AAR4817 Use and Operation of Zero Emission Buildings, Research Essay

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Leadership in Energy and Environmental Design (LEED)

Understanding the application and effectiveness of LEED –EBOM

1. Abstract

This essay written to fulfill the course requirement of AAR4817 Use and Operation of Zero Emission Buildings, for M.Sc sustainable Architecture studies is research based writing. The course intends to make an understanding of Zero energy building and various certification methods to certify them.

The essay titled as "Leadership in Energy and Environmental Design **(**LEED)", Understanding the application and effectiveness of LEED –EBOM explains and discusses certification of a building under LEED certification system and looks in detail into LEED for existing Building Operation and Maintenance (LEED- EBOM). First part of essay includes various literature review about LEED Building rating system from books and sites. Further it elaborates the criteria and assessment of LEED EBOM.

Research question has been set to particularly look into the specific matter while doing research. To answer these research questions, some case study are done on buildings certified under LEED. These case studies are discussed at the end of the essay. The case studies presented are chosen to have an overview of LEED EBOM certification system, distribution of LEED points under 6 categories and how they are possible to acquire on existing building.

2. Introduction

2. a Green Building

The concept of green building was first introduced when people started to get aware about their role in causing global climate change. People started to realize impact of their activities on the environment when they had to face the problems like global warming, scarcity of water and shortage in energy supply. Temperature increases is an obvious consequence which has effect on all living creatures. The steady growth of CO2 in earth's atmosphere has made it more urgent to search for renewable non-carbon energy alternatives.

The building sector which contributes about 40% of carbon dioxide emission to the environment and consumes a large amount of energy use has been now the matter of focus for carbon reduction policies and programs. A large majority of energy produced to fulfill the building construction and operation is from non renewable energy. The constant use of these energy sources has resulted in lessening of energy supply. Hence with the terror of supply source being extinct, concern for energy supply security is increasing every day, worldwide. This awareness about energy supply and efficient use in the building sector resulted in the concept of green buildings.

Green buildings incorporate construction practice that helps in reduction or elimination of negative energy in building. They are designed and constructed in such a way that they ensure healthy living condition for the occupants. Innovation in construction techniques, materials and design concepts results in a well functional and efficient Green house having less impact on environment. *A successfully designed green projects can involve an extensive array of factors, ranging from the resourceful use of materials, to careful consideration of function, climate, and location (*Patrick Larum, Green architecture, March, 1999*)*.

2. b. Green Building Certification

In recognition to the need of green buildings, numerous green building rating systems have been developed in recent years with the intention to promote high performance low energy buildings. Certification of green building is a process of assessing compliance with pre established criteria to achieve points and to be rated on various scale.

In case of new buildings to be constructed, certification is a means of demonstrating compliance with certain building codes. Whereas for existing buildings, certification is used to make comparison between similar buildings and to assess the degree to which an older building falls short of codes that have been introduced since the time of its construction. As much of the buildings existing were built before energy efficiency became a focus of government policy, certification of existing buildings can do more than provide ratings: it can identify measures to improve energy performance in them. (Arkesteijn and van Dijk, 2010).

Among the various building rating systems introduced worldwide on national and international level, BREEAM (United Kingdom), LEED (United States and Canada), and CASBEE (Japan) helps the building user to determine structure's level of environmental performance. They award credits for optional building features that support green design categories such as location and maintenance of building site, conservation of water, energy, and building materials, and occupant comfort and health. The number of credits awarded in evaluation generally determines the level of achievement.

Some of the major building environmental assessment tools currently in use worldwide are as listed below;

- Brazil: AQUA / LEED Brazil
- China: GBAS
- France: HQE
- Germany: DGNB / CEPHEUS
- Netherlands: BREEAM Netherland
- New Zealand: Green Star NZ
- Singapore: Green Mark
- South Africa: Green Star SA
- United States: LEED
- United Kingdom: BREEAM

LEED and BREEAM are two most important building assessment tools largely practiced worldwide for building certification. Many other green building rating systems established to fulfill national and regional requirements have adopted similar approaches. The essay will further discuss and elaborate in detail about LEED certification process and criteria.

