework but with energy and other credits tailored more specifically to Lab buildings. The USGBC committee charged with developing the Application Guideline for Laboratories is using the EPC as a starting point.

The Costs and Benefits of Sustainable Buildings

Given the policy background with regard to sustainable construction, what data are currently available about the incremental costs associated with it? A recent report "The Costs and Financial Benefits of Green Buildings: A Report to California's Sustainable Building Task Force" (Kats 2003) provided some important quantification of sustainable construction costs, based on data for 33 buildings registered with the USGBC. The average cost premium across all these buildings was 1.84%, ranging from 0.66% average for a LEED Certified level to 6.50% for the highest level, LEED Platinum. Interestingly enough, the average cost of designing to LEED Silver (2.11% premium) was found to be higher than the cost of designing to the next step, LEED Gold (1.82% premium).

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[12] The LEED-for-Labs rating system review draft is expected 10/04, with final approval expected sometime in 2005.

[13] Available online at http://www.labs21century.gov/toolkit/epc.htm

This average cost premium (equal to about $4 per square foot for average California construction costs) was more than offset by 20-year net present value cost savings of $5.79/sq.ft. **in energy costs alone**. The study estimated that other, more difficult to quantify benefits such as the productivity and health value of the sustainable buildings could have a net present value of $37 - $55 per square foot.

There has been some controversy over this report, in part because its finding of such low incremental cost for building a "green building" seems at odds with conventional wisdom about the additional expense of sustainable construction. However, these numbers are quite consistent with two GSA studies. The first, a 1998 study on green building cost generally, found an incremental cost increase of 2.5%. The features included in that design cost study were not specific to LEED, but GSA assumed that a building including those features would meet a LEED Silver rating.

A new study by GSA takes this analysis further (US General Services Administration, 2004). This detailed analysis defines incremental costs for specific credits under LEED, for 12 scenarios for typical new courthouse construction and major renovations of an existing GSA office building. Both design costs and LEED documentation costs were broken out separately in the analysis. While detailed data have not yet been released, an overview of this new study's findings show incremental costs of sustainable design comparable to those in the California study. GSA found that the added construction costs of a LEED building ranged from (-$0.81) to $17.19 per gross square foot, or (-0.4%) to 7.9%, compared to a baseline project cost. Note that some of those costs were negative – GSA found that in some cases it could build a green building for **less** than its standard building, primarily through improvements in design and construction process management. Note, too, that these are incremental construction costs only – they do **not** include the energy and other operating cost savings of higher efficiency buildings.

GSA concludes that, while these costs are not insignificant, they are minor in the scale of overall construction costs and cost uncertainties. A typical figure for construction budget estimation error is 5%, and a typical figure for construction cost contingency is 10%. Also, at 0-8%, the incremental cost of sustainable construction is well within the range of other common construction costs to achieve other important federal policies in public buildings like historic preservation, accessibility, general aesthetics, etc. In contrast to these other important public policy goals, however, the added first-costs for energy and water efficiency are typically recovered – several times over – by operating savings during the building's lifetime.

Another source of data about the cost and benefits of sustainable design is a report by DOE's Federal Energy Management Program. "The Business Case for Sustainable Design in Federal Facilities" reports two items of note. First, the report states, "Case studies show that energy use can be reduced by as much as 70% by incorporating energy-efficient and renewable energy systems, with payback periods below 10 years."[14] Second, in a modeling analysis of a prototype building, four building features that would typically be taken as a part of a LEED design (energy-efficiency measures, commissioning, water savings measures, and sustainable landscaping and stormwater management) increased the first cost of the prototype by $47,000, but saved $9,500 per year, for a simple payback of 5 years. A 37% reduction in annual energy costs was achieved at a total first cost increase of about 1.6%. (DOE/FEMP 2003)

Overall, there is growing evidence that a LEED Silver rating, started at the early design stages and pursued through an integrated planning process, can be achieved with at most a nominal increase in construction costs. This also applies to sustainable labs: at least two examples bear this out. First, a

[14] DOE High Performance Buildings Web site (http://www.eere.energy.gov/buildings/highperformance/), as cited in DOE/FEMP 2003, p. vi.

Silver-rated laboratory at Emory University was achieved at 0% net cost premium, even though LEED-NC was pursued after construction began. Second, a detailed cost analysis by the cost-estimating firm Davis Langdon Adamson[15] for one of the projects (Bren Hall, a LEED Platinum lab building at UC Santa Barbara) showed that this project could have achieved LEED Silver at no net increase in first-cost, despite the fact that design was 90% complete when the LEED/greening objectives were first introduced.[16]

Furthermore, a parametric modeling study tested the effect on first-cost of LEED if the same Bren Hall laboratory design were "relocated" to 5 other climates – but without a complete redesign for more climate-appropriate envelope and HVAC measures. Results showed that LEED Silver could be achieved with less than 1% construction cost premiums in all locations except Houston. LEED Gold rating could be achieved at an added construction cost of 2.6-6.3% (or 1.9-4.6% of total project costs). The highest added cost was in extreme cooling climates such as Merced CA and Houston TX due to requirements for conditioning outdoor air. These costs were for achieving LEED Gold ratings; energy saving measures themselves tended to account for less than half the total, and to have paybacks in most cases well under 10 years.[17]

With regard to the laboratory-specific requirements in ASHRAE 90.1-1999 on the use of VAV systems or exhaust energy recovery, analysis conducted through the Labs-21 program has concluded, "A life-cycle-cost analysis shows that the VAV system, the reduction in static pressure drop, and the energy recovery ventilation strategies are all cost-effective."[18]

Sustainable construction can therefore be cost-effective, but what about the documentation and certification costs associated with completing the process and receiving certification from USGBC? The experience of a number of LEED participants shows that the additional costs of certification are not excessive, but the benefits can be tangible. With regard to the incremental costs of higher design fees and LEED documentation and certification costs, GSA found that the total "soft costs" for a typical federal office or courthouse project ranged from about $100,000 to $210,000, or about $0.40 to $0.80 per gross square foot. Others have found the added cost to be lower. The Oregon Department of Energy has concluded, "Additional costs for the engineering and documentation associated with pursuing LEED are difficult to determine, but are estimated to be between $20,000 to $100,000."

The variation in documentation and certification cost can be explained by several factors. First, documentation costs are lowered when a project is designed from the beginning using the LEED process. When the documentation process is anticipated, it can be incorporated into the design and construction process with little to no incremental cost. Second, as marketplace actors (architects, engineers, contractors, etc.) are asked by their clients to provide sustainable buildings, they become more familiar with sustainable design and construction techniques. Once a designer, product manufacturer, or contractor has climbed up this learning curve, the incremental cost of sustainable and efficient products and equipment, building design features, construction, commissioning, and building

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15 Matthiessen, L., T. See and P. Morris. 2003. "Building on Bren: Putting a Price on Green Lab Design." Presented at the Labs-21 Conference, Denver CO. 21-23 October.

16 However, some of the LEED prerequisites and credits were already "embedded" in project design, due to requirements by California Title-24 codes or pre-existing UC design criteria.

17 This estimate was derived from data in Matthiessen et al., assuming saved electricity valued at $0.10/kWh and natural gas at $0.50/therm.

18 Enermodal Engineering and the National Renewable Energy Laboratory. "Laboratories for the 21st Century: Energy Analysis." p. 78. Available at:
http://www.labs21century.gov/pdf/cs_energyanalysis_508.pdf

operation can drop dramatically. The design fees associated with building buildings to LEED specifications are one example of this variability. Already some A&E firms are integrating sustainable design practices into their standard business practices. As they do, the cost of producing sustainable designs within those firms is falling. This familiarity also reduces the incremental cost of documentation, as those processes become part of standard business practice.

This is also true of USGBC itself, which is adapting to market pressures. The latest version of LEED-NC, version, 2.1, is a significant improvement over version 2.0 in terms of the ease with which projects can be certified. USGBC makes this point itself:

> As a result of these efforts [to reduce the complexity of certification], we anticipate that average documentation costs will be cut in half as a result of the [LEED-NC] 2.1 update. While LEED documentation costs can be as low as $10,000 for an experienced team, this appears to be unusual. Most teams are working on their first LEED project and often report costs in the range of $30,000-$60,000. Because the current design and construction pipeline is not accustomed to providing the information LEED requires, significant additional costs are incurred by people chasing down and compiling LEED required information after the fact. (Environmental Design and Construction, 2002)

Finally, it should be noted that the costs of documentation and LEED certification may not scale with project size or costs, so that the added cost per square foot (or as a percent of total project costs) may be much lower for large buildings than for smaller ones.

All phases of the sustainable design and construction market are quite dynamic, with significant process and product changes taking place. These changes represent a learning curve cost that is very likely to continue to reduce not only the “soft” costs (design, LEED certification, commissioning, etc.) but also the added construction costs, as new methods and techniques are adopted. Because individual buildings vary so much, in terms of site-specific opportunities and constraints, the choice of measures to achieve a LEED rating, and the timing (and skill) with which sustainability is integrated into the overall design process, it is difficult to generalize about the total life-cycle cost difference between a “standard” building and a sustainable building. There are no large data sets with measured values for both costs and benefits for the full range of building types and other circumstances. However, the data that are available to date suggest that building to the LEED levels of Certified, Silver, and perhaps Gold can be accomplished across a wide range of building types and locations at a manageable cost, and that the direct economic as well as indirect benefits of such a building can be significant.

Other than the direct, readily documented savings in operating costs from lower energy and water bills, the indirect benefits of sustainability are difficult to measure but probably even more significant. There are strong intuitive arguments for many of these additional benefits of sustainable construction. For example, improved health and productivity of both construction workers and completed building occupants seems to be a likely outcome of attention to the volatile organics emission characteristics of building materials and furnishings. Using materials that give off fewer noxious fumes would be less irritating to both installers and early occupants of a new building, and therefore lead to lower incidence of illness or discomfort and perhaps higher productivity. Similarly, an office building that was designed with a greater deal of attention toward occupant thermal comfort is likely to be more comfortable, and therefore to improve the satisfaction and perhaps productivity of its occupants. A growing number of field studies, strongly suggestive if not definitive, have attempted to document these health, comfort, and productivity benefits[19], but much more definitive “intervention studies” remain to be done, to validate these statistical association studies and intriguing anecdotes.

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[19] See the bibliography and meta-analysis reports at the “Indoor Health and Productivity” website, http://www.dc.lbl.gov/IHP/.

In summary, in terms of life-cycle cost, the most readily quantifiable benefit of sustainable construction is savings in energy and water costs to operate the building. DOE has a unique opportunity to provide leadership in energy and water efficiency for its new construction, and experience shows that the incremental costs associated with a wide range of energy efficiency improvements are easily justifiable.

Options for a DOE "Secretarial Challenge"

What then are the essential components of a DOE Secretarial Challenge for sustainable construction? We suggest that there are three essential elements:

(1) adoption of the LEED rating system as an overall framework for sustainable design;

(2) specific guidance, beyond the minimum prerequisites in LEED or the requirements of 10 CFR 434-435, to enhance the energy and water performance of DOE buildings; and

(3) mechanisms for assuring that the energy and water efficiency and sustainability of the completed building matches design intent.

Executive Order 13123 directs that "Agencies shall apply such [sustainability] principles to the siting, design, and construction of new facilities." An important aspect of the President's Management Agenda is the use of performance metrics in implementing federal policies. Use of LEED, with its built-in metric for sustainability, offers a path for demonstrating conformance with the President's Agenda, as well as a widely accepted commercial sector mechanism for achieving and measuring sustainable design.

Yet simply adopting LEED as a method of measuring sustainable building performance is not enough, because, as a design-stage tool, LEED by itself will not automatically assure an actual completed building with high energy performance. Also, the flexibility allowed by the LEED point system makes it possible to design a building to LEED Silver standards (or even higher) without any energy efficiency measures other than other than minimum energy building code compliance. In fact, nearly half of the projects rated as Certified under LEED version 2.0 achieved no added credits for energy performance; i.e., the buildings only complied with minimum requirements under ASHRAE 90.1 (and local building codes). DOE is in a unique position to provide leadership in sustainable construction by setting a benchmark for high energy performance and cost-effectiveness, along with other LEED sustainability criteria.

Following LEED will ensure good sustainable design. Beyond that, additional steps are needed to ensure the transformation of design intent into actual building performance. Therefore, the Secretarial Challenge goal should include a mechanism for performance assurance. (Specifics are discussed below).

In Table 5, we lay out these three components of a Secretarial Challenge in the three columns. We then provide policy options within each row, ranging from a base level to more stringent targets. Each of these policy options is discussed below. The row shown in bold represents our recommendation for adoption as a Secretarial Challenge goal.

Table 5. Policy Options for DOE Consideration

LEED-NC Level		Additional Performance Requirements	Performance Assurance Measures
I	Certified	15% above ASHRAE; 2 Water Efficiency points	Building utility meters
II	**Silver**	**30% above ASHRAE†; 3 Water Efficiency points**	**LEED credit EA3 (Additional Commissioning); Interval meters for electricity**
III	Gold	30% improved performance for total building load†; 4 Water Efficiency points	EA3 plus LEED credit EA5 (Measurement & Verification); Sub-metering of significant end-uses

† With special provisions for laboratory buildings – see text and Appendix B.

LEED Certification Level

As we have discussed, the use of USGBC's LEED-NC system provides a performance metric by which DOE can measure its progress toward the sustainable construction mandates of EO 13123.

Level I

At a minimum, therefore, we recommend the adoption of LEED Certification as a goal for DOE construction. Several other agencies have also adopted LEED, and the data available suggest that the performance level of Certified is readily achievable at minimal or zero net first-cost.

Level II

In fact, the cost data we have reviewed suggests that LEED Silver is also very cost-effective for the great majority of buildings. Policy makers from both the Army and GSA have learned from their experience with LEED/SPiRiT that this is the case. The Army has already adjusted its goals to recognize this, and GSA is likely to do so soon. Several municipalities have also developed LEED Silver policies. Laboratory facilities are achieving Silver at low incremental cost (see Appendix B.) Furthermore, the choice of a stringent but cost-effective goal is likely to focus attention at the design stage. This is certainly borne out by anecdotal data – careful attention to detail from the beginning of the design process can lead to significant gains in sustainable design at little or no additional cost. Finally, improvements in energy performance and water efficiency (see below) can be a significant component of added credits needed to move from LEED Certified to LEED Silver. These energy performance increases have well-documented life-cycle cost benefits. Therefore, DOE would benefit from a goal of LEED Silver as a cost-effective design goal for DOE facilities.

Level III

DOE could make a significant statement in sustainable policy leadership by requiring LEED Gold as a design goal; however, the preponderance of cost data suggests that such a goal might impose a significant cost premium in the construction of at least some DOE facilities. DOE could consider requiring LEED Gold as a future performance target; in the meantime project design teams could be encouraged to consider it as a "stretch goal" for new DOE facilities.

Additional Performance Targets

As we have discussed, it is important for DOE to provide some sort of energy and water performance leadership to the rest of the federal sector and beyond – in addition to the basic requirements now in LEED. In a similar spirit to EPA's focus on sustainable materials in applying LEED to their new buildings, DOE's energy and water conservation mission could be heightened when DOE "puts its money where its mouth is." Putting that money to work is also a cost-effective strategy, as energy and water performance improvements are those areas of sustainable construction that are best documented as cost-effective.

