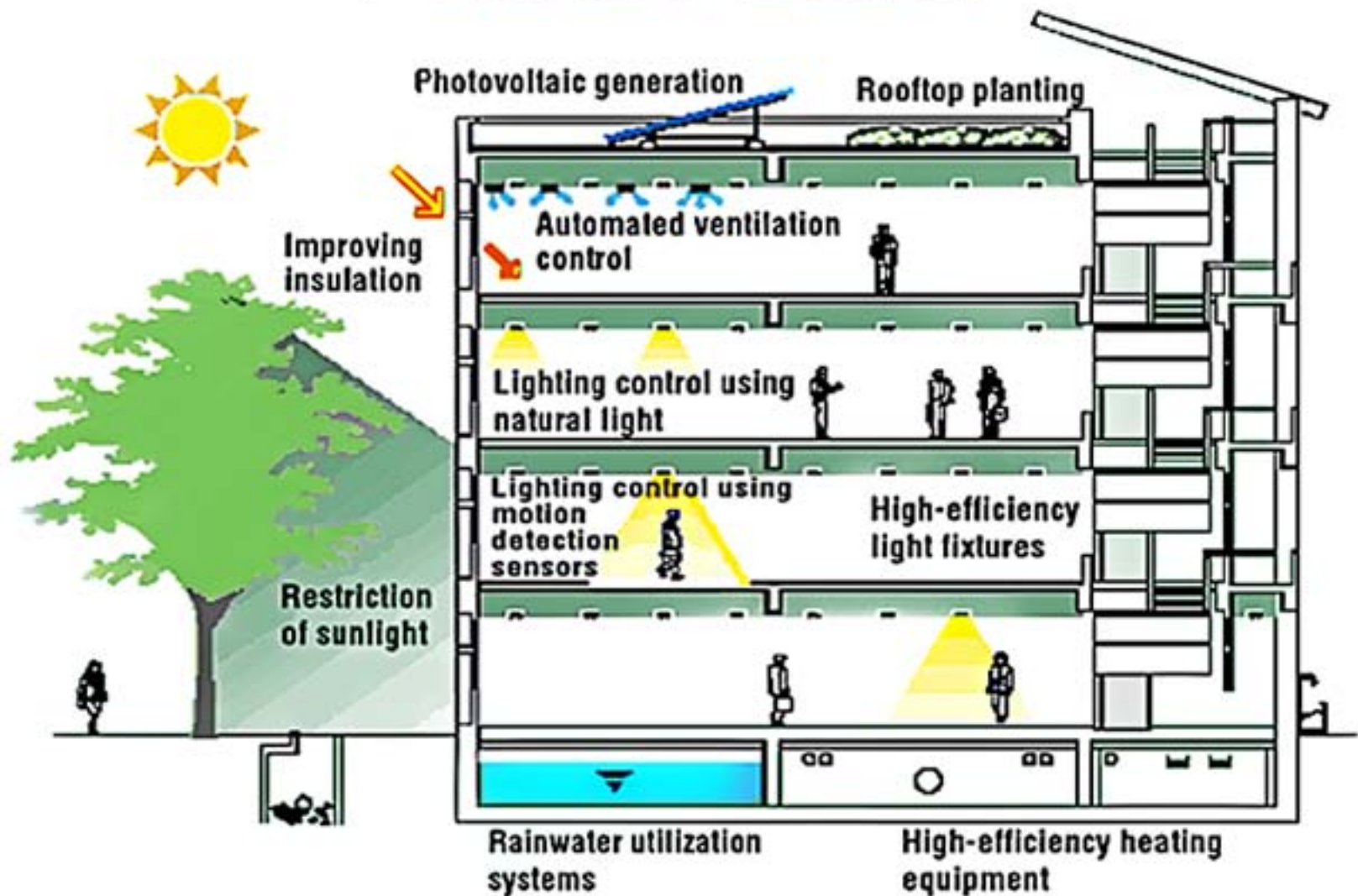




# GREEN BUILDING ACADEMY

## LEED Green Associate Made Easy



Conceptual Drawing of Green Building

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## **LEED Green Associate Made Easy – Version 1**