2. c. LEED, Leadership in Energy and Environmental Design

LEED is an internationally-recognized green building certification system that was developed by U.S. Green Building Council (USGBC) in March 2000. LEED promotes sustainable building and development practices through a suite of rating systems that recognize projects that implement strategies for better environmental and health performance. LEED is intended to be flexible enough to apply to all building types – commercial as well as residential**.** Implementation of LEED works

throughout the building's lifecycle – design and construction, operations and maintenance, tenant fit out, and significant retrofit.

For rating of specific building under LEED, it is first necessary to select the appropriate rating system. LEED categorizes buildings under following typologies each of which has a unique set of rating guidelines for certification.

- New Construction (NC)
- Existing Buildings: Operations & Maintenance (EB: O&M)
- Commercial Interiors (CI)
- Core & Shell (CS)
- Schools (SCH)
- Retail
- Healthcare (HC)
- Homes
- Neighborhood Development (ND)

(* USGB LEED rating system- http://www.usgbc.org)

3. Methodology

This essay is based o the detail study and analysis of LEED Existing building operation and maintenance scheme (LEED- EBOM). First part of the essay includes the importance of and immerges of green buildings, how the environmental change and global warming has brought consciousness among the people and how the peoples are since then looking for alternative ways to minimize the energy use and create lesser impact on the environment. Further it discusses about the importance and need of green building rating systems for certification of buildings and provides general idea about how they have been practiced all around the world.

Then after, I set few research questions to be answered by the end of research.

- The first and foremost intention of the research work is to have better understanding of building certification schemes, there scope of activities and range of coverage. How does LEED specifies for different typology, does the function and occupancy of building have impact on its certification process?
- Designing for energy efficiency at the earliest possible stage of the design process is the most effective means of improving energy performance in buildings. But most of the buildings existing are built before energy efficiency became an important issue in building construction. Does LEED accounts for the certification of an existing building (LEED-EBOM)? What are the scope and criteria to be fulfilled under LEED EBOM?

Most of the details and information provided here is the result of literature base on web and various books related to LEED. The method is base on the review of the USGBC LEED EBOM. I had to first assess USGBC's written document about LEED for better understanding and thorough knowledge of performance criteria and working techniques of LEED. After having general idea about LEED's scope of implication, I choose to further the research on LEED EBOM.

Further, essay includes some case studies chosen on the base of material availability to better elaborate working principles and criteria fulfilled by LEED EBOM. On the case studies, the

achievement criteria and how they fulfill the LEED requirements has been studied in detail. These will help to better understand certification procedure and criteria to achieve different award in LEED – EBOM.

4. LEED for Existing Building Operation and Maintenance (LEED- EBOM)

The LEED for Existing Buildings Rating System helps building owners and operators to measure the operations, improvements and maintenance of the building on a consistent scale, with the goal of maximizing operational efficiency while minimizing environmental impacts. It provides the framework required for the implementation of sustainable operations and maintenance practices in existing buildings. LEED EBOM addresses exterior and site maintenance programs, water and energy use, environmentally preferred products and practices for cleaning, sustainable purchasing policies, waste management and ongoing indoor environmental quality. To put it in simple words, LEED EB rating system provides a clear entry point for any building that is seeking to reduce operating expenses and pursue a green strategy in into LEED certification process.

