

Labs21 Environmental Performance Criteria: Toward “LEED™ for Labs”

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1. INTRODUCTION

Laboratory facilities present a unique challenge for energy efficient and sustainable design, with their inherent complexity of systems, health and safety requirements, long-term flexibility and adaptability needs, energy use intensity, and environmental impacts. The typical laboratory is about five times as energy intensive as a typical office building and costs about three times as much per unit area. Any efforts to reduce energy use and environmental impact are heavily impacted by special functional and health and safety requirements, which need to be considered in rating and benchmarking the overall environmental performance of a laboratory.

The Labs21 Environmental Performance Criteria (EPC) is a rating system for use by laboratory building project stakeholders to assess the environmental performance of laboratory facilities. Currently, the U.S. Green Building Council's LEED™ Rating System is the primary tool used. However, LEED™ was designed for U.S. commercial office buildings and as such, lacks some attributes essential to encouraging the application of sustainable design principles to laboratory buildings.

The Labs21 EPC is a project of the Laboratories for the 21st Century (Labs21) Program (<http://www.epa.gov/labs21century>). This is a program aimed at improving environmental performance of public and private laboratory buildings. The U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) are the lead sponsors of this effort. Labs21 recognized the need for a tool to provide guidance and evaluate laboratory environmental performance, and that building upon an already popular "green" rating tool like LEED™ would avoid "re-inventing the wheel". A workshop was held to develop an initial version, which was released in December 2001. Subsequently, volunteers were solicited to develop version 2.0.

2. DEVELOPMENT PROCESS

Eight working groups have been established to develop the EPC, reflecting the LEED™ sections:

- WG1 Sustainable Sites
- WG2 Water Efficiency
- WG3a Energy & Atmosphere (Energy Supply)
- WG3b Energy & Atmosphere (Energy Efficiency)
- WG3c Energy & Atmosphere (Laboratory Equipment)
- WG4 Materials and Resources
- WG5 Indoor Environmental Quality
- WG6 Innovation & Design Process

Participation in working groups is open to all interested stakeholders. Collectively, the working groups currently have over 40 participants, including architects, engineers, consulting experts, health & safety personnel, and facilities personnel. The EPC is being developed in a consensus-based approach. In the few cases where a consensus cannot be reached within a reasonable timeframe, a voting mechanism is used.

3. LABS21 EPC CREDITS

3.1 Overview

The Labs21 EPC 2.0 follows the format of LEED™ Version 2.0. The EPC has additional credits and prerequisites and in a few cases has modifications to the existing LEED™ credits (see figure 1). The EPC is more heavily weighted towards energy & atmosphere credits, since energy use has a more significant environmental impact when compared to other commercial buildings.