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## **Preface**

LEED Green Associate Made easy is intended to provide a **concise but complete study guide** for LEED Green Associate Examination. Although there are many study guides available in the market following are the special features of this book

1. Readers can interact with the author through the link provided at the end of each chapter
2. Specifically designed for working professionals with concise but complete contents sufficient to crack the LEED Green Associate exam
3. The content of the book is structured in such a way candidates can easily extend their preparation for LEED AP specialty exams
4. Online quiz available at the end of each chapter along with LEED Green Associate Made Easy Online Course

Based on the feedback from the candidates who have used this book, this study guide accompanied with practice questions are sufficient to pass the LEED Green Associate examination

I would recommend <http://greenlearner.com> for additional free practice exams.

**I would be pleased to hear your feedback & comments, feel free to contact me at [bazeeth@learning-green.com](mailto:bazeeth@learning-green.com)**

Good Luck for the exam



K.M. BAZEETH AHAMED

## **Chapter 1 – Introduction to LEED**

### **1.1 What is LEED?**

LEED is an internationally recognized green building certification system developed by **US Green Building Council**.

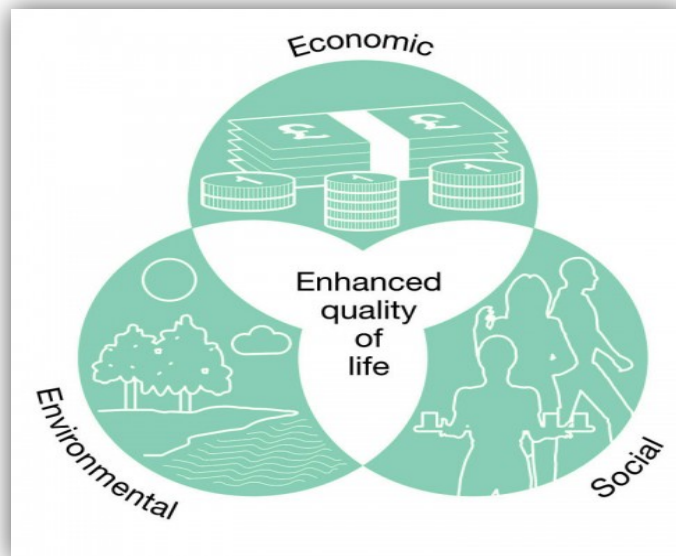
Leadership in Energy & Environmental Design (LEED) is intended to provide building owners and operators a concise framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions.

#### **The features of LEED are:**

- LEED provides third party verification that a building or community is designed, built and operated in a sustainable way.
- Voluntary certification system.
- Developed on consensus based approach.

#### **LEED rating systems are developed based on triple bottom line:**

- **Social Responsibility (People)** - Better living conditions of people
- **Environmental Stewardship (Planet)** - Less impact on environment
- **Economic Prosperity (Profit)** - Reduce the Life Cycle cost of building



**Figure 1. Triple Bottom Line**

## **1.2 Various LEED Rating Systems LEED for New Construction:**

- Commercial occupancies, Institutional occupancies (museum, hospital) and residential buildings of 4 and more habitable storey. For buildings with shared tenant space, project should occupy more than 50% of leasable square footage
- The scope of LEED NC also covers major renovation. Major renovations include significant change in HVAC, Building Envelope modifications & Major interior changes

### **LEED Core & Shell:**

- Projects where developer has no control over the tenant fit out (commercial buildings, warehouses etc)



- For buildings with shared tenant space, project should occupy less than 50% of leasable square footage

**Example:** *Dubai Mall, City Center. In the above examples the property owner has no control over the tenant fit-outs, they even do not have an idea who is going to occupy it in the design phase. The owner has only control over the common areas which may be around 10% of the Gross Floor area. Such projects are applicable for LEED Core & Shell.*