In contrast, two areas that seem to fall outside the scope of cost-effective performance leadership are the purchase of green power and the use of on-site-generated renewable energy. As discussed in Appendix B, none of the certified federal facilities have adopted either renewable energy or green power, and firm intent to pursue these two options is limited among registered projects, too (including DOE projects now in the planning and design stages). In the case of green power, this is likely a function of availability – green power is not available for purchase in all areas of the country. In the case of on-site-generation of renewable energy, the low adoption rate is likely attributable to two factors: the size of federal facilities (the LEED credit is given based on a percentage of total building load, so larger facilities will have greater difficulty achieving those points) and the low price of electricity paid by federal customers (making it difficult for renewable energy to be cost-effective.)

Note well that we do not argue that purchasing green power or using renewable energy technologies on-site to generate power are things that DOE facilities should not do. These options should certainly be pursued where appropriate, and the LEED credits encourage their use as an overall component of the LEED certification goal; however, the preponderance of data suggest that to require such features as part of a Secretarial Challenge would be an onerous requirement to place universally on DOE facilities.

Level I

At a minimum, DOE could require that all projects qualify for 1 LEED energy performance credit, which would be 15% better than ASHRAE Standard 90.1-1999. Over 80% of the projects certified under LEED 2.0 have achieved at least this level of performance. All three DOE facilities certified under LEED have met this criterion. This target is readily achievable, and including the additional energy credit would help other federal agencies to focus on energy performance as a significant component of sustainable construction.

In a similar manner, DOE could require 2 LEED water efficient landscaping credits for those facilities with landscaping. Again, all three DOE facilities implemented these credits. 72% of all LEED certified buildings received this credit. Elimination of landscaping irrigation is extremely cost-effective, as native vegetation normally requires less maintenance.

Level II

As a meaningful target for a Secretarial Challenge, though, these energy and water performance levels are rudimentary. Half of all LEED certified buildings have already achieved a performance target of 30% above ASHRAE 90.1-1999. Significant energy performance beyond ASHRAE 90.1 is also the focus for a number of efforts under development. In addition to the energy legislation targets and Sustainability Working Group MOU proposals discussed earlier, both the New Buildings Institute Advanced Building Guidelines and ASHRAE are already using 30% beyond current ASHRAE standards as a target for high-performance buildings. The FEMP "Business Case..." report suggested that energy savings of 37% were easily justifiable from a cost-effectiveness standpoint. Finally, were DOE to set such a target, it would have significant positive influence in the policy arena. Therefore, we recommend a target of 30% above ASHRAE 90.1-1999, at least for DOE office facilities and for office and support-type spaces in labs and other facilities.

For laboratory buildings, we propose some qualifying language based on the proposed new LEED Application Guide for Laboratories (LEED-AGL) when completed in 2005, and in the interim, using either LEED-NC or the Labs-21 Environmental Performance Criteria to guide design of new lab buildings (see Appendix B).

Specifically, we recommend that for now, laboratory facilities should meet the 4 energy performance points of LEED-NC and the laboratory-specific requirements of ASHRAE 90.1-1999. In addition, using EPC, DOE lab buildings would be required to achieve another 2 points (out of 8 possible) under EPC Energy & Atmosphere credits for:

- 7.1-7.5: Energy Supply Efficiency (combined heat and power)
- 8: Improve Laboratory Equipment Efficiency
- 9.1-9.2: Right-size Laboratory Equipment Load

(These last two are especially important to combine with an ASHRAE-90 based energy performance requirement, since no credit is given for improving the efficiency of plug-in equipment as a "non-ASHRAE load.")

Finally, using either EPC or (eventually) LEED-for-Labs, lab buildings would also be required to earn the same two credits as in LEED-NC, for Added Commissioning and M&V. DOE requirements for labs should also highlight the ASHRAE-90 requirements for energy-efficient ventilation.

For all new facilities, both office, lab, and other building types, DOE can establish a leadership element in water efficiency by requiring 1 LEED credit for interior water use reduction in addition to the landscaping points discussed earlier. A 20% reduction in water use below federal standards is achievable. FEMP's "Business Case" reports that payback periods for the water-saving technologies they analyzed ranged from 0.3 to 2.8 years. For example, when properly designed into a building, the first cost of waterless urinals can be negative - the additional cost of the waterless technology is more than paid for by the reduction in plumbing costs.

Level III

Setting performance targets above ASHRAE's current guidelines leaves out some components of a building's total energy use.[20] These additional building components include elevators and escalators, exterior lighting, and plug loads. Plug loads such as office equipment, in particular, are recognized as a growing component of total building consumption, and in some cases can account for 20% or more of total electricity use.

A high level of energy performance leadership would include these equipment and plug load components in any performance requirement. At Level III, then, we recommend consideration of a DOE energy performance target for the **whole building**, including all energy end-uses, that is 30% above a whole-building baseline established by current ASHRAE-90.1 combined with typical plug load and process equipment efficiencies.

Performance Assurance

Next, we need to consider Performance Assurance in setting commitment levels for the DOE challenge. As we have mentioned, merely designing a sustainable building is not the intended outcome – instead the goal is to build sustainably and operate sustainably, over the long term. How can we translate design intent into performance?

One important component of performance assurance is process management. To be effective, sustainable design must be integrated into all phases of the delivery of a new building, from initial planning to construction, commissioning, and occupation. The LEED metric allows designers to measure themselves against a specific structure of sustainable design performance. The documentation and certification process ensures that this metric has been used.

Beyond management of the design/construction process, there must also be some mechanism of carrying that sustainable ideal through the actual use of the building. One critical component of properly operating a building is a good understanding of its utility usage. Unfortunately, DOE buildings have often been built without utility meters at the building level because utility metering is done on a site-wide basis. The adage "You can't manage what you can't measure" is particularly valid here. Operation

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[20] However, a recent (2004) *Addendum e* to ASHRAE Standard 90.1, developed to provide guidance to "above-standard designs" such as LEED, does include a special provision for considering total building energy use, including plug loads, as part of both the baseline and alternative (proposed) building designs.

of high performance buildings requires an understanding of the building's response to varying conditions. Utility meters are therefore an extremely important component of sustainable buildings, to ensure that building performance matches design intent.

Our recommended levels below address each of these issues: process management, building commissioning, and proper operation of the building using the performance feedback provided by metering.

Level I

At a minimum, DOE needs to ensure that its sustainable design philosophy is borne out in the design and construction process. To do this, certification through LEED (rather than simply using LEED as a design standard) is an important way to enforce an effective design process. This is consistent with the intent of the Presidential Management Agenda to use performance metrics in implementing such management policies.

There are two components here: translating design philosophy into design documents and construction practices that are sustainable; and verifying that the design and construction intent has been met in the actual performance of the building. In terms of these two components, at the base level (Level I), it is important both to certify the design process through LEED's Green Building Rating System, and to measure the building's actual performance. At Level I, we recommend completing the LEED certification process (to verify design intent) and installing building-level meters for all utilities (electricity, gas, water, and steam). Having a meter is the critical first step in measuring actual building performance.

Level II

At the second level, we would include those components already mentioned, as well as the LEED Commissioning Credit point (EA3). The key difference between this and the required level for certification is that the design firm will ensure through a third party that everything is documented properly in the construction process. In short, the level of oversight is more stringent. In addition to the design and construction review, we also recommend the installation of at least one interval meter for the whole-building electric service. Interval meters allow for a better understanding of the building's electricity demand, which can be invaluable in operating it effectively and preparing for an optimal response to local or regional grid emergencies – as federal facilities have been repeatedly called on to do in both the Western region and the Northeast. The use of interval meters is standard practice in the commercial sector; they are underutilized in current DOE construction.

In addition to the benefits associated with taking on these steps to assure performance, installing and using improved metering equipment would meet the metering requirements of the proposed energy legislation. Current statutory requirements (10 CFR 435) call for federal buildings to be built with the "capability for easily installing" these systems, though they stop short of requiring the systems themselves. The proposed legislation will close that gap, and DOE can get ahead of the curve by anticipating this requirement.

Level III

At Level III, we recommend requiring LEED credit EA5 (Measurement & Verification) in addition to those requirements above. The M&V credit calls for continuous (interval) metering equipment on a number of building end-uses. Although such metering is sometimes regarded as not cost-effective, having end-use specific consumption information can often be the only mechanism by which building operations and maintenance may be fully optimized. Furthermore, inclusion of end-use metering in the initial construction of a building is often significantly more cost-effective than adding such meters as a later retrofit. The use of sophisticated energy management and control systems that include continuous metering capabilities is also becoming more prevalent in medium and large federal buildings. As our electricity system moves into a deregulated environment, the ability to measure and control individual building components becomes more important. As electricity becomes more of a commodity, the ability of a building to respond to demand becomes more market-driven. Using these systems allows that level of building response. Two of the three DOE facilities that have achieved LEED certification installed these systems, so they are being recognized in the field as practical and valuable.

Implementation Options for Challenge Adoption

There are several options for DOE to limit and/or phase in the application of the proposed "LEED-Plus" policy for both new building construction and major retrofits. Some of the options include:

- *Pilot projects* – Rather than apply the requirements for LEED certification and energy and water efficiency immediately to all new and retrofit projects, the Secretary could direct that each Office or each DOE site identify one or more pilot projects. Or, the Secretary could call for designated pilot projects representing at least [10%] of planned construction by each Office (or site). After a specified period of time (2 or 3 years), the Secretary would review the experience with this pilot phase and consider extending the policy to all new or retrofitted buildings.[21]
- *Stage of Construction* – For DOE projects that have not yet received a CD-0 approval, it should be straightforward to include the LEED-plus criteria as part of the very first stages of project planning and pre-conceptual design. Even for projects that have received their CD-0 but not CD-1 approval, it should be feasible to incorporate the LEED, energy, and water criteria in the early stages of preliminary design. The further along the project, during the preliminary design stage following CD-1, or actual plans and specifications following the CD-2 decision, the more difficult or costly it may be to incorporate energy-efficient and sustainable features. However, there are several examples of successful LEED buildings (such as the Bren Hall lab-classroom building, LEED Platinum) that managed to incorporate these features cost-effectively – even at a relatively late stage of design.
- *Project Size* – DOE might limit the LEED-Plus criteria to capital projects costing $5 million or more (the same cut-off set for the Critical Decision Approval process defined in DOE Order 413.3). It is also possible to set an even higher threshold initially, so that (for example) the policy might apply for the first [3] years only to construction projects over [$25] million.[22] Alternatively, the policy could be applied based on floor space, and applied only to buildings of [50,000] gsf or larger. An initial threshold, whether based on project cost or floor space, can be adjusted in future years based on program experience.
- *Building Type and Space Type* – As discussed elsewhere (see Appendix B), the LEED-plus criteria may need to be applied differently (or at least more flexibly) in different types of DOE buildings with unique constraints and opportunities, especially energy-intensive lab and processing facilities. Even for these building types, however, there is often a substantial amount of floor space devoted to office and support functions – spaces that can be subject to the "normal" LEED-plus requirements

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[21] It might also be argued that several DOE sites (ANL, NREL, ORNL, LBNL, BNL, SNL, ...) and Offices already have successful experience with designing and constructing certified LEED buildings, Labs-21 pilot projects, or other energy-efficient, green, and high-performance facilities that may not be certified under LEED.

[22] In a list of 100 DOE capital projects in the "Critical Decision" pipeline as of 4/03, two-thirds had estimated costs greater than $25 million and one-third were larger than $100 million; this list included all capital projects, not just buildings.

that would apply to an all-office building. Yet another approach to phased implementation would be to apply the LEED-Plus policy first to new DOE office/administrative buildings, then after [2] years to lab/office buildings, and last to industrial process facilities and others.

Of course, these phase-in options could be implemented either separately in various combinations – and there is no reason why projects in some of these subgroups could not be "strongly encouraged" to achieve some or all of the LEED-plus criteria even before they are required to do so. The Secretary, OECM, or other appropriate decision-makers could also propose internal incentives, such as accelerated project review or other administrative benefits, for those projects that take the lead in pursuing LEED-plus objectives.

Recommendation

The Department of Energy has a unique role among federal agencies as a champion of wise use of energy resources. As such, it has an opportunity to provide leadership in an area within the LEED system that has been recognized as somewhat weak – the energy performance of LEED buildings. The Department of Energy should require a level of energy performance in excess of basic LEED requirements. We therefore recommend adoption of a Secretarial Challenge goal of LEED Silver certification for new DOE construction, with the additional components of energy performance 30% above ASHRAE for office buildings (qualified as discussed in Appendix B for laboratories), a minimum of three water efficiency credits (i.e., zero landscaping irrigation and 20% above standard for indoor water consumption), and commissioning and metering of the completed facility to ensure that the building operates in the way it was intended.

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Appendix A

Comparing LEED-NC and US Army SPiRiT Rating Systems

Comparing the energy elements in LEED-NC (new construction) with the US Army's SPiRiT rating system is not straightforward, even though SPiRiT is derived from LEED and shares its basic structure. SPiRiT places more emphasis on energy performance (compared with other sustainability features). SPiRiT also makes it relatively easier for a building that achieves a given level of improved energy efficiency (design-stage prediction) to qualify for a SPiRiT rating than for the same rating level using LEED. In the following text, we discuss three aspects of the rating systems: the six components that make up their rating, the percentage of total points necessary to achieve a given rating level, and the importance of energy performance as a function of the total credits available.

Rating system components

To provide flexibility in applying the rating system to an individual building, both rating systems provide a menu of measures worth one or more "credits" toward the minimum number of credits required for each level of certification. Both LEED-NC and SPiRiT offer credits in the same six categories, although SPiRiT substitutes "building delivery process" and "mission requirements" for the "innovation" credits in LEED (see Figures A-1 and A-2). The "delivery process/mission" credits in SPiRiT account for a larger percentage of total credits than the "innovation and design" credits in LEED, with the IEQ and Materials credits a correspondingly smaller share.