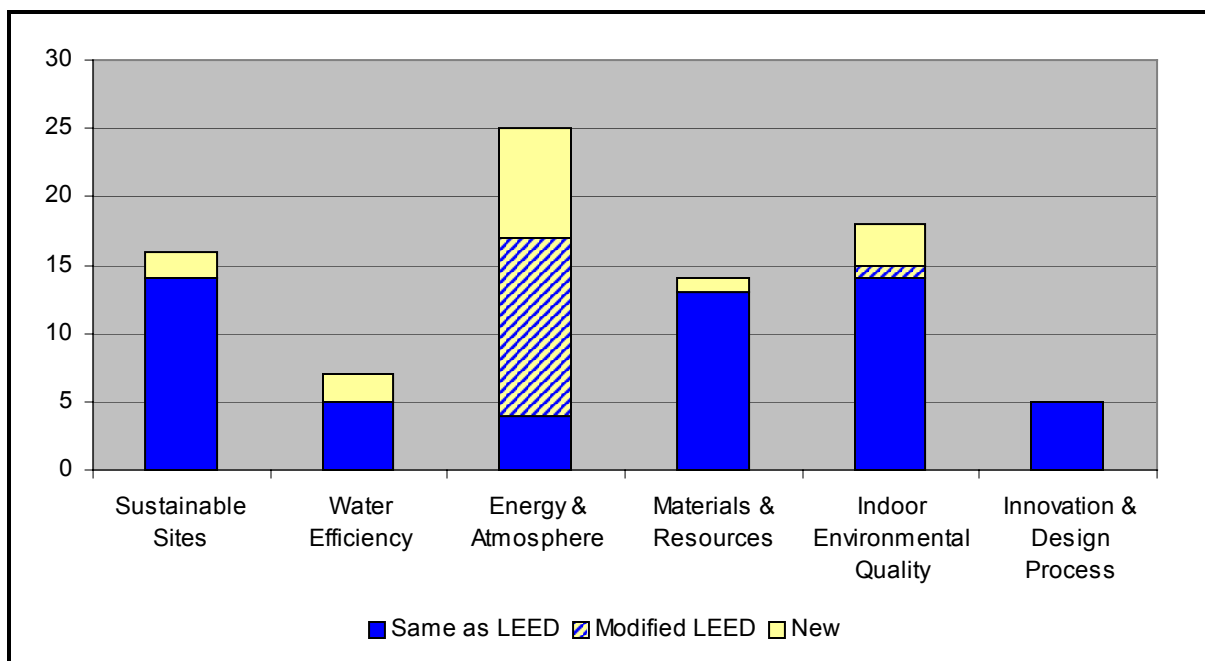


Figure 1 EPC credits in each section

In the following sections, we only discuss additional credits (over and above LEED™ credits) and modifications to LEED™ credits. All other LEED™ credits are assumed to remain the same. For example, in the Sustainable Sites (SS) category the LEED™ prerequisite and credits SS-1 through SS-8 remain unchanged. Labs21 EPC proposes an additional credit (SS-9), Safety and Risk Management with a potential two-point credit. In the interest of brevity, the technologies and strategies are not included in the credit descriptions below. The latest version of the EPC may be downloaded from <http://labs21.lbl.gov/epc.html>.

3.2 Sustainable Sites

All the LEED™ 2.0 credits for sustainable sites are valid for laboratory facilities. However, unlike other commercial buildings, laboratories typically have air and water effluents that could present risks to people and the environment. Accordingly, the EPC adds credits for design efforts to manage these risks.

Credit 9 Safety and Risk Management

Intent

Minimize building effluents and environmental, safety and health impacts to site and neighbors.

Requirements

Credit 9.1 (1 point) Meet all standards and generally accepted guidelines for outdoor protection of workers and general public from airborne chemical, radioactive and biological hazards. Use mathematical modeling, physical modeling and/or post-construction testing and certification to prove compliance. Use effluent controls that minimize generation of waste subject to special regulations.

Credit 9.2 (1 Point) Prevent releases of hazardous chemicals and other pollutants to sanitary sewer, using containment and engineering controls.

In developing credit 9.1, there was significant discussion on whether the requirement should specify a standard. Unfortunately, existing standards are not necessarily consistent or even comprehensive in the scope of effluents they address, and would be beyond the scope of the EPC to address limitations in standards and codes. Therefore, the requirement for this credit focused on design process – in essence giving a credit for “conscientious effort” to study and address air effluents via CFD modeling and/or wind tunnel modeling. The premise is that a conscientious design effort will increase the probability of a better design.

3.3 Water Efficiency

All the LEED™ 2.0 credits for water efficiency are valid for laboratory facilities. The EPC adds a prerequisite to ensure that no domestic water is used “once-through” for any laboratory equipment, since this is often a major cause for excess water use.

The EPC also adds a credit specifically addressing process water use, since this is significant in laboratories. Unfortunately, there are no standards for water use efficiency that can be used as a benchmark (analogous to ASHRAE 90.1 for energy efficiency). Therefore, this 2-point credit provides 1 point for baselining and meter installation and 1 point for reducing process water use.

Prerequisite 1	Laboratory Equipment Water Use
<u>Intent</u>	
Reduce water use for laboratory equipment	
<u>Requirements</u>	
Prerequisite 1.0	No domestic water shall be used “once-through” for any laboratory equipment, unless it is needed as direct contact process water.

Credit 4	Process Water Efficiency
<u>Intent</u>	
Reduce process water use and process wastewater generation	
<u>Requirements</u>	
Credit 4.1 (1 point):	Calculate and document baseline of annual process water use and process wastewater generation. Install water meters to measure process water use.
Credit 4.2 (1 point):	Adopt technologies and strategies to reduce process water use and process wastewater generation by 20%. Document the reductions from baseline.

3.4 Energy & Atmosphere

Given the significance of energy use in laboratory buildings, this section dominated the development of the EPC, and contains several additions and modifications to LEED™.

3.4.1 Energy Efficiency

Generally, there are two approaches to address energy efficiency requirements, each with associated advantages and disadvantages.