### **LEED for Commercial Interiors:**

- Works hand in hand with CS buildings
- Applicable for tenant spaces that do not occupy entire building

**Example:** *Consider the examples in Core & Shell again i.e. Dubai Mall and City Center. The tenants of the building have control only over the fit-out and interior works within their lease. Such projects can go for LEED Commercial Interiors. Suppose Carrefour, a chain of hyper market has an outlet in Dubai Mall or City Center, they can go for LEED Commercial Interiors.*

### **LEED for Schools:**

- Academic buildings of K-12 schools (both new & major renovation) shall qualify for LEED for Schools
- Non academic buildings of schools, Post secondary academic buildings and pre kindergarten buildings may qualify for both LEED for NC or LEED for Schools



## **LEED for Existing Buildings Operation &**

### **Maintenance:**

- Applicable for Existing buildings (may or may not be certified under LEED NC, CS or school etc) for sustainable operation and maintenance of the building
- Shall also cover system upgrades, minor space use change
- Individual tenant spaces do not apply

### **LEED for Neighborhood Development:**

- For township developments (focuses more on sustainable Infrastructure)

### **LEED for Homes:**

- Residential buildings less than 4 habitable stories(single family, multi-family low riser), affordable housing, manufactured & modular housing

## **1.3 LEED Reference Manuals:**

LEED Reference Manuals are publications by USGBC which details all technical aspects of a particular LEED Rating System. LEED Reference Manual details credit intent, requirements, strategies calculations etc for each credit/prerequisite in a rating system.

The table shows the list of LEED Rating Systems and associated Reference Guide.

| S.No | Rating System                                | Reference Manual                                 |
|------|--|--|
| 1    | LEED for New Construction & Major renovation | Green Building Design & Construction Manual      |
| 2    | LEED for Core & Shell 3                      |  |
| 3    | LEED for Schools                             |  |
| 4    | LEED for Homes                               | LEED for Homes Reference Guide 2009              |
| 5    | LEED for Commercial Interiors                | Green Interior Design and Construction Manual    |
| 6    | LEED for Operations and Maintenance          | Green Building Operations and Maintenance Manual |
| 7    | LEED for Neighbour Hood Development          | Green Neighbourhood Development Manual           |
| 8    | LEED for Health Care                         | Under Development                                |
| 9    | LEED for Retail                              |  |
| 10   | LEED for Retail Interiors                    |  |
| 11   | LEED for Existing Schools                    |  |

**Table 1. LEED Rating Systems**

## 1.4 Multiple Certifications of a Single Project:

It is possible for projects to get multiple certifications.

**Example:** A project certified under LEED NC & Major Renovation/School/Core & Shell may get certified under LEED Operation & Maintenance, after the building is occupied. Similarly a tenant space of a LEED Core & Shell building may get certified under LEED Commercial Interiors

## 1.5 Single Certification for Group of Buildings:

It is possible to get LEED Certification for a group of buildings within same property boundary as a single project

**Example:** *A residential campus with three high storey (4 or more habitable stories) buildings can apply for LEED NC & Major Renovation, as a single project, which include all three buildings. In this way, the documentation time and fee are saved.*

Such projects should follow **Multiple Buildings Guideline** apart from the reference manual

## 1.6 What happens when more than one rating system is applicable for a project?

- The rating system which is most applicable for the project should be selected.
- Apply 60/40 rule. Select the rating system which is applicable for 60% or more the project area.