LEED for existing building certification is based on actual building operation performance but not the design expectations; the certification procedure thus looks into the operational requirements. LEED for existing building O & M provides certification and recertification of building operation to recognize owners ongoing certification achievements. *LEED EB can be implied for the certification of following categories of building*;*

- Non LEED building seeking for initial certification.
- LEED for new construction – certified building seeking for ongoing certification.
- LEED for school buildings - certified building seeking for ongoing certification.
- LEED for core & shell - certified building seeking for ongoing certification.
- LEED for Existing building- certified building seeking for ongoing certification

(*LEED for existing buildings; operation and maintenance, Publication for public use and display)

4. a. LEED- EBOM Goals

The major aim of LEED EB is to minimize the environmental impact of what goes into the building, what happens inside a building and what leaves a building. LEED, as many other certification schemes, intends to analyze a building's green performance. It addresses the goals majorly under six LEED categories– Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, Indoor Environmental Quality, and Innovation. Major goals to be fulfilled by LEED EBOM can be listed in general as followings;

- It helps to decreases your building's energy costs and consumption.
- operating costs of the building lowers considerably.
- Implementation of sustainability innovation and strategies in building use.
- Effectively highlight building's green initiative in tenant relations and retention as well as in leasing

4. b. Point Distribution and Evaluation

LEED-EBOM evaluates each of these points and awards credits according to the characteristics fulfilled by the building.

- ***Sustainable Sites;*** Proper thinking and innovation in site management and maintenance techniques can largely reduce the negative consequences of buildings on their local and regional environment. The Sustainable Sites section identifies opportunities in improving exterior building management. It encourages alternate transportation, for instance use of electric car for transportation and easy accessibility to public vehicle can help reduce CO2 production due to vehicle use. Proper collection and use of storm water on the site, minimize light pollutions, and reduce the heat island effect are few essential points considered under this criteria. There are eight credits in this section with twelve possible points.

- ***Water Efficiency;*** The Water Efficiency category in LEED EBOM measures water consumption within the building and on the exterior landscaping. These points are possible through efficient use and wastewater management strategies implication. In this section of LEED- EBOM there is one prerequisite and four credits on a scale that awards up to ten points.

- ***Energy & Atmosphere;*** The Energy & Atmosphere (EA) section looks into the energy use and supply issued in the building. Utilities as; electricity, water, natural gas are the largest operational cost for buildings, accounting for as much as 50% of overall operational costs on average. This part of LEED- EB rewards building for the efficient design of Heating, Ventilating, and Air Conditioning (HVAC) systems and performance-based measurements of the building's systems, as well as onsite renewable energy generation. There are three prerequisites and six credits for a total of thirty possible points.

- ***Materials & Resources;*** Buildings produce a large amount of waste during their operation and use. The Material & Resource section aims to minimize waste, divert such waste produced during building operation away from landfills and encourage the recycling of such materials and make use of locally available materials which reduces the environmental impacts. Thus, it rewards building policies that contain responsible procurement practices and effective waste management strategies. This section has two prerequisites and nine credits with a fourteen possible points.

- ***Indoor Environmental Quality;*** The Indoor Environmental Quality (IEQ) of a building affects both the health of occupant and the comfort of indoor. The IEQ section focuses in use of low-emitting materials, day lighting and lighting quality, possibility to access views from indoor, thermal comfort in the living areas, and Indoor Air Quality (IAQ) management, which addresses ventilation effectiveness, moisture management, and control of contaminants. The IEQ section has three prerequisites and three credits for a total of nineteen possible points.

- ***Innovation in Operations;*** Strategies for operating buildings more sustainably are constantly evolving and improving. The Innovation in Operations section provides an opportunity for

applicants to earn four additional points by implementing innovative projects that are not recognized in any other category. This section has three credits with a total of 7 possible points.

The remaining three points are achievable by having a LEED Accredited Professional on the team (1 point) and documenting sustainable building cost impacts (2 points). The Innovation credits are of great importance to the growth and development of the LEED rating system as a whole because they reward creative solutions to real problems.

There are four levels of certification in the LEED-EBOM (USGBC, LEED for existing building O & M) rating system, each categorized as follows;

- Certified 34-42
- Silver 43-50
- Gold 51-67
- Platinum 68-92

The point distribution and for each categories and those that can be earned under LEED EB are more detailed on the table presented on the Annex at the end of essay, refers to LEED-EB O&M reference guide.