- Prescriptive Approach: This approach would essentially give points for implementing certain energy efficiency measures (e.g. VAV fumehoods), or for doing certain design process steps (e.g. CFD modeling). This approach is easier to specify, but also has less flexibility – a building design may have energy efficiency measures that the credit did not anticipate.
- Performance approach: This approach would define a baseline energy performance and give points for percentage reductions from the baseline. This approach is conceptually preferable, but more difficult to specify and verify.

Addressing laboratory energy efficiency is an especially challenging task, since laboratories can have very different functional requirements. LEED™ credit 1 adopts a performance-based approach and uses ASHRAE 90.1 energy cost budget method (ECB) as the benchmark, with points awarded for reductions below the benchmark. However, ASHRAE 90.1 ECB does not specifically address baseline assumptions for laboratory systems.

The EPC development team chose to tentatively maintain the performance-based approach using ASHRAE 90.1 ECB, but modifying it to include specifications for laboratory systems. Furthermore, recognizing that ventilation is typically 50% of laboratory energy use, the EPC adds a prerequisite to ensure that ventilation requirements are optimized. Since ventilation requirements cannot be universally prescribed, the prerequisite simply requires a process to arrive at the appropriate ventilation requirements. The prerequisite and the credit are given below.

Prerequisite 4 Assess Minimum Ventilation Requirements

Intent

To determine minimum ventilation requirements in laboratories based on user needs, health/safety protection and energy consumption.

Requirements:

The ventilation requirements shall be determined and documented by a team including each of the following professionals: A/E Team, Laboratory Consultants*, User Representative, Owner Facilities Group, Facilities Maintenance, Owner Environmental Health & Safety, Commissioning Agent*, Construction Manager* (*If these have not been appointed, an individual who independently and conscientiously represents these interests.)

The team shall, at a minimum, do the following:

- Determine the necessary fresh air ventilation rate and number of fume hoods and other exhaust devices based on applicable codes and the planned use of the laboratory over the next 5 years.
- Consider exhaust alternatives such as instrument exhausts and ventilated storage cabinets with very low flow ventilation and good ergonomic accessibility.
- Develop a workable fume hood sash management plan including: a) Informational placards for hoods; b) Awareness and Use Training. The Sash Management Plan should be incorporated in the Chemical Hygiene Plan for the laboratory.

The process and findings should be documented.

Credit 1 Optimize Energy Performance (Replaces LEED Credit 1)

Intent

To achieve increasing levels of energy performance to reduce environmental impacts associated with excessive energy use.

Requirements

Reduce design energy cost compared to the energy cost budget for regulated energy components described in the requirements of ASHRAE/IESNA Standard 90.1-2001, as demonstrated by a whole building simulation using the Energy Cost budget Method described in section 11, with the following modifications to the specifications for the budget building design and proposed design:

<i>Laboratory Space</i>	<i>Budget Building Design</i>	<i>Proposed Design</i>
Fumehood/exhaust device density	Same as proposed design	Based on prerequisite 4
Plug loads	Same as proposed design	Based on laboratory requirements and operation
Lighting power density in lab spaces	1.8 W/ sf (net)	As designed
Fumehood configuration	100 fpm face velocity w/ vertical rising sash 18" open	As designed
Ventilation system control	100% outside air, constant volume, no heat recovery	As designed, using same occupied hours schedule as budget design

All other characteristics of the budget building design and proposed design (e.g. envelope, etc.) shall remain the same as in the standard. Plug loads should be included in the simulation, but

should be excluded in calculating the percentage difference between budget building and proposed design.

Credit 1.1 (1 point)	Reduce design energy cost by 5%
Credit 1.2 (2 points)	Reduce design energy cost by 10%
.....	
Credit 1.10 (10 points)	Reduce design energy cost by 50%

There is legitimate concern that a performance based approach can be "gamed", especially in laboratory facilities, with all their inherent assumptions on functional requirements. The EPC team will be testing the viability of this approach with case studies.

3.4.2 Energy Supply

LEED™ credit 2 provides points for on-site renewable energy generation, expressed as a percentage of the building's total energy use. Since laboratories typically have 3-5 times the energy intensity (energy use per unit area) of an average commercial office building, the percentage values in LEED™ are consequently 3-5 times as hard to achieve for laboratories. In order to compensate for this, the EPC reduces the percentage thresholds for each point.