## 1.7 Understanding the LEED Rating System

**Each LEED Rating Systems has the following Environmental Categories:**

- |                       |                         |
|-----------------------|-------------------------|
| • Sustainable Sites   | • Materials & Resources |
| • Water Efficiency    | • Indoor Environmental  |
| • Energy & Atmosphere | Quality                 |

- Innovation in Design
- Regional Priority

### Each of the above categories has:

- Pre-requisite
- Credit
- Points

**LEED 2009 for New Construction and Major Renovations**  
Project Checklist

**Sustainable Sites** Possible Points: 26

| Y | N | ? | d/C |  | Points |
|---|---|---|-----|--|--------|
| Y |   |   | C   | Prereq 1 Construction Activity Pollution Prevention                            |        |
|   |   |   | d   | Credit 1 Site Selection  | 1      |
|   |   |   | d   | Credit 2 Development Density and Community Connectivity                        | 5      |
|   |   |   | d   | Credit 3 Brownfield Redevelopment  | 1      |
|   |   |   | d   | Credit 4.1 Alternative Transportation—Public Transportation Access             | 6      |
|   |   |   | d   | Credit 4.2 Alternative Transportation—Bicycle Storage and Changing Rooms       | 1      |
|   |   |   | d   | Credit 4.3 Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles | 3      |
|   |   |   | d   | Credit 4.4 Alternative Transportation—Parking Capacity                         | 2      |
|   |   |   | C   | Credit 5.1 Site Development—Protect or Restore Habitat                         | 1      |
|   |   |   | d   | Credit 5.2 Site Development—Maximize Open Space                                | 1      |
|   |   |   | d   | Credit 6.1 Stormwater Design—Quantity Control                                  | 1      |
|   |   |   | d   | Credit 6.2 Stormwater Design—Quality Control                                   | 1      |
|   |   |   | C   | Credit 7.1 Heat Island Effect—Non-roof   | 1      |
|   |   |   | d   | Credit 7.2 Heat Island Effect—Roof   | 1      |
|   |   |   | d   | Credit 8 Light Pollution Reduction   | 1      |

**Water Efficiency** Possible Points: 10

| Y | N | ? | d/C |   | Points |
|---|---|---|-----|---|--------|
| Y |   |   | d   | Prereq 1 Water Use Reduction—20% Reduction  |        |
|   |   |   | d   | Credit 1 Water Efficient Landscaping        | 2 to 4 |
|   |   |   |     | Reduce by 50%                               | 2      |
|   |   |   |     | No Potable Water Use or Irrigation          | 4      |
|   |   |   | d   | Credit 2 Innovative Wastewater Technologies | 2      |
|   |   |   | d   | Credit 3 Water Use Reduction                | 2 to 4 |
|   |   |   |     | Reduce by 30%                               | 2      |
|   |   |   |     | Reduce by 35%                               | 3      |
|   |   |   |     | Reduce by 40%                               | 4      |

**Table 2 – Illustration of Prerequisite credits and points**

- **Prerequisites** are compulsory requirements for a project to be certified.
- **Credits** are optional requirements while **Points** can be earned by complying with the credit requirements.

**Examples:** Under Sustainable Sites Category Construction activity pollution prevention is a prerequisite. Projects should comply with this requirement in order to get LEED Certification.

Under Water Efficiency Category Water Efficient Landscaping is a credit. The project can earn 2 points, if it reduces the water requirement for landscaping by 50% and can earn 4 points, if no potable water is used for irrigation at all.

Based on the number of points scored, the following are the Levels of LEED Certification in LEED NC & Major renovation



**Figure 3. USGC Levels of LEED Certifications**

## **1.8 LEED Project Scorecard/ Project Checklist**

LEED Project score card or Project checklist is an excel sheet published by USGBC which list all the environmental categories, prerequisites, credits and points.

It is worth noting that each credit does not carry equal weight age (number of points). The weight age of each credit is based on environmental benefit and human benefit on achieving the credit.