Figure A-1. Components of LEED-NC Rating

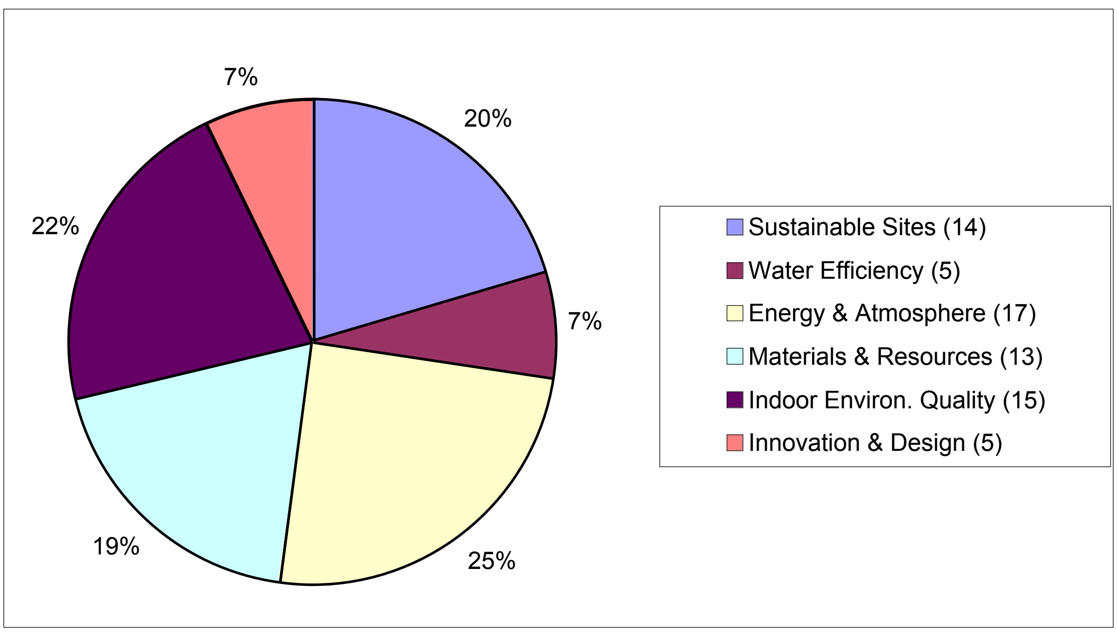
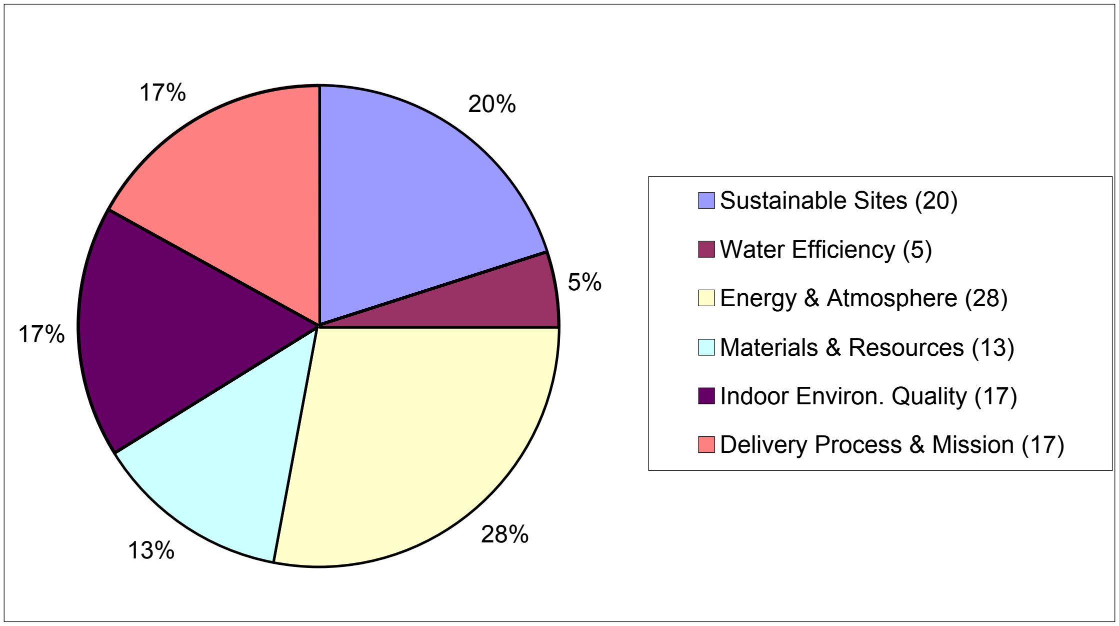


Figure A-2. Components of SPiRiT Rating



Certification levels

Both LEED and SPiRiT have 4 levels of certification. The first level is called "Certified" in LEED and "Bronze" in SPiRiT - the other three levels share the same names: Silver, Gold, and Platinum. While the names are similar, the ratings differ in the total number of achievable credits. LEED is based on a 69 point scale, while SPiRiT is based on a 100 point scale. As a result, the number of credits required at each level differ. More significantly, the percentage of total credits available needed to achieve a given level differs, especially for the first two levels of certification. At the Certified level, LEED requires 26 of 69 credits, 38% of all credits possible; SPiRiT requires only 25% (25 of 100 points) for Bronze. LEED requires 48% of all possible credits for Silver (33 of 69), but SPiRiT only 35%. At the Gold level, LEED requires 39 of 69 points (57%) while SPiRiT requires only 50%. At the Platinum level, though, the pattern is reversed. LEED requires only 74% of total credits (52 of 69) to achieve Platinum, while SPiRiT requires 75 points (75%). In sum, at the lower levels, it is somewhat easier to qualify for SPiRiT compared to LEED; at the same time, achieving SPiRiT Platinum requires a greater percentage of total points than LEED Platinum. These point and percentage comparisons are illustrated in Figures A-3.1 and A-3.2 below.

Figure A-3.1. Rating Levels, LEED-NC vs. SPiRiT

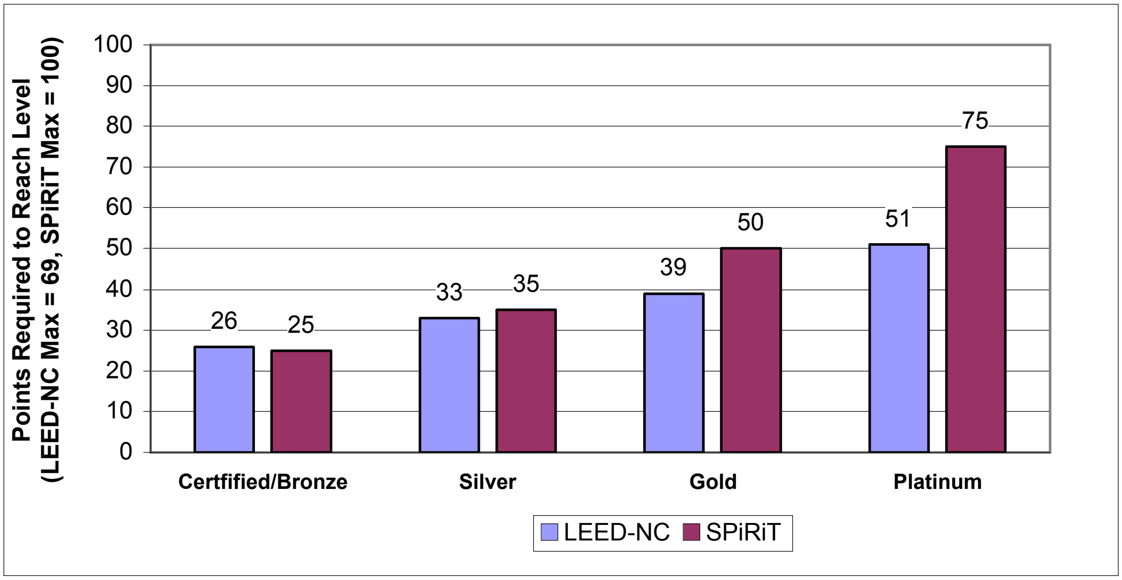
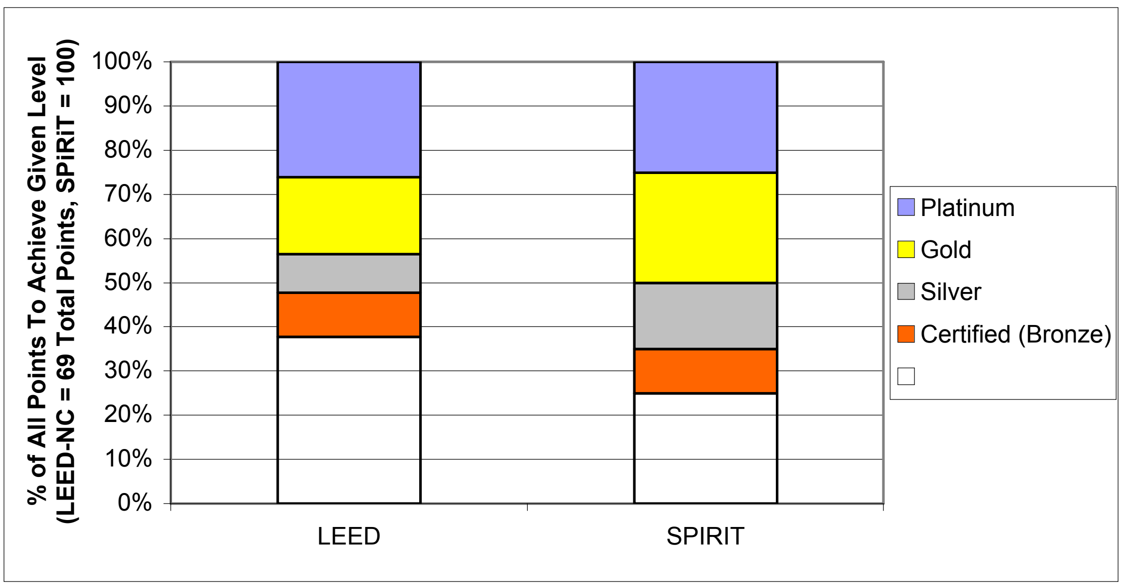


Figure A-3.2. Rating Levels, LEED-NC vs. SPiRiT



Energy credits

Last, we can turn to the differences between LEED and SPiRiT in their treatment of credits for energy performance above a given baseline. LEED awards 1 credit for every 5 % efficiency improvement beyond an ASHRAE 90.1 baseline (beginning with 1 point for 15% > ASHRAE), up to a maximum of 10 points for 60% efficiency improvement. SPiRiT awards 1 credit for every 2.5% efficiency improvement beyond a baseline of the Army TI-800 standard, up to a maximum of 20 points for 50 % efficiency improvement. (The Army's TI-800 standard is reported to be similar to ASHRAE 90.1 for most building types, while perhaps a little more stringent – a detailed comparison of the two baseline standards is beyond the scope of this paper.)

In general, compared with LEED, SPiRiT places more emphasis on energy performance than on other dimensions of building sustainability. SPiRiT offers more credits for energy performance (and a slightly higher percent of all available credits). Energy performance credits are also easier to earn with SPiRiT, for a given percentage of performance improvement beyond a baseline (noting that the two baselines may differ somewhat). Finally, the energy performance credits in SPiRiT contribute a significantly larger share of points needed toward any of the rating levels, compared with LEED.

If we assume for now that the two baselines are roughly comparable for most building types, Figure A-4 shows a graphic comparison of the credits in LEED and SPiRiT. The figure shows that, for a given building, the energy performance credits are generally easier to achieve with SPiRiT than with LEED (once again, assuming that the two baselines are roughly comparable). For example:

- A 30% efficiency improvement (beyond ASHRAE-90.1) is worth 4 points in LEED, or about 12% of the 33 points needed for a LEED-Silver rating
- The same 30% efficiency improvement (beyond TI-800) is worth 12 points in SPiRiT, or about 34% of the 35 needed for SPiRiT-Silver.

Figure A-4. Energy Performance Credits: LEED-NC vs. SPiRiT

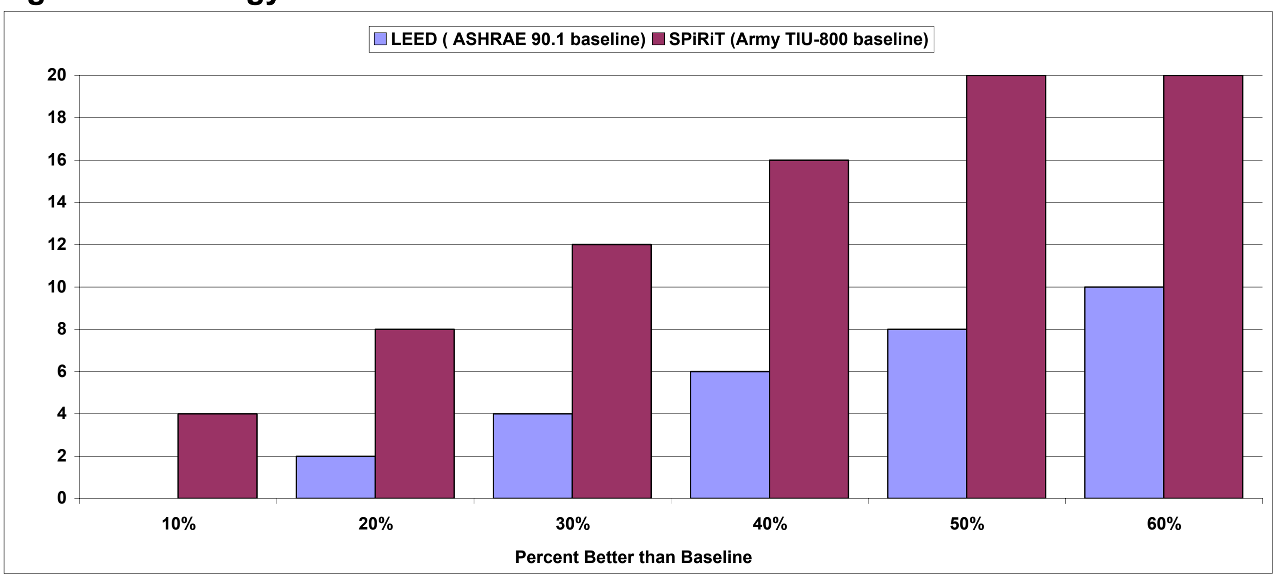


Table A-1 below provides the same data in tabular form, showing energy performance percentage comparisons between LEED-NC and SPiRiT at 10% increments above each rating system's baseline. Note that LEED-NC credits begin at 15% above ASHRAE and reach their maximum (10 points) at 60% above ASHRAE. SPiRiT credits begin at 2.5% above TI-800 and reach their maximum (20 points) at 50% above the TI-800 baseline.

Table A-1. Energy Performance Credits: LEED-NC vs. SPiRiT

Appendix B

Energy and Water Savings Features in LEED Buildings and Labs-21 Case Studies[23]

Overview

To help inform decisions about a DOE policy on possible requirements for energy efficiency and water-saving features in new construction, this Appendix reviews data on the characteristics of LEED buildings, with an emphasis on federal and other governmental buildings. We also focus on laboratory, industrial, and office space, since these are the types of buildings most common found (and planned for new construction) at DOE field sites. Because the number of laboratory buildings already certified[24] under LEED is small, we also reviewed those lab projects "in the pipeline" based on the LEED registry list (https://www.usgbc.org/LEED/Project/project_list_registered.asp). Finally, we looked at the case studies reported under the Laboratories for the 21st Century (Labs-21) program.

Key Findings

Overall, these data show that:

- The LEED Silver rating appears widely achievable, with more than half of all 84 certified buildings achieving this level or better. This proportion holds true for most subgroups of buildings, by type, ownership, and floorspace.
- Data on the much larger number of LEED registered buildings (~1200), not yet certified, while incomplete, suggest that the Silver level (or higher) is likely to be achieved by at least as high a fraction of all future LEED buildings. LEED-certified lab buildings include one at the Platinum level (Bren Hall, UCSB) and three at the Gold level (including two EPA laboratories).
- Over half of the certified LEED buildings earned at least 4 energy performance credits (i.e., 30% more efficient than required by ASHRAE Standard 90.1), although this was somewhat less common in laboratory buildings. One reason for this is the stringent ASHRAE restrictions on fan power even in ventilation-intensive labs.[25]
- For the 5 lab buildings certified under LEED, one earned 5 energy performance credits (35%>ASHRAE), one earned 3 credits (25%>ASHRAE), and three earned 2 credits (20%>ASHRAE). For the 25 additional lab buildings "in the pipeline" (i.e., registered but not certified) for LEED, seven are targeting at least 4 energy performance credits, two are definitely not, and the rest have not yet reported this information.

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[23] We greatly appreciate the contributions of Paul Mathew to this Appendix, especially for the discussions of LEED for Labs, Labs-21 Environmental Performance Criteria (EPC) and Labs-21 case studies.

[24] In this Appendix we use the term "certified" to refer both to completion of the LEED certification process and to the first, most basic of 4 LEED rating levels (Certified, Silver, Gold, Platinum); we hope the meaning is clear from the context.

[25] Anecdotally, it appears that, even though there is no formal exception for laboratories, these ASHRAE-90 fan power limitations may not always be followed in practice. Additionally, ASHRAE requires either VAV fume hoods or ventilation heat recovery, in which case they would be considered part of the base-case building rather than count toward energy savings beyond ASHRAE. Also, additional measures to improve fume hood efficiency are not recognized as "exceeding ASHRAE" because hoods are considered process loads rather than part of building HVAC. This combination makes it more difficult for high-ventilation lab spaces to beat ASHRAE by 30%. However, fume hood controls may be eligible for "innovation" points under LEED-NC.