Credit 2	Renewable Energy	<i>(Replaces LEED Credit 2)</i>
<u>Intent</u>		
Encourage use of renewable energy technologies to reduce fossil fuel energy use		
<u>Requirements</u>		
Supply a net fraction of the building's total energy use (as expressed as a fraction of annual energy cost) with on-site renewable energy systems.		
Credit 2.1 (1 point)	Renewable energy, 2% contribution	
Credit 2.2 (2 point)	Renewable energy, 5% contribution	
Credit 2.3 (3 point)	Renewable energy, 10% contribution	

Laboratories are usually good candidates for cogeneration systems, given ventilation loads as well the need for backup generation. The EPC adds a credit for energy efficient on-site generation, as measured in terms of total source energy use. By taking this approach, the credit provides flexibility as regards system type, system efficiency, waste heat utilization, etc.

Credit 7	Energy Supply Efficiency
<u>Intent</u>	
Reduce the total non-renewable source energy required for the facility through increased energy supply efficiency	
<u>Requirements</u>	
Calculate the total annual non-renewable source energy requirements for the facility as designed, using the calculated site energy requirements and the source conversion values provided in the table below. Calculate the percentage reduction in the total annual non-renewable source energy,	

achieved through the use of combined heat and power systems, or other methods of cascading energy recovery of primary fuel supplies.

<i>Fuel Type</i>	<i>Site (kBTU)</i>	<i>Source (kBTU)</i>
Electricity	1	3.013
Natural gas	1	1.024
Fuel oil	1	1
Steam	1	1.38
Hot Water	1	1

Local air emissions regulations must be met. This credit cannot be applied for fuel switching without the use of energy generation equipment.

Credit 7.1 (1 point) Reduce source energy use by at least 10%

Credit 7.2 (2 points) Reduce source energy use by at least 20%

.....

Credit 7.5 (5 points) Reduce source energy use by at least 50%

One issue pertinent to on-site generation is emissions. Ideally, this credit should establish a baseline for emissions. The California standards (CARB) was considered to be too stringent as a national baseline. Therefore, the credit simply requires meeting local standards. As national standards emerge, they can be incorporated.

3.4.3 Laboratory Equipment Efficiency

Equipment loads in laboratories are typically much higher than commercial buildings and can vary widely, from 2 W/sf to 15 W/sf. In addition to direct consumption, equipment loads also affect cooling energy use. Equipment loads are often overlooked as an area for increased efficiency. The EPC adds two credits to encourage reducing equipment loads.

Credit 8 encourages the selection of energy efficient laboratory equipment. There is little if any laboratory equipment that has an EnergyStar™ rating. The credit reflects the EnergyStar™ approach by requiring the selection of equipment that is above the 75th percentile in terms of efficiency. Obviously, this will only apply when there is a choice of functionally equivalent equipment.

Credit 8 Improve Laboratory Equipment Efficiency

Intent

Save energy with efficient laboratory equipment.

Requirement

Credit 8.0 (1 Point) Use Energy Star™ compliant equipment or equipment in the top 25th percentile for at least 75 percent of new Class 1 and Class 2 equipment and at least 30 percent of all Class 1 and Class 2 equipment. Acceptance of equipment in the 25th percentile requires a minimum of 4 different models that meet the functional needs of the research. If only 2 or 3 functionally equivalent models are available, acceptance requires selection of the most energy efficient model.

Another issue pertaining to equipment loads is that HVAC designers often overestimate the equipment loads and consequently oversize HVAC systems (chillers, fans, etc.). This can be avoided by getting a more accurate estimate of equipment loads by metering similar laboratory spaces, as required in credit 9.1. An additional credit is given for providing for metering.

Credit 9 Right-size Laboratory Equipment Load

Intent

"Right-size" mechanical equipment by improving estimates of heat-gain from laboratory and process equipment.

Requirements

Credit 9.1 (1 point) Measure base usage of equipment electrical loads in a comparable laboratory space for each functional type of laboratory space and design electrical and cooling systems based on these measurements.

Credit 9.2 (1 point) Design electrical distribution system to provide for portable or permanent check metering of laboratory equipment electric consumption. Design for safe access to electrical feeder enclosures and provide sufficient space to attach clamp-on or split core current transformers.

3.5 Materials & Resources

All the LEED™ 2.0 credits for materials and resources are valid for laboratory facilities. There was some concern about the appropriateness of credit 1, which encourages building reuse - the concern is that adapting existing buildings for laboratory spaces inhibits energy efficient design. However, it was concluded that energy efficiency issues are adequately covered in other credits and that this credit should be retained, to encourage building reuse where possible.