# LEED 2009 for New Construction and Major Renovations

## Project Checklist

Project Name \_\_\_\_\_

Date \_\_\_\_\_

### Sustainable Sites

Possible Points: 26

| Y                                   | N | ? |            |  |
|-------------------------------------|---|---|------------|--|
| <input checked="" type="checkbox"/> |   |   | Prereq 1   | Construction Activity Pollution Prevention                           |
| <input checked="" type="checkbox"/> |   |   | Credit 1   | Site Selection 1   |
| <input checked="" type="checkbox"/> |   |   | Credit 2   | Development Density and Community Connectivity 5                     |
| <input checked="" type="checkbox"/> |   |   | Credit 3   | Brownfield Redevelopment 1   |
| <input checked="" type="checkbox"/> |   |   | Credit 4.1 | Alternative Transportation—Public Transportation Access 6            |
| <input checked="" type="checkbox"/> |   |   | Credit 4.2 | Alternative Transportation—Bicycle Storage and Changing Room 1       |
| <input checked="" type="checkbox"/> |   |   | Credit 4.3 | Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicle 3 |
| <input checked="" type="checkbox"/> |   |   | Credit 4.4 | Alternative Transportation—Parking Capacity 2                        |
| <input checked="" type="checkbox"/> |   |   | Credit 5.1 | Site Development—Protect or Restore Habitat 1                        |
| <input checked="" type="checkbox"/> |   |   | Credit 5.2 | Site Development—Maximize Open Space 1                               |
| <input checked="" type="checkbox"/> |   |   | Credit 6.1 | Stormwater Design—Quantity Control 1                                 |
| <input checked="" type="checkbox"/> |   |   | Credit 6.2 | Stormwater Design—Quality Control 1                                  |
| <input checked="" type="checkbox"/> |   |   | Credit 7.1 | Heat Island Effect—Non-roof 1  |
| <input checked="" type="checkbox"/> |   |   | Credit 7.2 | Heat Island Effect—Roof 1  |
| <input checked="" type="checkbox"/> |   |   | Credit 8   | Light Pollution Reduction 1  |

### Water Efficiency

Possible Points: 10

|                                     |  |  |          |                                      |
|-------------------------------------|--|--|----------|--------------------------------------|
| <input checked="" type="checkbox"/> |  |  | Prereq 1 | Water Use Reduction—20% Reduction    |
| <input checked="" type="checkbox"/> |  |  | Credit 1 | Water Efficient Landscaping 2 to 4   |
| <input checked="" type="checkbox"/> |  |  | Credit 2 | Innovative Wastewater Technologies 2 |
| <input checked="" type="checkbox"/> |  |  | Credit 3 | Water Use Reduction 2 to 4           |

### Energy and Atmosphere

Possible Points: 35

|                                     |  |  |          |  |
|-------------------------------------|--|--|----------|--|
| <input checked="" type="checkbox"/> |  |  | Prereq 1 | Fundamental Commissioning of Building Energy Systems |
| <input checked="" type="checkbox"/> |  |  | Prereq 2 | Minimum Energy Performance                           |
| <input checked="" type="checkbox"/> |  |  | Prereq 3 | Fundamental Refrigerant Management                   |
| <input checked="" type="checkbox"/> |  |  | Credit 1 | Optimize Energy Performance 1 to 19                  |
| <input checked="" type="checkbox"/> |  |  | Credit 2 | On-Site Renewable Energy 1 to 7                      |
| <input checked="" type="checkbox"/> |  |  | Credit 3 | Enhanced Commissioning 2                             |
| <input checked="" type="checkbox"/> |  |  | Credit 4 | Enhanced Refrigerant Management 2                    |
| <input checked="" type="checkbox"/> |  |  | Credit 5 | Measurement and Verification 3                       |
| <input checked="" type="checkbox"/> |  |  | Credit 6 | Green Power 2  |

### Materials and Resources

Possible Points: 14

|                                     |  |  |            |  |
|-------------------------------------|--|--|------------|--|
| <input checked="" type="checkbox"/> |  |  | Prereq 1   | Storage and Collection of Recyclables                            |
| <input checked="" type="checkbox"/> |  |  | Credit 1.1 | Building Reuse—Maintain Existing Walls, Floors, and Roof 1 to 3  |
| <input checked="" type="checkbox"/> |  |  | Credit 1.2 | Building Reuse—Maintain 50% of Interior Non-Structural Element 1 |
| <input checked="" type="checkbox"/> |  |  | Credit 2   | Construction Waste Management 1 to 2                             |
| <input checked="" type="checkbox"/> |  |  | Credit 3   | Materials Reuse 1 to 2   |