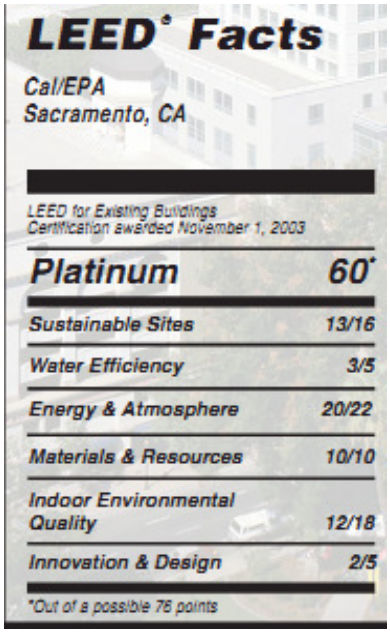
5. Case Study 1

Joe Serna Jr. California EPA headquarters Building; Sacramento, California

Project Introduction:

The EPA headquarter building located in downtown, Sacramento is one of the largest project of its kind in the locality (Project profile, Joe Serna Jr. California EPA Headquarters Building Sacramento, California). The building is 25-story, 950,000-square-foot and functions as an offices building. It was built in 2000 in a public-private partnership with the City of Sacramento**.**

The building was awarded with LEED platinum award in November, 2003. It scored 60 out of 76 possible points and has set an example project under LEED EBOM. After the beginning of operation of the building, they sought a valid, comprehensive way to recognize and verify the building's ongoing sustainable performance. With some refinements and expansions to its as-designed features, Cal/EPA became the first LEED for Existing Buildings Platinum certified building in 2004(Project profile, http://www.usgbc.org/project).



LEED EBOM point achieved by the building

Action Area
Systems calibration, monitoring, commissioning, and maintenance for energy performance
After-hours heating and lighting controls
Exterior lighting systems
Landscaping and grounds management
Water-efficient landscaping, restrooms and cooling cycles
Elimination of garbage can liners
Collection and storage of recyclables
Occupant recycling
Reduced landfill disposal costs
Entryway cleaning to prevent particle and dirt buildup

Major considerations of project

Certification Achievement:

The figure above is a list of major actions that had helped in energy reduction and in achieving LEED EBOM platinum award. Increased water and energy efficiency and reductions in waste disposal are the most important consideration in certification of the project. These factors have has significantly lowered operational costs of Cal/EPA building.

Proper management of water by the use of Native, drought-resistant grasses, plants, and trees. This helped in minimizing storm water runoff and to reduce heat buildup. The building also features low-flow toilets, water-free urinals, and water-efficient fixtures. These measures have decreased exterior water use up to 50 % and interior water use by 20 %.

Energy saving measure includes highly efficient HVAC and lighting systems, photovoltaic rooftop panels, and a plate and frame heat exchanger that reduces on/off cycling of the chiller equipment, extends equipment life, and saves energy. Further the building purchases Green-certified power.

The building takes special care in its operation to reduce solid waste production. Innovative idea has been applied to eliminate garbage can liners and use reusable cloth bags in centrally located recycling bins, this minor change in the behavior only save $80,000 per year. Cal/EPA also demonstrates environmental leadership via employee incentives and a facility layout that encourages walking, biking, car pooling, and driving alternative-fueled vehicles. Materials are chosen based on recycled content, durability, and adjustability to space changes, and salvaged materials are used whenever possible. The waste reduction program—which boasts a 56 % occupant recycling rate—keeps more than 200 tons of garbage out of landfills every year.