- In terms of other energy credits, Added Commissioning was the most common credit (57% of certified LEED buildings; for registered buildings reporting on this item, 80% planned to earn it). The next two most common credits were M&V (35% of certified buildings) and Green Power (32%), followed by one or more renewable energy credits (under 15% of certified buildings).
- Three or more water efficiency credits were earned by two-thirds of all certified LEED buildings. Among the individual water credits, the three most common were: 50% savings in landscape water; no use of water for landscape (except recovered rainwater or graywater); and 20% reduction in interior water use. Each of these were found in at least 75% of the certified LEED buildings.
- Additional data on 8 laboratory case studies prepared for the Labs-21 program[26] suggest that savings of 30% or more are achievable compared with a conventional building, but achieving this level of savings compared with an ASHRAE-90 base case may depend on the interpretation of fairly stringent ventilation requirements in ASHRAE and local codes.
- There is growing evidence that a LEED Silver rating, started at the early design stages and pursued through an integrated planning process, can be achieved with at most a nominal increase in construction costs. This also applies to sustainable labs:
    - A Silver-rated laboratory at Emory University was achieved at 0% net cost premium, even though LEED-NC was pursued after construction began.
    - A detailed cost analysis by the cost-estimating firm Davis Langdon Adamson[27] for one of the projects (Bren Hall, a LEED Platinum lab building at UC Santa Barbara) showed that this project could have achieved LEED Silver at no net increase in first-cost, despite the fact that design was 90% complete when the LEED/greening objectives were first introduced.[28]
    - Added cost for a high-level Gold rating of Bren Hall would have been about 4.1% of construction costs. Post-construction addition of a 47-kW PV system brought LEED points to the Platinum level, for a cumulative first-cost increase of 7.1%.
    - Added "soft" costs for design, modeling, and LEED documentation were 0.6% (about $2/gsf), but this included an extensive case study not required for LEED.
- A parametric modeling study tested the effect on first-cost of LEED if the same building design were "relocated" to 5 other climates – but without a complete redesign for more climate-appropriate envelope and HVAC measures. Results showed that LEED Silver could be achieved with less than 1% construction cost premiums in all locations except Houston. LEED Gold rating could be achieved at an added construction cost of 2.6-6.3% (or 1.9-4.6% of total project costs). The highest added cost was in extreme cooling climates such as Merced CA and Houston TX due to requirements for conditioning outdoor air. These costs were for achieving LEED Gold ratings; energy saving measures themselves tended to account for less than half the total, and to have paybacks in most cases well under 10 years.[29]

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[26] Three of the case studies were also certified under LEED (versions 1 and 2), at Silver, Gold, and Platinum levels, respectively.

[27] Matthiessen, L., T. See and P. Morris. 2003. "Building on Bren: Putting a Price on Green Lab Design." Presented at the Labs-21 Conference, Denver CO. 21-23 October.

[28] However, some of the LEED prerequisites and credits were already "embedded" in project design, due to requirements by California Title-24 codes or pre-existing UC design criteria.

[29] This estimate was derived from data in Matthiessen et al., assuming saved electricity valued at $0.10/kWh and natural gas at $0.50/therm.

In the case of new DOE laboratory buildings, these data suggests that while 30% better than ASHRAE 90 might be a reasonable goal for new DOE lab buildings, as a minimum *requirement* DOE might consider a somewhat lower energy performance target, at least for the *laboratory-type space* within a new facility, while still directing that new lab projects should continue to include all energy efficiency (and water-saving) measures that are cost-effective. Also, for the office and support spaces, which often represent at least 40% of the floorspace of a laboratory building, DOE could retain the 30% >ASHRAE criterion.

Until a new LEED rating system for laboratories is approved,[30] the Labs-21 Environmental Performance Criteria (EPC) can help guide design decisions for new laboratory buildings. EPC is based on the LEED framework but with energy and other credits tailored more specifically to Lab buildings (http://www.labs21century.gov/toolkit/epc.htm). The USGBC Committee charged with developing a LEED-for-Labs rating system is using the EPC as a starting point.

Whereas LEED-NC provides 4 Energy Performance points for beating ASHRAE by 30%, the EPC allows 4 points for lab buildings that are 20% >ASHRAE (6 points for 30% >ASHRAE). Using EPC, DOE could require a minimum of 4 Energy Performance points for labs (20% >ASHRAE) plus another two points (out of 8 possible) under Energy & Atmosphere credits for:

- 7.1-7.5: Energy Supply Efficiency (combined heat and power)
- 8: Improve Laboratory Equipment Efficiency
- 9.1-9.2: Right-side Laboratory Equipment Load

(These last two are especially important to combine with an ASHRAE-90 based energy performance requirement, since no credit is given for improving the efficiency of plug-in equipment as a "non-ASHRAE load.")

Using either EPC or (eventually) LEED-for-Labs, lab buildings would also be required to earn the same two credits as in LEED-NC, for Added Commissioning and M&V. DOE requirements for labs should also highlight the ASHRAE-90 requirements for energy-efficient ventilation.

Data Sources

The next section summarizes key characteristics of 84 Certified LEED (v2)[31] buildings shown on the USGBC LEED database as of April 2004. Because the timeline from initial LEED registration to a completed, certified building can be 2-3 years or longer, we also looked at buildings currently "in the pipeline" to see if this added to the patterns observed for buildings that had completed the certification process.[32] The second part of this Appendix presents data from the same source on a selected number of LEED-Registered buildings as of April 2004. We did not examine all 1200+ buildings listed as LEED-Registered, but instead selected 86 projects that were either federally sponsored or laboratory-type buildings (including lab/office, both federal and non-federal).

Data for Certified buildings on the USGBC website in most cases include the LEED rating level, building floorspace, occupancy type, and ownership, as well as the number of LEED points awarded in

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[30] The LEED-for-Labs rating system review draft is expected 10/04, with final approval expected sometime in 2005.

[31] We did not compile data for an additional 19 buildings certified under LEED 1.0, however 3 of these earlier projects are of special interest to DOE as laboratory buildings: the Donald Bren School of Environmental Science at UCSB (university, LEED Platinum), the Nidus Center (private, LEED Silver), and the US EPA New England Regional Laboratory (federal, LEED Gold).

[32] Note that some number of the projects now registered for LEED may not complete the certification process, whether or not they follow LEED criteria through design and construction.

each credit category. For LEED Registered buildings, however, on-line data are less complete since most of these are still in the pre-design or design stages. Also, some data are not published on-line due for confidentiality reasons.

This analysis focused on LEED credits in the "Energy and Atmosphere" category, and on the Energy Performance credits in particular (i.e., efficiency improvements beyond ASHRAE Standard 90.1-1999), as well as the "Water Efficiency" credits. In terms of building characteristics, we disaggregated LEED buildings by:

- rating level;
- building type (with special attention to labs, offices, and industrial buildings that account for most DOE buildings and planned construction);
- ownership (federal, state/local, university or institutional, and private); and
- floorspace.

The sample size was not large enough to allow useful cross-tabulations by more than one variable at a time.

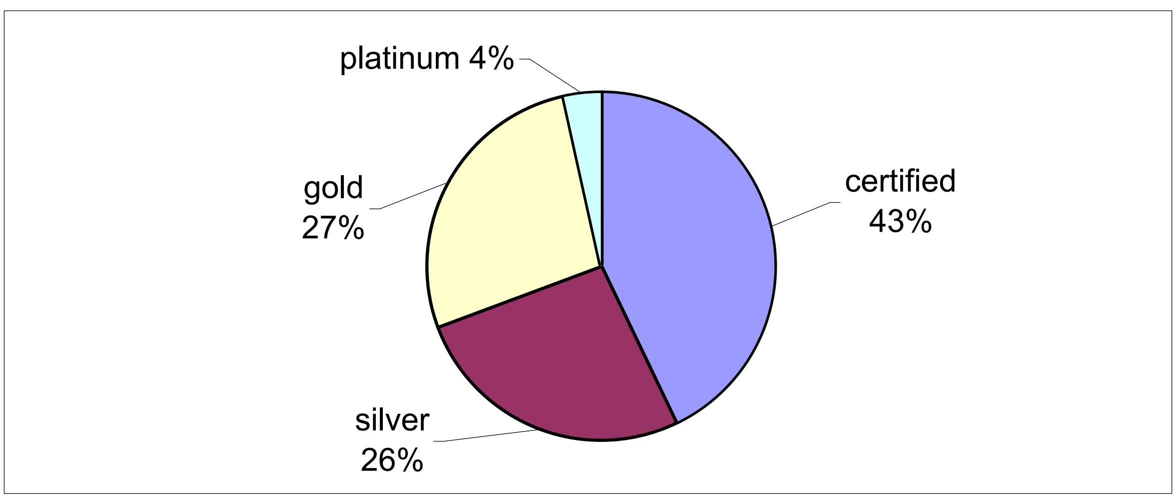
A third section summarizes information on Labs-21 case studies, and a related analysis of the incremental cost of achieving LEED ratings for a prototype building in different climate zones.

Certified LEED (v2) Buildings

1) Of the 84 Certified LEED buildings, more than half are rated Silver or higher.

This proportion (as shown in Figure B-1) remains about the same when buildings are disaggregated: by floorspace (except for the 10k-25k gsf category[33]), by building type, or by ownership (Figures B-2 through B-4). However, for federal buildings only 40% (i.e., 4 of 10 buildings, a small sample) are rated Silver or better. LEED Gold rated buildings are more likely to be privately owned and less likely to be federally owned (Figure B-4).

Figure B-1. Rating Levels of Certified LEED (v2) Buildings.



[33] Since 20% of buildings do not have published information on gsf, these missing data might change some of the trends observed as a function of floorspace.

Figure B-2. LEED Ratings by Building Type.

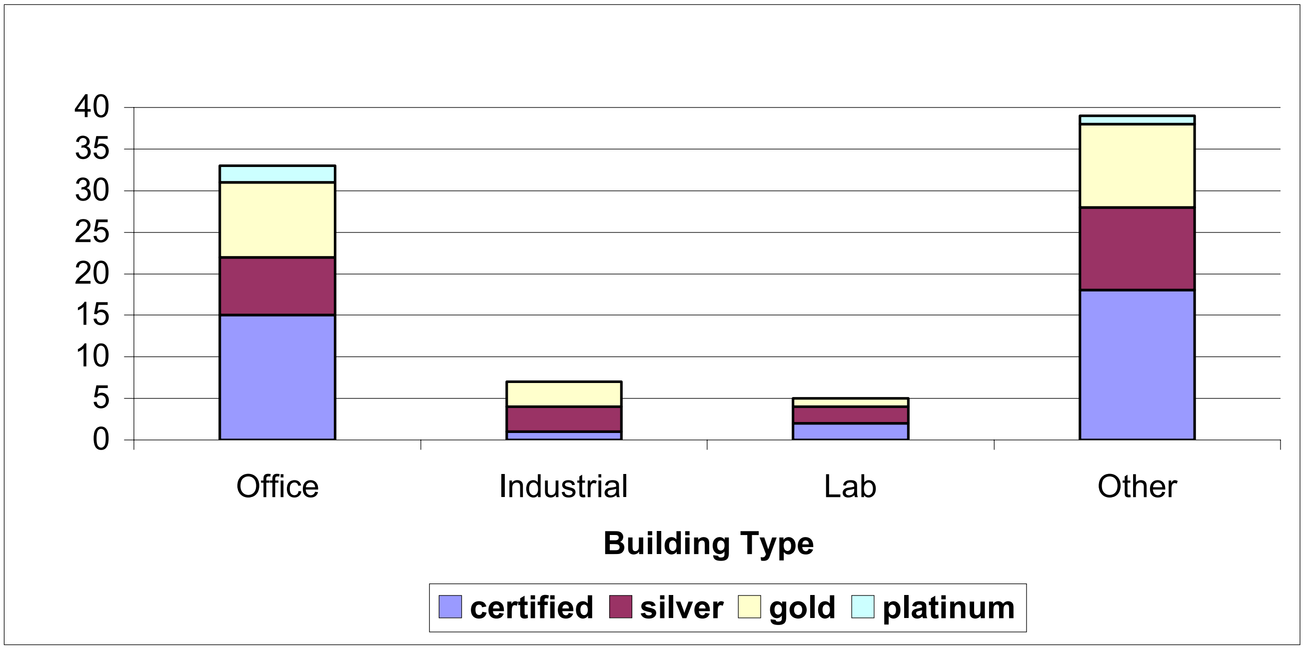


Figure B-3. LEED Ratings by Floorspace.

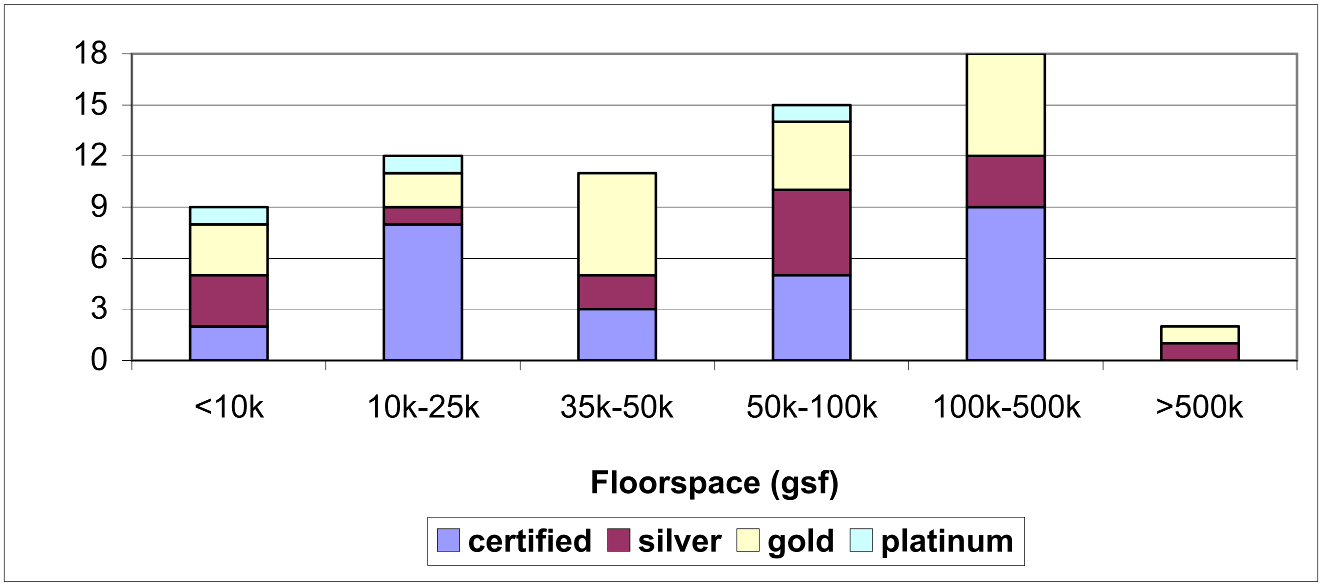
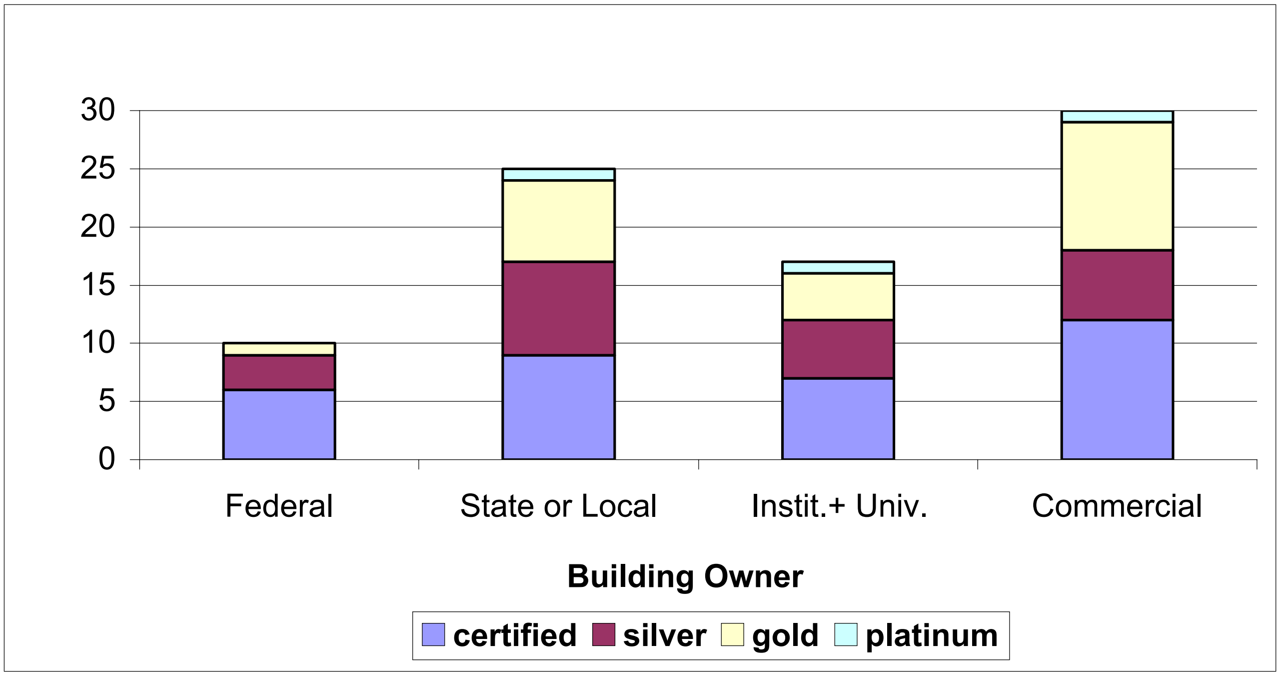


Figure B-4. LEED Ratings by Ownership.