### Materials and Resources, Continued

|                                     |  |  |          |                               |
|-------------------------------------|--|--|----------|-------------------------------|
| <input checked="" type="checkbox"/> |  |  | Credit 4 | Recycled Content 1 to 2       |
| <input checked="" type="checkbox"/> |  |  | Credit 5 | Regional Materials 1 to 2     |
| <input checked="" type="checkbox"/> |  |  | Credit 6 | Rapidly Renewable Materials 1 |
| <input checked="" type="checkbox"/> |  |  | Credit 7 | Certified Wood 1              |

### Indoor Environmental Quality

Possible Points: 15

|                                     |  |  |            |   |
|-------------------------------------|--|--|------------|---|
| <input checked="" type="checkbox"/> |  |  | Prereq 1   | Minimum Indoor Air Quality Performance                        |
| <input checked="" type="checkbox"/> |  |  | Prereq 2   | Environmental Tobacco Smoke (ETS) Control                     |
| <input checked="" type="checkbox"/> |  |  | Credit 1   | Outdoor Air Delivery Monitoring 1                             |
| <input checked="" type="checkbox"/> |  |  | Credit 2   | Increased Ventilation 1                                       |
| <input checked="" type="checkbox"/> |  |  | Credit 3.1 | Construction IAQ Management Plan—During Construction 1        |
| <input checked="" type="checkbox"/> |  |  | Credit 3.2 | Construction IAQ Management Plan—Before Occupancy 1           |
| <input checked="" type="checkbox"/> |  |  | Credit 4.1 | Low-Emitting Materials—Adhesives and Sealants 1               |
| <input checked="" type="checkbox"/> |  |  | Credit 4.2 | Low-Emitting Materials—Paints and Coatings 1                  |
| <input checked="" type="checkbox"/> |  |  | Credit 4.3 | Low-Emitting Materials—Flooring Systems 1                     |
| <input checked="" type="checkbox"/> |  |  | Credit 4.4 | Low-Emitting Materials—Composite Wood and Agrifiber Product 1 |
| <input checked="" type="checkbox"/> |  |  | Credit 5   | Indoor Chemical and Pollutant Source Control 1                |
| <input checked="" type="checkbox"/> |  |  | Credit 6.1 | Controllability of Systems—Lighting 1                         |
| <input checked="" type="checkbox"/> |  |  | Credit 6.2 | Controllability of Systems—Thermal Comfort 1                  |
| <input checked="" type="checkbox"/> |  |  | Credit 7.1 | Thermal Comfort—Design 1                                      |
| <input checked="" type="checkbox"/> |  |  | Credit 7.2 | Thermal Comfort—Verification 1                                |
| <input checked="" type="checkbox"/> |  |  | Credit 8.1 | Daylight and Views—Daylight 1                                 |
| <input checked="" type="checkbox"/> |  |  | Credit 8.2 | Daylight and Views—Views 1                                    |

### Innovation and Design Process

Possible Points: 6

|                                     |  |  |            |  |
|-------------------------------------|--|--|------------|--|
| <input checked="" type="checkbox"/> |  |  | Credit 1.1 | Innovation in Design: Specific Title 1 |
| <input checked="" type="checkbox"/> |  |  | Credit 1.2 | Innovation in Design: Specific Title 1 |
| <input checked="" type="checkbox"/> |  |  | Credit 1.3 | Innovation in Design: Specific Title 1 |
| <input checked="" type="checkbox"/> |  |  | Credit 1.4 | Innovation in Design: Specific Title 1 |
| <input checked="" type="checkbox"/> |  |  | Credit 1.5 | Innovation in Design: Specific Title 1 |
| <input checked="" type="checkbox"/> |  |  | Credit 2   | LEED Accredited Professional 1         |