6. Case Study 2

Armstrong World Industries

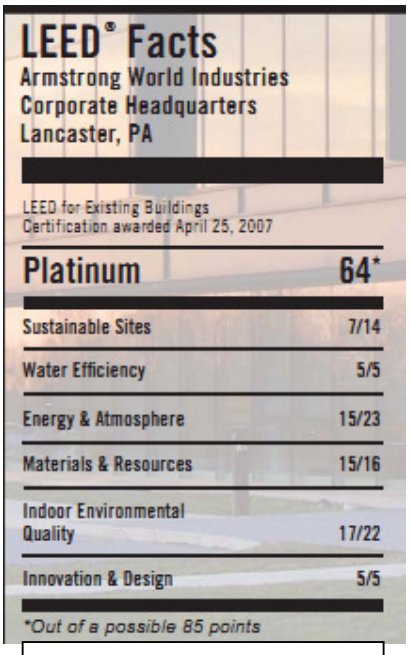
Project Introduction:

The Armstrong World Industries headquarters was built in 1998 and has become the sixth existing building to achieve platinum certification level under LEED EB. The building is built on a 700-acre campus land in Lancaster, Pennsylvania. It is three-story high and 126,000-square-foot building, and houses 225 employees. the glass and steel structured building consists of two wings connected by a day lit atrium. In 2006 the project earned an Energy Star label from the U.S. Environmental Protection Agency, and in 2007 it earned a Platinum rating in the U.S. Green Building Council's LEED for Existing Buildings Rating System (project profile, http://www.usgbc.org/projectlist). It is the first building outside of California to achieve this level of certification under LEED EBOM (http://www.armstrong.com/corporate/leed-eb-platinum.html). The building achieves 64 LEED point acquiring the most on material and resource category.

Certification Achievement:

Among the building's characteristics that contribute to its environmental performance, below are enlisted some of the major point that has helped building to achieve LEED platinum award;

- Building uses clean, renewable energy - Armstrong purchases two million kilowatt-hours of wind power each year, which is enough to provide 75% of the project's electricity use.
- Controlled energy use –building automation system installed optimizes energy use and provides continuous feedback on the building's performance.
- Reduced water use is one of the major achievements of the building for LEED certification. The building reduced water use from 800,000 gallons to 420,000 gallons. This abrupt reduction in water use was obtained by implementing various strategies as installing waterless urinals, dual-flush toilets, and water sensors for the faucets. The team also discovered a malfunction in the humidification process that was wasting more than 28,000 gallons of water each year.
- Recycling – building uses recycled materials and recycles the waste produced in the building.
- Maintenance – Environmentally responsible, Green Seal-certified cleaning products are used;
- Improved acoustics – Armstrong acoustic ceilings and sound-absorbing surfaces are used throughout the building;
- Landscaping – Building is landscaped with plants that require little maintenance and no irrigation, and a catch basin slows the rate at which storm water is released into the adjoining wetlands.



LEED EBOM point achieved by the building

7. Conclusion

The green building rating systems has a common goal of minimizing the environmental impact of what goes into a building, what happens inside the building, and what leaves the building. The buildings under LEED certification are intended to use any form of resources more efficiently as compared to any other conventional buildings. LEED certified buildings often provide healthier work and living environments, which contributes to higher productivity and improved employee health and comfort.

Though being widely practiced and having been frequently revised, there are some drawbacks of LEED that might cause inconvenience to the user seeking for LEED certification or to those who already have LEED certification. The increase cost of the project is a major issue for most of the users, the cost of initial design and construction rises when a LEED rating is pursued. This cost however can be effectively mitigated by the savings incurred over time due to the lower-than-industry-standard operational costs typical of a LEED certified building.

LEED is a design tool and not a performance measurement tool. It is also not yet climate-specific, because of this; designers may make materials or design choices that acquire a LEED point, even though they may not be the most site or climate-appropriate choice available. These weaknesses on LEED are expected to be addressed on the newer versions.

Building certified under LEED-EBOM can achieve considerable lowering in the energy use of building and in enhancing energy performance. LEED- EBOM for building certification is a process rather than an achievement. It is an entry point for a project to achieve green building certification, once a building achieves LEED EBOM certification, it can further implement better ideas and strategies to achieve better energy efficiency.