2) More than half of all LEED-certified buildings earned at least 4 Energy Performance credits (i.e., were designed to be at least 30% more efficient than ASHRAE 90 levels).

Similar patterns were observed for most subcategories of buildings (Figures B-5 through B-9). However, earning at least 4 Energy Performance credits was less common for: buildings rated at the lowest "Certified" level (12 of 36), lab buildings (1 of 5), and two of the floorspace subcategories. Of the five lab buildings in the list, one earned 5 Energy Performance points (35%>ASHRAE), one earned 3 points (25%>ASHRAE), and three earned 2 points (20%>ASHRAE).

Not surprisingly, buildings with higher LEED ratings tend to earn a greater number of Energy Performance points (since they earn more points overall), as shown in Figure B-10. However, the wide vertical scatter in these data show that it is possible for a building at the most basic level of LEED ("Certified" rating) to emphasize energy efficiency, and conversely, that some very high-scoring buildings can achieve a relatively high rating (Silver or Gold) with virtually no attention to energy performance beyond what is required by building codes (ASHRAE 90 levels).

Figure B-5. Energy Performance Credits for Certified LEED Buildings.

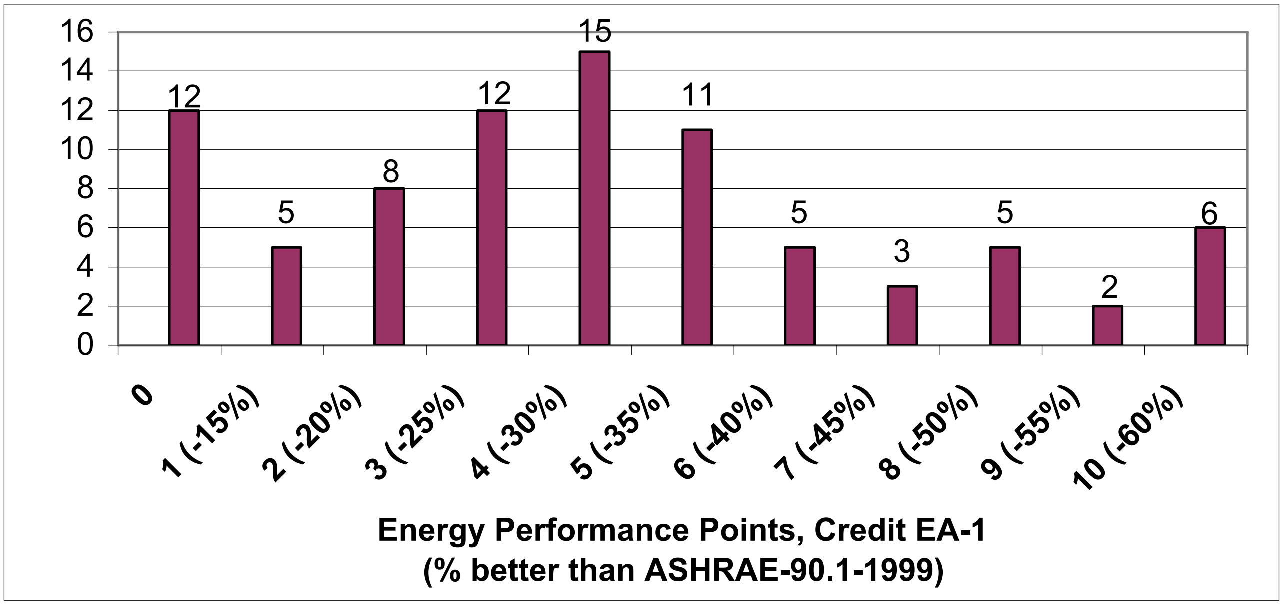


Figure B-6. Energy Performance Credits by Rating Level.

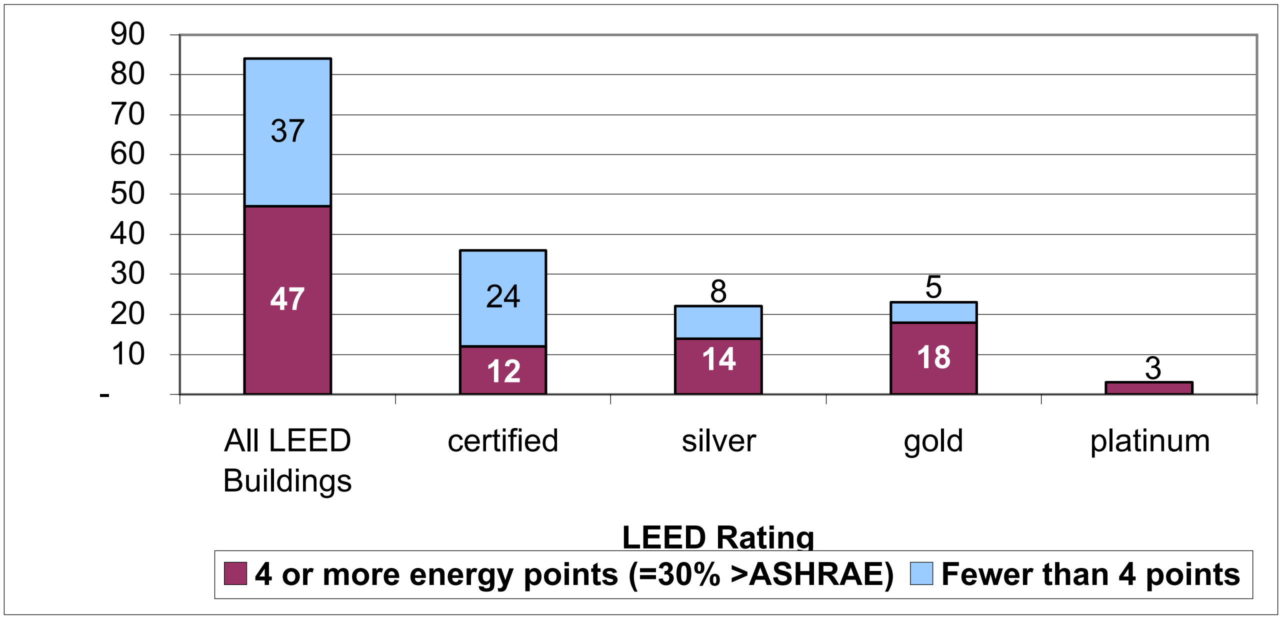


Figure B-7. Energy Performance Credits by Building Type.

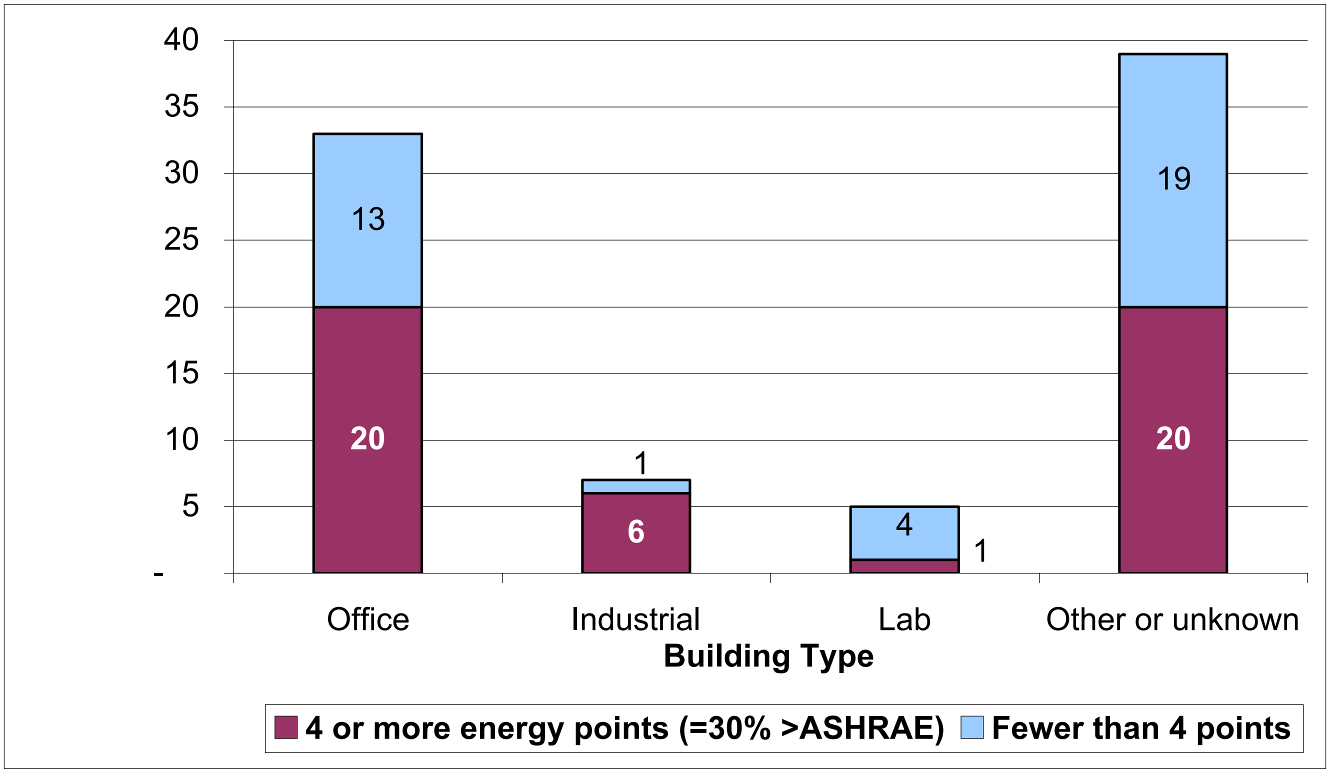


Figure B-8. Energy Performance Credits by Ownership.

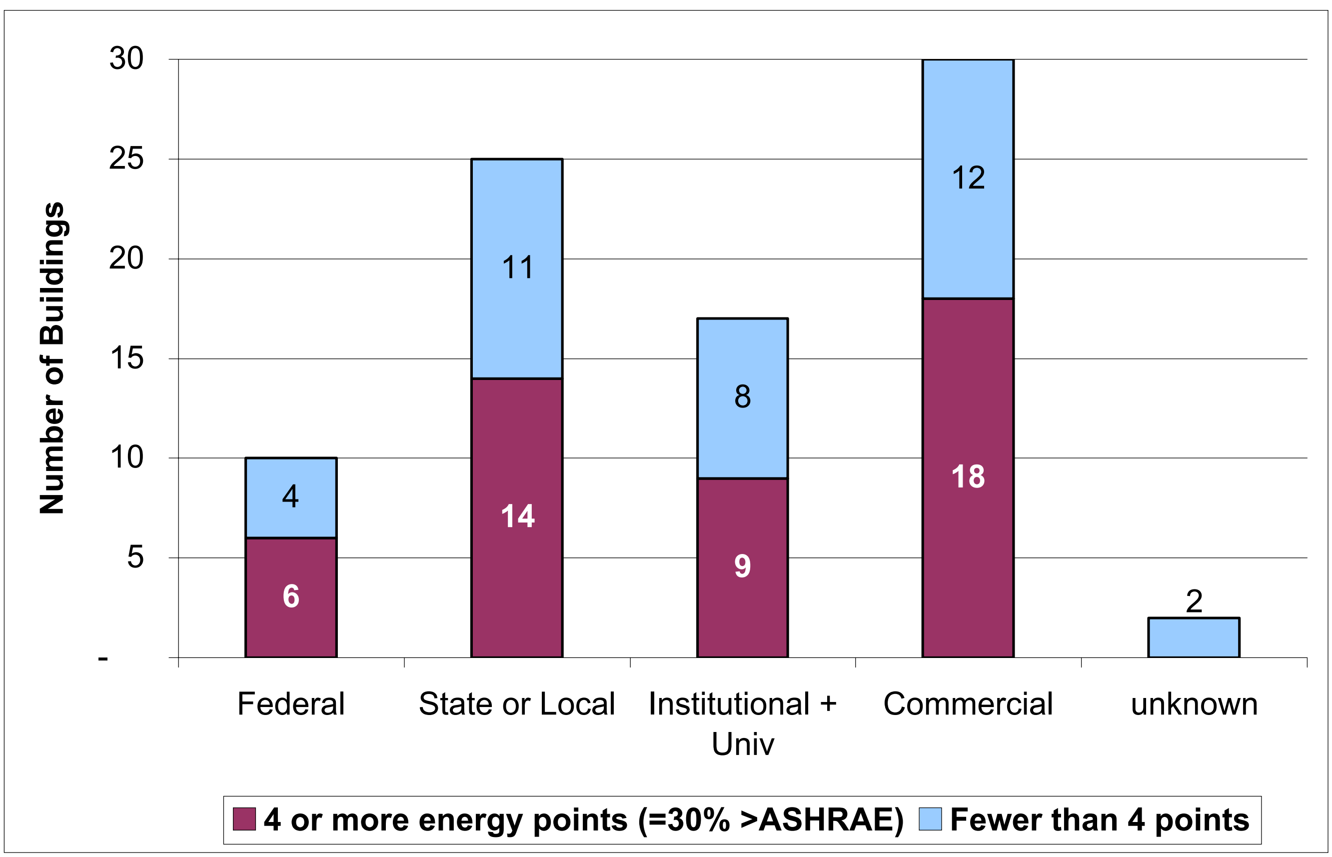


Figure B-9. Energy Performance Credits by Floorspace.