### Regional Priority Credits

Possible Points: 4

|                                     |  |  |            |                                      |
|-------------------------------------|--|--|------------|--------------------------------------|
| <input checked="" type="checkbox"/> |  |  | Credit 1.1 | Regional Priority: Specific Credit 1 |
| <input checked="" type="checkbox"/> |  |  | Credit     |                                      |

### Table 3. LEED Project Check List NC – 2009



## **1.9 Minimum Program Requirements (Not applicable to LEED for Homes and ND)**

- Should be a complete permanent project on land
- Should have occupancy of minimum 1 FTE (1 FTE = 40 hrs occupancy per week)
- Should comply with Federal, state or local environmental laws
- Projects should have reasonable & consistent site area. Gerrymandering not allowed
- Projects should agree to share the information on Energy and Water consumption for a minimum 5 years
- NC, CS, O&M and school projects should have a min GFA of 2% of site area or 1000 sq. ft whichever is higher
- CI projects should have min 250 sq. ft area
- LEED O&M Buildings should be in operation for a minimum of 12 months prior to the submission of application

### **Purpose of MPR:**

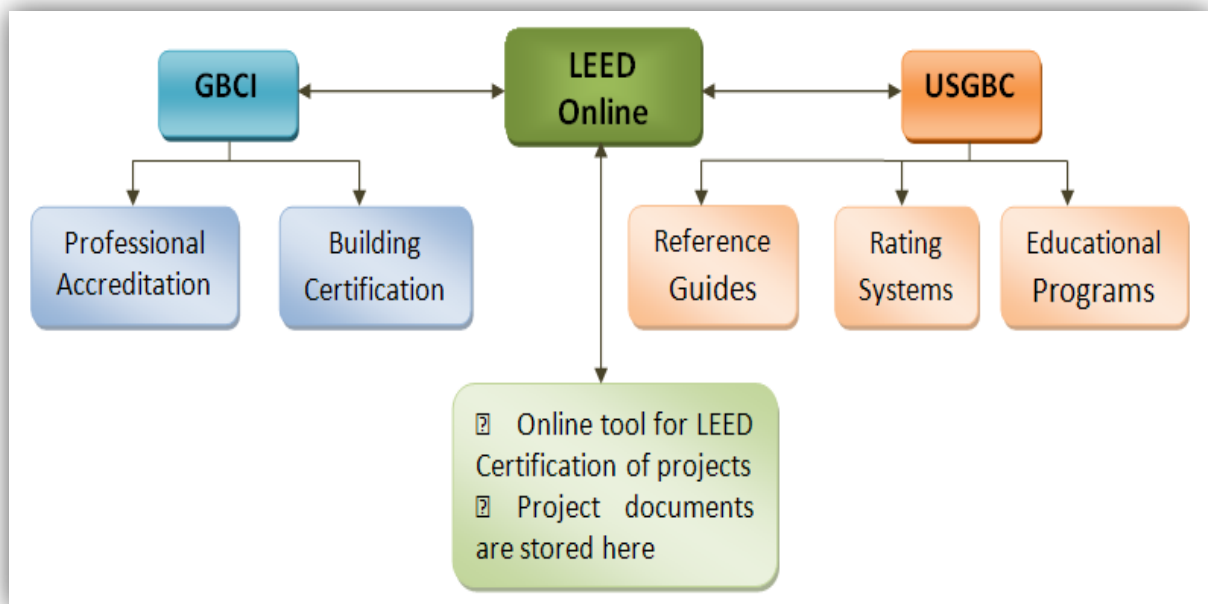
- To provide clear guidance to the customers
- To reduce the challenges that may arise during the certification process
- To protect the integrity of LEED program

## 1.10 Requirements for a Project to be LEED

### Certified:

1. The project should comply with all the prerequisites of the rating system
2. The project should earn minimum number of points required for certification.
3. The project should comply with Minimum Program Requirements of the rating system.