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- http://www.usgbc.org (USGBC site for LEED rating systems and reference)
- Rating system selection guidance, version 4; http://www.usgbc.org
- Greening Existing Building, thesis report by Tyson H. Driksen, Brown University and Mark D. McGowan, Fordham University

Reference Sites;

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- http://www.energy.ca.gov/greenbuilding/documents/background/08-INTRO_TO_LEED.PDF
- http://www.iea.org/papers/pathways/buildings_certification.pdf

Case Study 1;

- http://www.calepa.ca.gov/epabldg/
- http://www.usgbc.org/ShowFile.aspx?DocumentID=3383

Case Study 2;

- http://www.usgbc.org/ShowFile.aspx?DocumentID=5105
- http://www.armstrong.com/corporate/leed-eb-platinum.html

ANNEXES

Possible LEED EBOM point for certification of Building (Greening existing Buildings, Jerry Yudelson)

LEED Credit Category	LEED-EBOM POINTS
Sustainable Sites	
Prerequisite Construction Activity Pollution Prevention	-
LEED Certified Design And Construction	4
Building Exterior And Hard scape Management Plan	1
Integrated Pest Management, Erosion Control, And Landscape Management Plan	1
Site Selection	-
Development Density And Community Connectivity	-
Brownfield Redevelopment	-
Alternative Commuting Transportation 10% Reduction 25% Reduction 50%Reduction 75%Reduction Or Greater	3 to 15* 3* 4* 4* 4*
Alternative Transportation Public Transportation Access Bicycle Storage And Commuting Low-Emitting And Fuel-Efficient Vehicles Parking Capacity Delivery Service Incentives Car-Share Membership Alternative Transportation Education	-
Site Development Protect Or Restore Habitat Maximize Open Space	 1 -
Storm water Design Quantity Control Quality Control	 1 -
Heat Island Effect Non roof Non roof 25% Shade Non roof 50% Shade Non roof 75% Shade Roof	 1 - - - 1
Light Pollution Reduction	1
Tenant Design And Construction Guidelines	-
Water Efficiency	
Prerequisite Minimum Indoor Plumbing Fixture And Fitting Efficiency	Required
Water Performance Measurement Whole Building Metering Sub metering	 1* 1*
Additional Indoor Plumbing And Fitting Efficiency 10% Reduction 15% Reduction	Up to 5 1* 1*

20% Reduction 25% Reduction 30% Reduction	1* 1* 1*
Water Efficient Landscaping 50% Reduction 62.5% Reduction 75% Reduction 87.5% Reduction 100% Reduction	Up to 5 1* 1* 1* 1* 1*
Innovative Wastewater Technologies	-
Water Use Reduction 20% Reduction 30% Reduction 35% Reduction 40% Reduction	
Cooling Tower Water Management Chemical Management Non-Potable Water Source Use	 1 1
Energy And Atmosphere	
Prerequisite Energy Efficiency Best Management Process	Required
Prerequisite Fundamental Commissioning Of The Building Energy Systems	-
Prerequisite Minimum Energy Performance	Required (ENERGY STAR rating 69)
Prerequisite Fundamental Refrigerant Management	Required
Optimize Energy Performance	Up to 18
Optimize Energy Performance, Lighting Controls	-
Optimize Energy Performance, HVAC	-
Optimize Energy Performance, Equipment, And Appliance	-
Existing Building Commissioning Investigation And Analysis Implementation Ongoing Commissioning	 2 2 2
Renewable Energy	Up to 6
Enhanced Commissioning	-
Enhanced Refrigerant Management	1
Performance Measurement And Verification Building Automation System System Level Metering 40% 80% Base Building Tenant Sub metering	 1 1* 1*
Green Power	-
Emissions Reduction Reporting	1
Materials And Resources	
Prerequisite Sustainable Purchasing Policy	Required
Prerequisite Solid Waste Management Policy	Required
Prerequisite Storage And Collection Of Recyclables	-
Sustainable Purchasing Ongoing Consumables 40% Of Purchases	 1