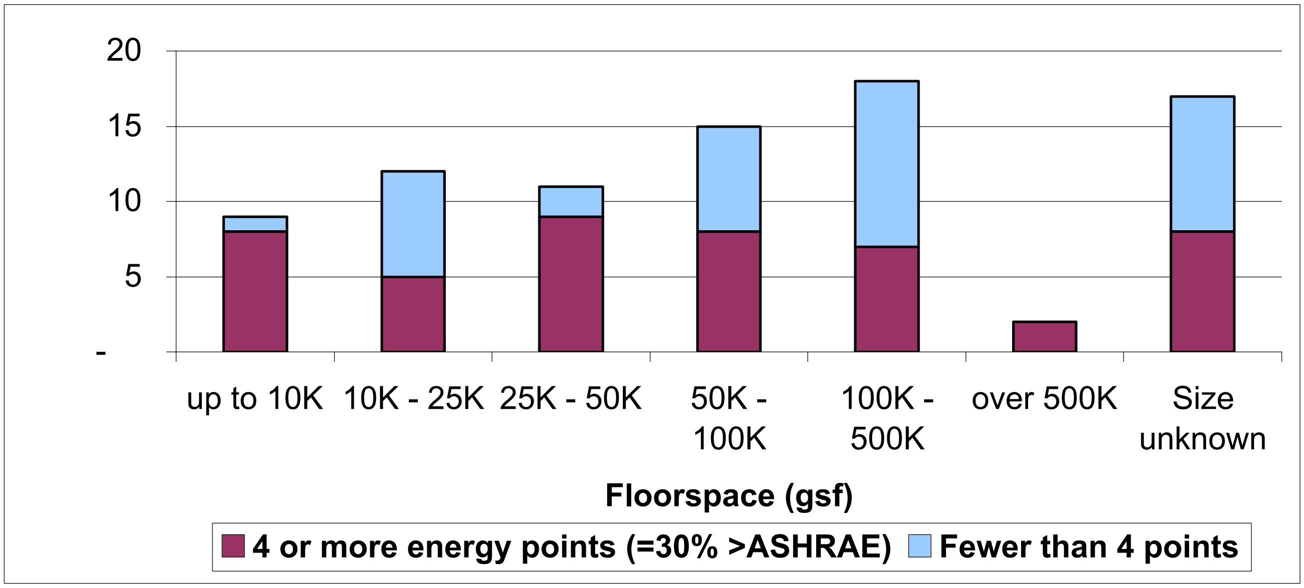
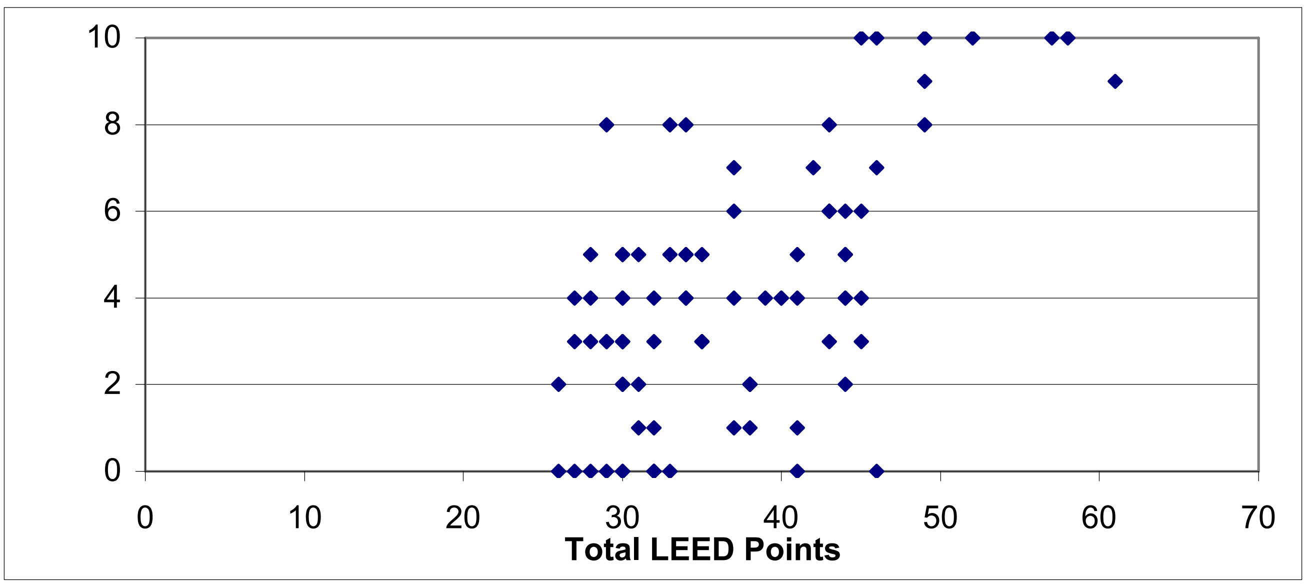


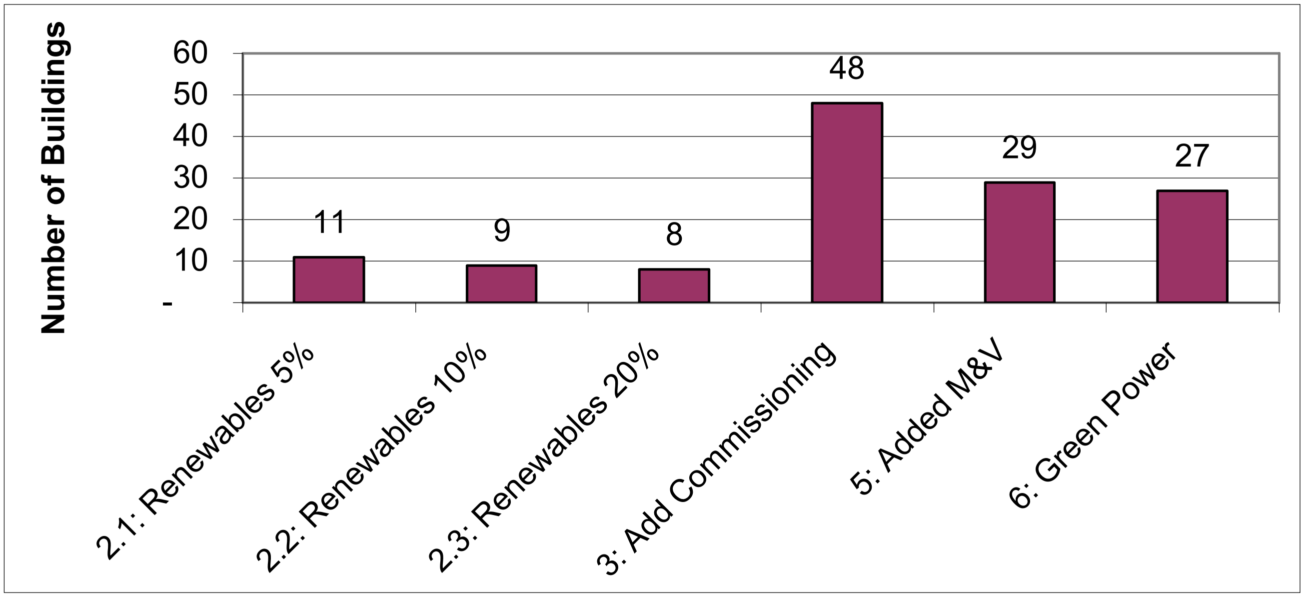
Figure B-10. Energy Performance Credits vs. Total LEED Credits.



3) Among other energy credits, Added Commissioning, Measurement and Verification, and Green Power were the most common; fewer LEED buildings invested in renewables.

Figure B-11 shows the distribution of other energy efficiency credits in LEED (with the exception of the "Ozone Depletion" credit (EA 4) which is not a current area of emphasis for a possible DOE Secretarial Challenge and in any case is a commonly earned credit).

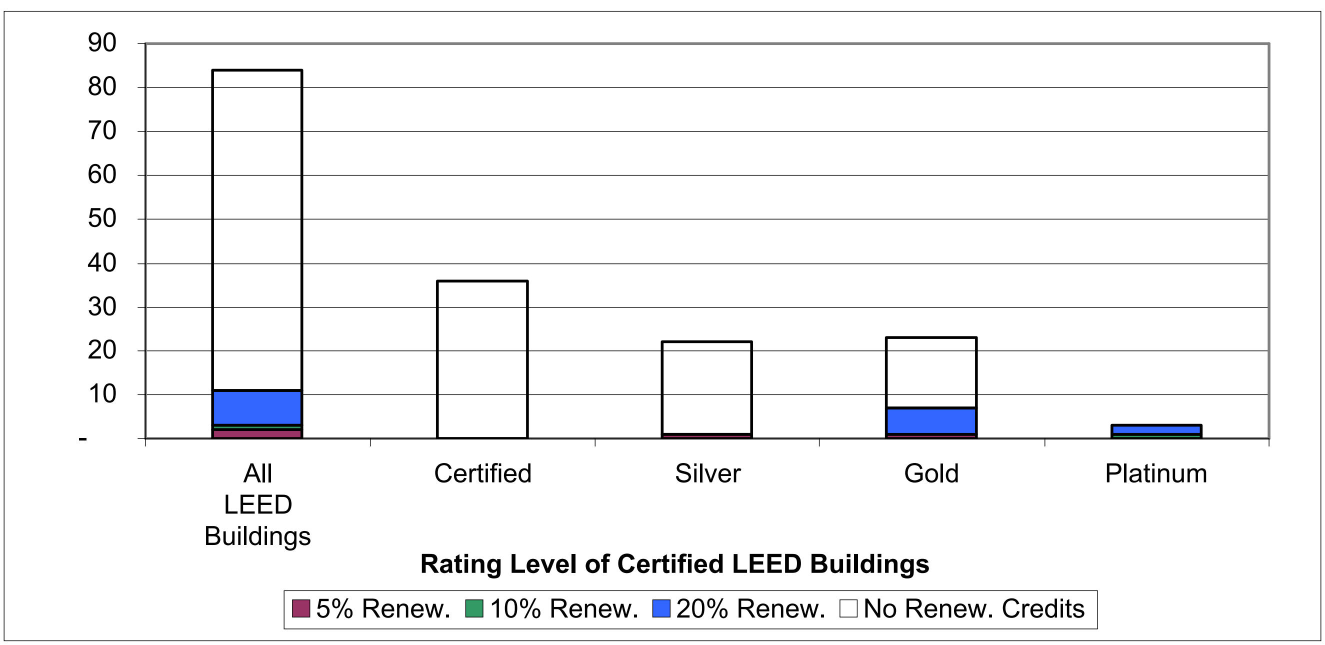
Figure B-11. Other Energy Credits Earned by Certified LEED Buildings.



The LEED Credit for Green Power was earned by about one-third of all certified projects. This percentage varied little among projects in the first four rating levels; none of the three Platinum buildings earned credits for green power. There were also no definitive patterns across building size or type in terms of the fraction of certified buildings earning the credit. There was, however, a pattern with federal buildings - none of the 10 certified federal buildings earned the green power credit.

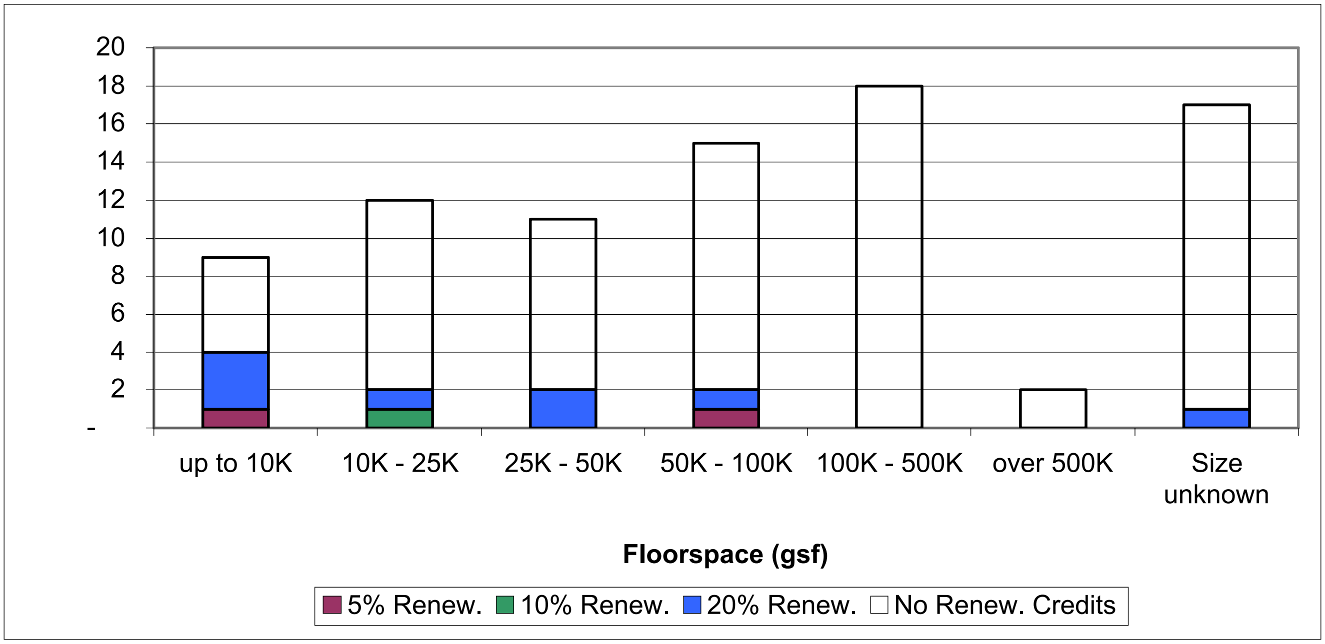
With regard to the renewable energy credits, all but one of the projects qualifying for renewable energy credits were at the Gold or Platinum LEED levels.

Figure B-12. Renewable Energy Credits by LEED Rating Level



Buildings that received the renewable energy credits tended to be small or medium-sized buildings.

Figure B-13. Renewable Energy Credits by Building Size



4) More than two-thirds of all certified LEED buildings earned 3 or more credits for water efficiency.

Figures B-14 through B-18 summarize the water efficiency credits earned by certified LEED buildings, for all buildings and for subgroups based on building type, ownership, and floorspace. Figure B-15 shows specific water credits earned; the other Figures emphasize the number of buildings earning at least 3 points in this category.

Figure B-14. LEED Water Credits by Rating Level

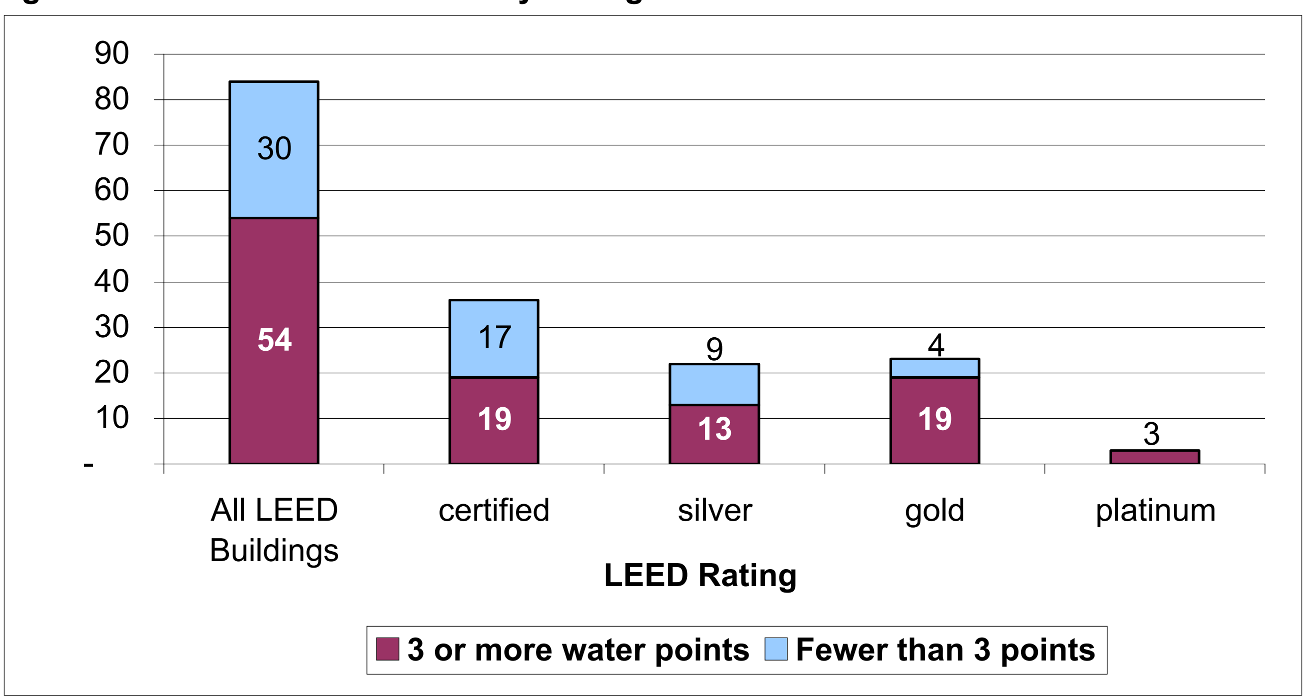


Figure B-15. Water Credits Earned by Certified LEED Buildings.