The EPC adds a prerequisite and a credit pertaining to the handling of hazardous materials. The prerequisite is to ensure that an information system for tracking hazardous materials is installed, and the credit is for effectively managing hazardous material streams.

Prerequisite 2 Hazardous Material Handling

Intent

Develop information system to manage hazardous materials stream.

Requirement

Prerequisite 2.0 Develop a system to maintain current information about hazardous material types, quantity, location, and disposal/use histories, and deliver information to a central location.

Credit 8 Chemical Resource Management

Intent

Reduce potential harm to the environment and people through improved management of chemicals.

Requirements

Credit 8.0 (1 point) Develop an action plan to eliminate, minimize, substitute, recycle, and dispose of harmful chemicals safely. Plan should improve distribution, and limit quantities, storage and waste.

3.6 Indoor Environmental Quality

All the LEED™ 2.0 credits for indoor environmental quality are valid for laboratory facilities. The EPC adds prerequisites pertaining to minimum health and safety requirements (including meeting ANSI Z9.5), and credits to encourage measures that improve worker health and safety.

Credit 9 Indoor Environmental Safety

Intent

Ensure health and safety of employees

Requirements

Design laboratories to ensure contaminants are contained and workers are protected.

Credit 9.1 (1 point) Optimize indoor airflow based on results of computational fluid dynamics (CFD) or physical modeling.

Credit 9.2 (1 point) Conduct fume hood commissioning that includes ASHRAE-110 Method of Testing Performance of Laboratory Fume Hoods (latest version) *As Installed*. Scope of testing to include 6.1 Flow Visualization, 6.2 Face Velocity Measurements and 7.0 Tracer Gas Test Procedures. The hood performance rating for the Tracer Gas Test procedure shall be at least 4.0 AI 0.1 as specified in ASHRAE-110.

Credit 9.3 (1 point) Design all alarm systems in the laboratory to be inherently self-identifying and failsafe.

The EPC also modifies LEED credit 6, exempting pressure-controlled laboratory spaces from requiring operable windows, since this compromises safety.

3.7 Innovation & Design Process

All the LEED™ 2.0 credits for innovation and design process are valid for laboratory facilities. The EPC provides a list of suggestions for innovation credits e.g. mini-environments, displacement ventilation, design for flexibility, etc.

4. TOWARD LEED™ FOR LABS

As noted earlier, the EPC leverages the existing LEED™ Rating System 2.0. The EPC is a public domain document that is available for anyone to use as they see fit. Labs21 does not provide a project certification process. The USGBC is considering developing and publishing a LEED™ Application Guide for Laboratories and/or a Laboratory Supplement to LEED™, and has expressed a strong interest in using the EPC as a basis for this effort.

The development of a LEED for Labs raises new certification issues related to the definition of building types. Thus far, LEED™ has been applied uniformly to all building types i.e. building type is not an issue. Obviously, if LEED™ has versions specific to building types, it is necessary to define each building type to determine applicability of the appropriate versions. This is especially relevant in mixed-use buildings (e.g. 40% office, 60% laboratory).

Another issue pertains to the number of points. This version of the Labs21 EPC increases the number of possible points from 69 to 85. This will dictate a commensurate increase in the threshold values for certification and the ratings of silver, gold and platinum. As of this writing, threshold values have not yet been proposed, and will be determined based on pilot-testing on selected laboratory facilities.

5. CONCLUSION - LEED™ FOR COMPLEX BUILDINGS

From the standpoint of rating systems, complex buildings may be defined as those that have special functional requirements that directly and significantly impact sustainability criteria e.g. laboratories, large hospitals. As this paper has shown, such buildings challenge the applicability of a general rating system for all commercial buildings, and may well justify the development of a LEED™ version for that particular building type. Obviously, there are advantages to having only one version of a rating system, and the number of “special” versions should be kept to a minimum. Also, the special versions should as far as possible maintain all the existing LEED™ credits (e.g. the EPC modifies only 3 LEED™ credits). With appropriate guidelines and standards for creating special versions for complex buildings, LEED™ can broaden its scope while maintaining overall consistency.

6. REFERENCES

ASHRAE/IESNA Standard 90.1 –1999. Energy Standard for Buildings Except Low-Rise Residential Buildings. ASHRAE, Atlanta, GA.

LEED™ Rating System Version 2.0, U.S. Green Building Council. June 2001.

7. ACKNOWLEDGEMENT

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