Durable Goods, Electric	1
Durable Goods, Furniture	1
Facility Alterations And Additions	1
Reused Mercury In Lamps 90 Pg/Lum-H	1
Food	1
Building Reuse	-
Tenant Space, Long-Term Commitment	
Maintain 40% Of Interior Nonstructural Components	
Maintain 60% Of Interior Nonstructural Components	
Maintain 25% Of Existing Walls, Floors, And Roof	
Maintain 33% Of Existing Walls, Floors, And Roof	
Maintain 42% Of Existing Walls, Floors, And Roof	
Maintain 50% Of Existing Walls, Floors, And Roof	
Maintain 55% Of Existing Walls, Floors, And Roof	
Maintain 75% Of Existing Walls, Floors, And Roof	
Maintain 95% Of Existing Walls, Floors, And Roof	
Maintain 50% Of Interior Nonstructural Elements	
Construction Of Waste Management	-
Divert 50% From Disposal	
Divert 75% From Disposal	
Solid Waste Management	
Waste Stream Audit	1
Ongoing Consumables 50% Waste Diversion	1
Durable Goods	1
Facility Alterations And Additions	1
Materials Reuse	-
5% Salvaged, Refurbished, Or Reused Materials	
10% Salvaged, Refurbished, Or Reused Materials	
Reuse 30% Of Furniture And Furnishings	
Recycled Content	-
10% (Postconsumer + ½ Pre consumer)	
20% (Postconsumer + ½ Pre consumer)	
Regional Materials	-
10% Extracted, Processed, And Manufactured Regionally	
20% Extracted, Processed, And Manufactured Regionally	
Rapidly Renewable Materials	-
Certified Wood	-
Indoor Environmental Quality	
Prerequisites Minimum IAQ Performance	Required
Prerequisites Environmental Tobacco Smoke (ETS) Control	Required
Prerequisite Green Cleaning Policy	Required
IAQ Management Program	1
Outdoor Air Delivery Monitoring	1
Increased Ventilation	1
Reduce Particulates In Air Distribution	1
Construction IAQ Management Plan	
During Construction	1
Before Occupancy	-
Occupant Comport	1

Low-Emitting Materials Adhesives And Sealants Paints And Coating Flooring Composite Wood And Agri fiber Products Furniture Ceiling And Wall Systems	-
Indoor Chemical And Pollutant Source Control	-
Controllability Of Systems, Lighting	1
Controllability Of Systems, Thermal Comfort	-
Thermal Comfort Design Employee Verification Compliance	1 - - -
Daylight And Views 50% Daylight/45% Views Daylight For 75% Of Spaces Daylight For 90% Of Spaces Views For 90% Of Spaces	1
Green Cleaning High Performance Cleaning Program Custodial Effectiveness Assessment Sustainable Cleaning Products And Materials Purchases Sustainable Cleaning Equipment Indoor Chemical And Pollutant Source Control Indoor Integrated Pest Management	 1 1 1 1 1 1
Innovation And Design Process	
Innovation In Design	Up to 4
LEED Accredited Professional	1
Documenting Sustainable Building Cost Impacts	1
Regional Priority Credits	
Regional Priority Credits	Up to 4
Points Totals	
Total Possible Points For Sustainable Sites	26
Total Possible Points For Water Efficiency	14
Total Possible Points For Energy And Atmosphere	35
Total Possible Points For Materials And Resources	10
Total Possible Points For Indoor Environmental Quality	15
Total Possible Points For Innovation And Design Process	6
Total Possible Points For Regional Priorities	4
Total Rating System Points Available	110
Certification Levels (Minimum Points) Certified Silver Gold Platinum	 40 50 60 80
* Cells indicate credits where points are cumulative for increasing level of achievement.	