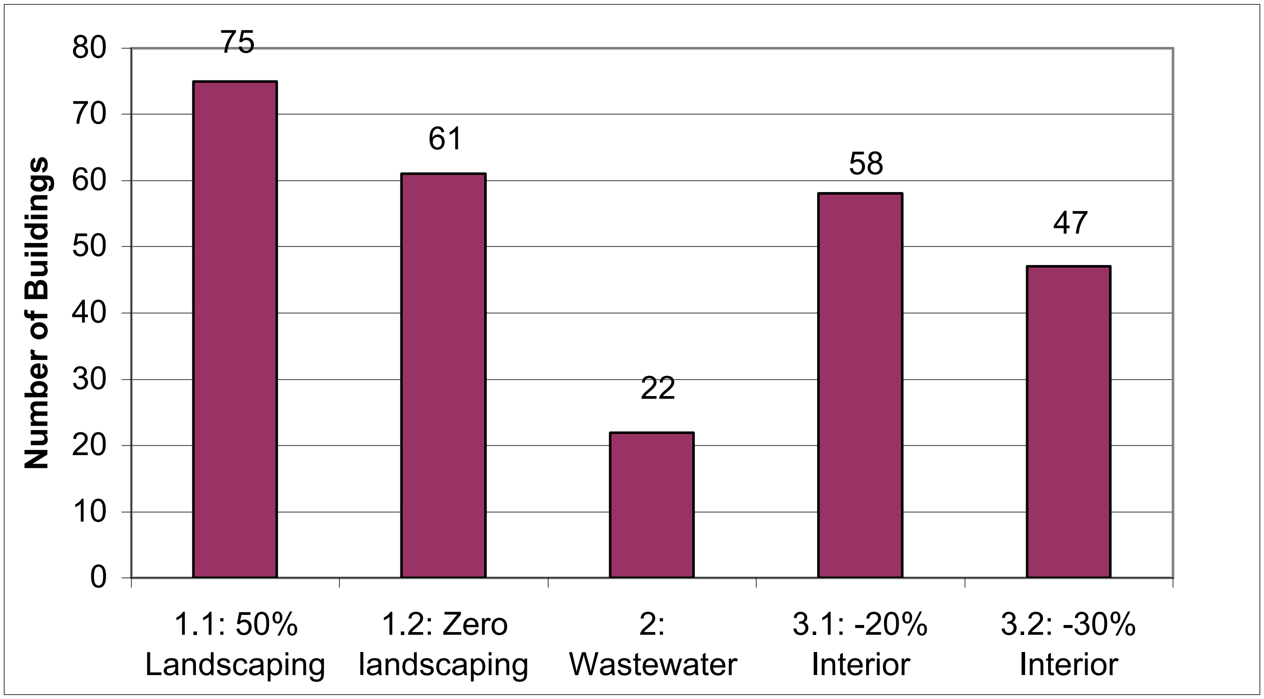


Figure B-16. Water Credits by Building Type.

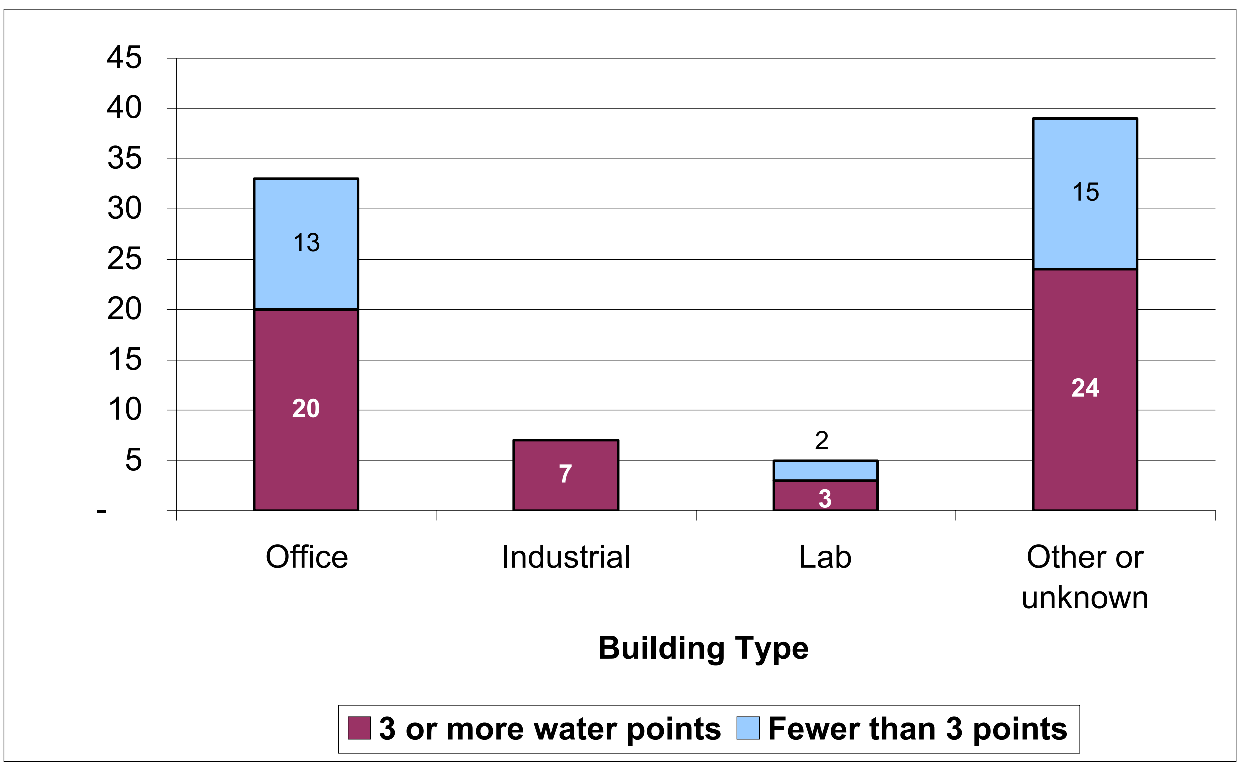


Figure B-17. Water Credits by Ownership.

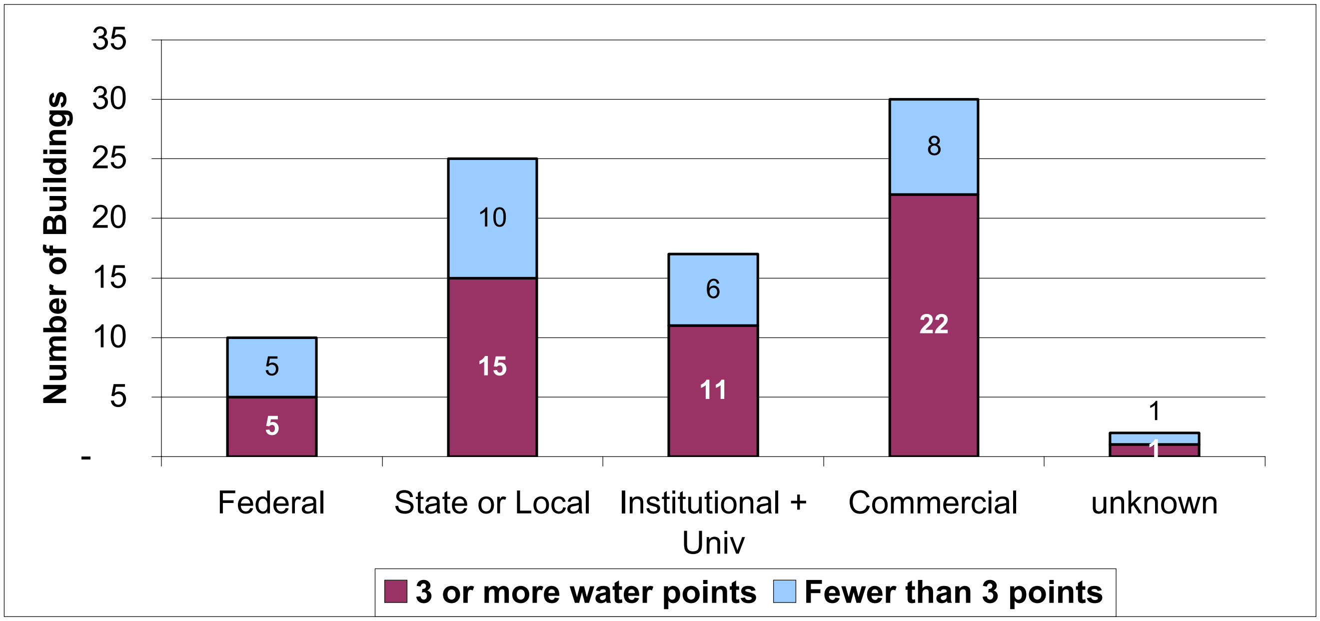
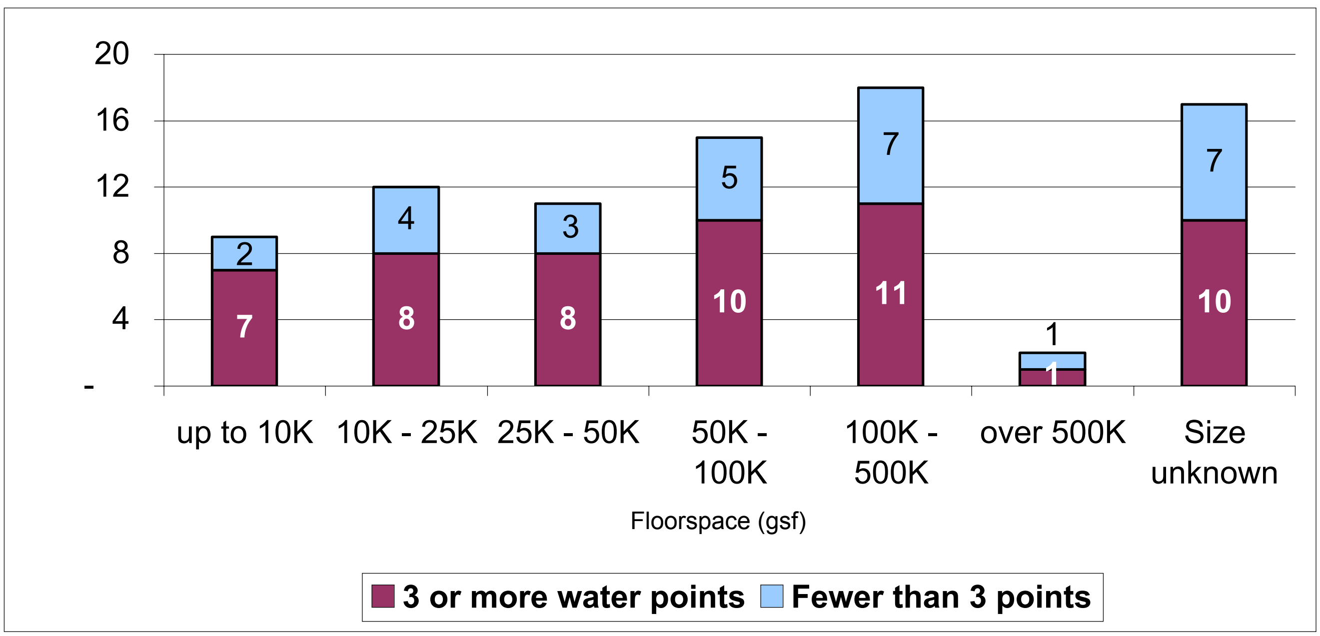


Figure B-18. Water Credits by Floorspace.



Registered LEED Buildings

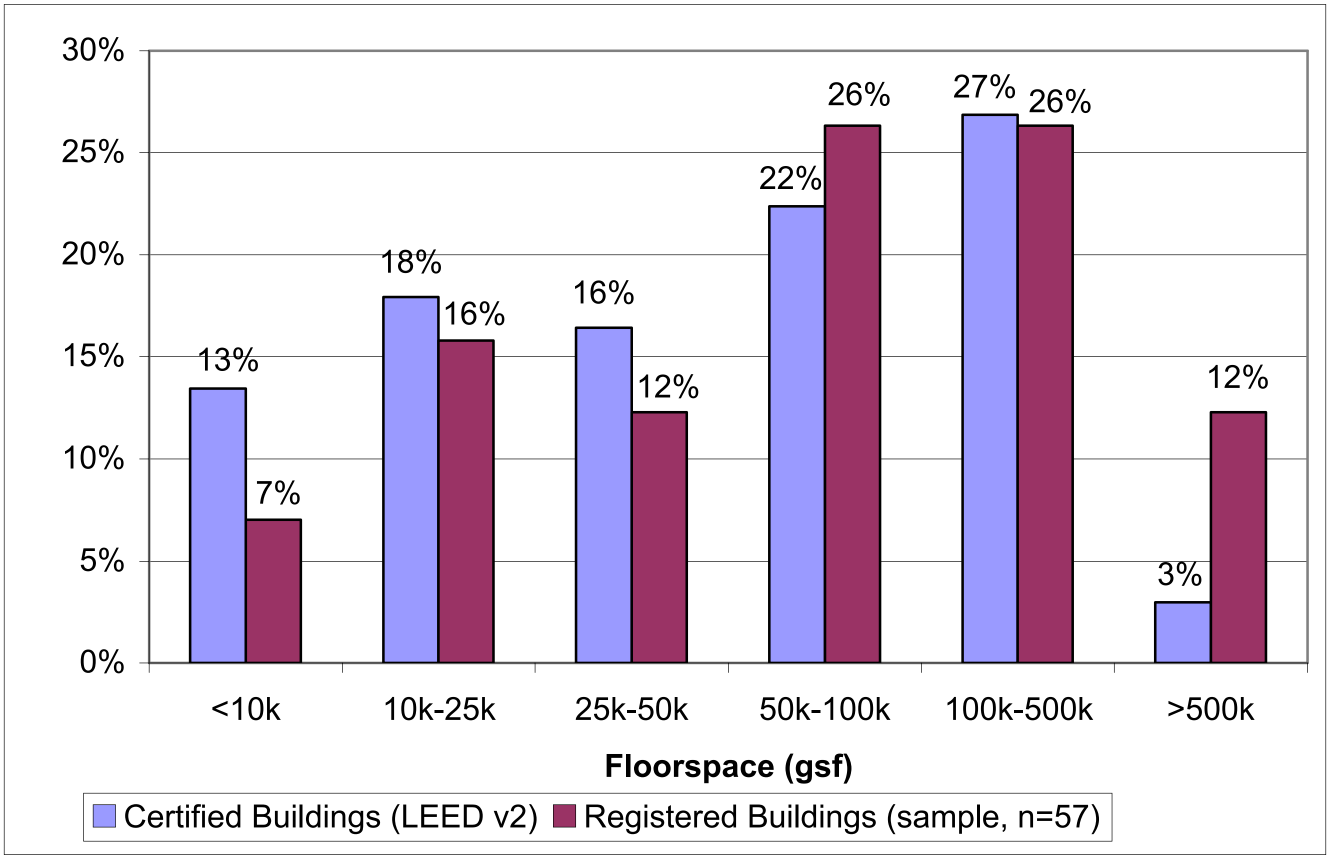
Among the 1200+ buildings listed on the USGBC website as LEED-Registered,[34] we examined data for 86 projects that were identified either as federally owned or as laboratory-type buildings (both federal and non-federal). Of these, 25 were laboratory or lab/office buildings, ranging in size from 5600 to 395,000 gsf (median: 77,000 gsf). Another 22 were offices, including several over 500,000 gsf, 3 were

[34] This master list also includes buildings certified under LEED 1.0 and LEED 2.0/2.1; we excluded these certified buildings from the analysis discussed here.

industrial projects, and the remaining 35 were other building types (courthouse, multifamily, school, recreation) or not identified.

For the overall sample of LEED Registered buildings, floorspace data were reported for 57 of 86 entries; the size distribution of this sample was very similar to that of the Certified LEED buildings, as shown in Figure B-19.

Figure B-19. Floorspace Distribution of Certified vs. Registered (sample) LEED Buildings.



Only some of the LEED Registered buildings report on specific points being targeted in the design process; of course, none of these points are "guaranteed" to be achieved until the project completes the LEED certification process. Also, many of the project files show "?" rather than a Yes or No for many LEED credits.

Despite these limitations, the available data show that, among the 25 laboratory (or lab/office) projects, at least seven have announced an intention to achieve 4 or more Energy Performance points (4 federal projects, 2 state, 1 local). Only two lab projects (1 federal) do not intend to achieve 4 or more points for Energy Performance; the rest are TBD.

Registered Federal Buildings

These data cover 70 projects registered for LEED by federal agencies but not yet certified (excluding projects for which there were no data shown for building characteristics or intended LEED credits).

- DOE or its National Labs accounted for 10 of these 70 projects.
- By building type, 10 were labs or lab/office; 23 were office or office-mixed use; 1 industrial, 8 courthouse, and the rest other uses or not specified.

- Half of the projects (35 of 70) indicated which LEED credits were being pursued (yes, no, maybe). Based on these statements of intent:
    - 11 (of 35) projects intended to achieve at least 4 energy performance points; another 17 projects planned for a range of energy performance credits up to 4 points (or more). Only 7 projects had specific plans for fewer than 4 energy performance points.
    - Only 5 projects had definite plans to achieve LEED points for renewable energy; many did not indicate whether or not they would pursue renewable energy credits.
    - 14 of 34 projects were definitely planning to achieve 3 or more water credits; only 6 had decided to pursue 2 or fewer water credits; the rest were undecided (in addition to the 40+ projects that did not indicate which LEED credits they were pursuing).
- 30 of the projects provided enough data on their intended LEED credits to determine the minimum LEED rating level they were pursuing. Of these, 8 were intending to achieve enough points to qualify for at least a Silver rating, and another 5 intended to achieve enough points for at least a Gold rating.

Table B-1 provides a summary of the registered buildings which could be identified as federal and for which data was available.

Table B-1. Federal Buildings Registered With USGBC for LEED-NC Participation.

			Intended LEED Points (Range: "Yes" + "Maybe")								

			Intended LEED Points (Range: "Yes" + "Maybe")								

			Intended LEED Points (Range: "Yes" + "Maybe")								

			Intended LEED Points (Range: "Yes" + "Maybe")								

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			Intended LEED Points (Range: "Yes" + "Maybe")								

Labs-21 Case Studies

In addition to the LEED-rated labs and other buildings, we looked at the building characteristics, including energy- and water-saving measures, in eight Labs-21 Case Study buildings (http://www.labs21century.gov/toolkit/case_studies.htm), selected to illustrate exemplary practice in design and operation of high-performance, energy-efficient and sustainable lab facilities. The results are summarized in Table B-2. Three of the Labs-21 case studies were also certified under LEED (v.1 or v.2): Pharmacia (Gold), Nidus Center (Silver) and Bren Hall (Platinum).

These laboratory buildings include physical, chemical, and biological labs (plus one teaching facility) in different regions of the U.S. They range in size from 41,000 to over 500,000 gsf. Three of the 8 case study labs are federal facilities; two others are state-owned. One is a retrofit (EPA National Vehicle and Fuel Emissions Test Lab); the rest are new construction. Laboratory space represents 40-60% of total floorspace at each site; the rest is mainly offices, circulation or other public space, and support areas. Most of the labs use either variable air volume hoods or heat recovery (or both) to reduce the energy penalty associated with very high outdoor air requirements.

In terms of predicted and measured energy performance, Table B-2 shows that every one of these projects were designed to save at least 30% of the energy of a base-case building. The base case was "standard practice", which in some cases corresponded to an ASHRAE 90.1 compliant design; in at least one case (Bren Hall) the baseline was more stringent than ASHRAE (California's Title 24 code). Where utility bill data were reported, actual energy use was either about the same or (in 4 of 8 buildings) substantially below the levels predicted by design stage modeling. Note that some of the energy intensity data in Table B-1 are for electricity only rather than the total for fuel + electricity.

At least five of the sites also implemented water-saving measures, including all three of the LEED rated projects.

Table B-2. Characteristics and Energy Performance of Labs-21 Case Study Labs.
[Source: http://www.labs21century.gov/**]**

Project	Lab Type	Owner	LEED Rating	Floor space (gsf)	Lab Space (%)	Site Energy Intensity (kBtu/sqft)		% Savings (modeled) (d)	VAV Fume Hoods	Energy Recovery	Comments
						Modeled	Actual				
Process Environ. Tech. Lab, Sandia NM	Physical Sci., Chem.	Federal DOE/SNL	—	151,435	—	341	269	43%	Y	Y	Commissioning, M&V
Lewis Stokes Lab, Bethesda MD	Biologic	Federal NIH	—	294,532	47%	230	—	40%	Y	Y	Commissioning, M&V
Fred Hutchinson Cancer Research Ctr., Seattle WA	Biologic	Private	—	532,602	38%	— (a)	347	33%(e)	Y(h)		Commissioning, M&V, water efficiency
GA Public Health Lab, Decatur GA	Clinical Testing	State	—	66,030	53%	— (a)	358	36%			Commissioning, M&V
Nat. Vehicle & Fuel Emissions Test Lab, Ann Arbor MI	Auto. Testing	Federal EPA	—	135,000	—	— (a)	335	60%(f)		Y	Commissioning, M&V Retrofit project
Pharmacia, Skokie IL	Chemistry	Private	Gold	176,000	51%	696	150(b)	40%	Y	Y	Commissioning, M&V, water efficiency.
Nidus Center, Creve Coeur MO	Biotech.	Private	Silver	41,233	60%	301	322(c)	38%	Y	Y	Commissioning, M&V, water efficiency.
Donald Bren Hall Santa Barbara CA	Teaching	State UCSB	Platinum	84,672	45%	174(b)	107(b)	30%(g)	Y		Commissioning, M&V, water efficiency.

Notes to Table B-2:
a) Model estimate was for electricity only, representing less than half of total site energy in all three buildings. Actual electricity use in each building was about 2/3 of model-predicted use.
b) Electricity use only (site kBtu); for Pharmacia Lab the modeled energy use is for fuel + elec., but measured electricity-only use was also less than predicted.
c) Actual energy use is average of 2 years of utility data.
d) Except as noted, most modeled savings are based on an ASHRAE-90 compliant base case.
e) Savings includes 26% from design/construction + 7% early retrofit
f) 200 kW fuel cell helped achieve 60% peak kW savings
g) Improvement compared with CA Title 24 code (more stringent than ASHRAE 90.1).
h) VAV used on entire supply system.

Appendix C
Comments from Reviewers

A number of interested parties were sent e-mail messages requesting comments on the white paper. Comments were received from 12 people. The comments generally fell into three categories: those that generally approved the goals set in the white paper, those that felt that specific adjustments had to be made to the goals, and those that had comments that we felt were outside of the scope of the white paper to address.

Comments of Agreement with Challenge Recommendations

Reviewers generally agreed on the following points:

- USGBC's LEED system is an acceptable metric for sustainable new construction.
- Energy and water performance are appropriate areas for DOE to show leadership in its new construction policies
- Office and laboratory space are appropriate facility types to which a Secretarial Challenge goal should be applied, while production facilities and other "unique" facilities are not.
- Most DOE facility sizes should be included in the Challenge, with only very small facilities being exempt.
- Buildings that have not yet entered the Title I phase of design should be required to meet the Challenge. Buildings that have already begun design should not be required to retroactively apply these design requirements.
- It is important to integrate the Secretarial Challenge with other DOE construction policies, so that one clear, consistent message is conveyed about DOE intentions for new construction.

Comments Requiring Adjustment to Challenge

- While reviewers generally agreed that the LEED metric was an appropriate one for DOE to adopt, there was less agreement on the LEED certification level that should be required. Some reviewers felt that the recommendation of LEED Silver was appropriate. Others thought that Silver was too stringent a goal, and LEED Certified would be more appropriate. Still others felt that the costs of the LEED certification process were too high, and that DOE should therefore self-certify its buildings.

  One reviewer provided a way of accommodating these concerns: a tiered approach to the Challenge that would raise the LEED level required as the size of the building increased. This is an elegant solution to the issue. Instead of one level for all DOE facilities, we now recommend three levels:

  (1) For buildings between 10,000 and 50,000 square feet, a requirement to meet the point totals for LEED Certified, but using self-certification by a LEED-accredited on-site professional, not full USGBC certification.

  (2) For buildings between 50,000 and 100,000 square feet, a requirement for USGBC certification at the LEED Certified level.

(3) For buildings over 100,000 square feet, a requirement for USGBC certification at the LEED Silver level.

By scaling the requirements in this way, we believe that we have, in essence, normalized the cost of certification across the cost of construction, making the Challenge goal cost-effective for all included facilities.

- Concerns similar to the certification level issue were raised with regard to three other components: metering costs, commissioning costs, and measurement and verification (M&V) costs.

(1) With regard to the cost of metering, the goal has been adjusted in a similar tiered fashion to require only basic consumption metering of electricity and natural gas for small facilities. These meters are very inexpensive in the scale of construction costs (less than $1,000), and they provide the first level of feedback on the building's energy performance. One FEMP workshop[35] estimated savings from simple awareness of energy consumption at 2.5% to 5%.

At larger building sizes, we recommend interval electricity meters. Use of more advanced metering to identify simple operations and maintenance improvements could generate savings as high as 15% to 40%. Even high-priced interval meters will typically cost well under $10,000

Furthermore, the cost of meter installation at building construction is significantly lower than retrofitting a meter into a building later. For these reasons, as well as those listed in the white paper text above, we believe building-level metering is a must-have component for DOE facilities to be operated properly. Again, the tiered approach provides a cost-leveling mechanism to avoid unduly burdening small facilities.

(2) The cost of additional commissioning was also a concern expressed by several reviewers, although the estimates of the cost burden that would result varied. While some DOE facilities have reported commissioning costs under $100,000, DOE's publication "Greening Federal Facilities" gives a commissioning cost range for new construction of 0.5% to 1.5% of total construction cost.[36] But, as the report notes, "In new construction, commissioning helps bring projects in on schedule and within budget without sacrificing quality or performance. The earlier commissioning begins (in the design and construction process), the greater the benefits tend to be. Commissioning can also save money by avoiding unnecessary redesigns, contractor requests-for-information, and contractor callbacks."[37]

For large facilities, proper construction commissioning can have substantial value. We believe the benefits of third-party commissioning are well worth the cost for these larger facilities, so we recommend it for the large (over 100,000 sq ft.) DOE facilities.

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[35] "Advanced Metering for the Federal Sector," September 25, 2003. See summary information at: http://www.eere.energy.gov/femp/technologies/om_advmetering.cfm

[36] "Greening Federal Facilities," p. 190. US Department of Energy. May, 2001.

[37] Ibid, p. 191.

(3) Reviewers expressed concern about the cost of requiring additional measurement and verification procedures in DOE facilities. While we believe that measurement and verification can have significant benefits in helping to ensure that buildings are properly operated and maintained, it is likely the case that requiring additional M&V may be too onerous for DOE facilities. We have therefore removed O&M as a requirement for the Challenge, although we still encourage it where cost-effective.

- Several reviewers raised the issue of renewable energy, with arguments both for and against such a requirement for DOE facilities. On the one hand, some reviewers commented that the use of on-site generation using renewable energy technologies would be a good additional example of DOE performance leadership. On the other hand, some reviewers were concerned that such a requirement would not be cost-effective, particularly at the low electricity prices that most DOE facilities pay.

  Ultimately, the intent of the Secretarial Challenge has been to develop a policy that would help guarantee life-cycle-cost-effective DOE facility construction. Energy and water performance enhancement has been shown repeatedly to improve the life-cycle cost-effectiveness of buildings. Where renewable energy can be implemented cost-effectively in DOE facilities, it is certainly encouraged. Overall, though, requiring a renewable energy component in the Secretarial Challenge seemed too onerous.

- Finally, a number of comments were made with concern about the cost impact of the Secretarial Challenge. While most reviewers saw the goals of the Challenge as appropriate, questions were raised about how the costs of achieving these goals would be met in the context of always-limited construction resources. Overall, as has been mentioned above, the intent of sustainable design in general and the Secretarial Challenge goals in particular is to enhance the focus of DOE facility design, construction, and operation on the total life-cycle cost of the building. We include provisions for exceptions to Challenge components where achieving those goals are demonstrably not life-cycle cost-effective. We believe that the Challenge requirements we have recommended will produce DOE facilities that provide the best value to the Department of Energy and, ultimately, the American taxpayer.

Other Comments

Two issues were raised that we deemed outside the scope of this white paper to address: pollution prevention, and transportation issues. In both cases, the reviewers made legitimate points about the need for DOE to address the environmental issues involved. We felt, however, that a Secretarial Challenge for construction of DOE facilities did not lend itself well to addressing these issues. We therefore note them as issues worthy of examination but outside the scope of this document.

Finally, there were a few comments made on the LEED certification process, the number of LEED buildings certified, the number of buildings registered for certification, etc. All of the numbers reported in this paper were drawn from USGBC's databases as of June, 2004. The LEED registration database provides a mechanism for owners, architects, or other design team members to indicate an interest in receiving a LEED designation. There is no requirement for a facility to register intent to achieve LEED certification, nor is there a requirement for a facility registering intent to achieve LEED certification. The amount of information submitted in the registration database also varies. In many cases, it may be difficult to discern the ultimate owner of the building from the information provided.

By contrast, the USGBC certification database is a list of those buildings that have completed design, gone through the certification process, and had their LEED points reviewed and confirmed by USGBC. This database is the definitive list of buildings that have achieved USGBC LEED certification.[38]

Finally, a number of buildings have been built using the LEED design checklist but have not gone through the formal USGBC certification process. These buildings were not included in the discussion above.

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[38] The latest USGBC information about LEED-certified buildings can be found at: https://www.usgbc.org/LEED/Project/project_list.asp