## 1.11 USGBC, GBCI and LEED Online:



**Figure 2: GBCI, LEED Online & USGBC**

## **The main roles of USGBC, GBCI and Leed online are illustrated below:**

- USGBC is responsible for developing rating systems, reference guides and education program
- GBCI administers building certification and professional accreditation.
- Both **USGBC** and **GBCI** are linked with **LEED ONLINE**. It means that if you have used id registered with usgbc/gbci/leedonline, you can use the same user id and password in [www.usgbc.org](http://www.usgbc.org) or [www.gbci.org](http://www.gbci.org) or [www.leedonline.com](http://www.leedonline.com)

## **It is worth noting the following points**

- Only buildings can be certified by LEED
- Professionals can only be Accredited or earn LEED Credential
- Individuals cannot be members of USGBC. Only companies can be members. Full time employees of USGBC member companies are considered as USGBC members. USGBC member companies can use USGBC logo.
- LEED does not endorse or certify any products.

US Green Building Council is a non-profit organization (formed in 1993) committed to a prosperous and sustainable future through cost-efficient and energy-saving green buildings.

## **Mission**

To transform the way buildings and communities are designed, built and operated, enabling an environmentally and socially responsible, healthy, and prosperous environment that improves the quality of life.

## **Vision**

Buildings and communities will regenerate and sustain the health and vitality of all life within a generation.

GBCI was established in 2008 to administer project certifications and professional credentials within the framework of the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED®) Green Building Rating Systems™.

LEED online is an online tool through which entire LEED Certification is handled.

- It is an online storage system where all details (credit templates, drawings, supporting documents etc) for LEED documentation are stored.
- Project Team gets access to CIR database, rating system errata etc through LEED online.(CIR is discussed in detail later)

## **1.12 What do we discuss in the next chapters?**

In the following chapters we will discuss Prerequisites and Credits under each of category below

- Sustainable Sites
- Water Efficiency
- Energy & Atmosphere
- Materials & Resources
- Indoor Environmental Quality

**For each Credit/prerequisite of the above categories we will discuss:**

- Why the credit/prerequisite is significant?
- How the project team should approach the credit or prerequisite?  
What strategies the Project team can peruse to comply with the credit
- What are the key references or standards associated with the credit or prerequisite?
- What are the important terminologies associated with each credit or prerequisite?

The free online version of this chapter is available at:

<http://learning-green.com/introduction-to-leed/>

Candidates can clarify their doubts in this chapter by asking questions in the comments section. Download the Worksheet at the end of the chapter and complete them as an Assignment.

## **Chapter 2 – Sustainable Sites**

### **2.1 Construction Activity Pollution Prevention**

Construction activity pollution prevention is a prerequisite in many rating systems it mainly addresses Erosion, Sedimentation and Air borne dust generation due to construction activity.

#### **Why? – The Significance:**

- Erosion results in loss of topsoil.
- Top soil is rich in biological nutrients and organic matter which supports plant life.
- Loss of topsoil reduces the capacity of the site to support plantation. This may further increase the fertilizer requirement for the landscape thereby making more damage to the environment.
- Storm water runoff from the construction site is rich in contaminants because of construction materials which disturbs aquatic life.
- Erosion due to wind pollutes the air with particulate matter and suspended particles.

#### **How? – The strategies:**

**Stock Piling:** Topsoil is removed from the site and piled in safe place, replaced by free drain gravel and finally restored after the construction



Other Erosion and Sedimentation Control strategies can be classified into **Stabilization strategies** and **Structural strategies**

**Following strategies are considered Stabilization Strategies:**

**Temporary Seeding:** Plant fast growing grasses to temporarily stabilize the soil

**Permanent Seeding:** Plant grass, trees and shrubs to permanently stabilize the soil

**Mulching:** Mulching is the process of spreading material like sawdust, straw, hay, grass, wood chips or gravel over the topsoil to stabilize it.

**The figure below shows walkway of a construction site mulched with sawdust.**



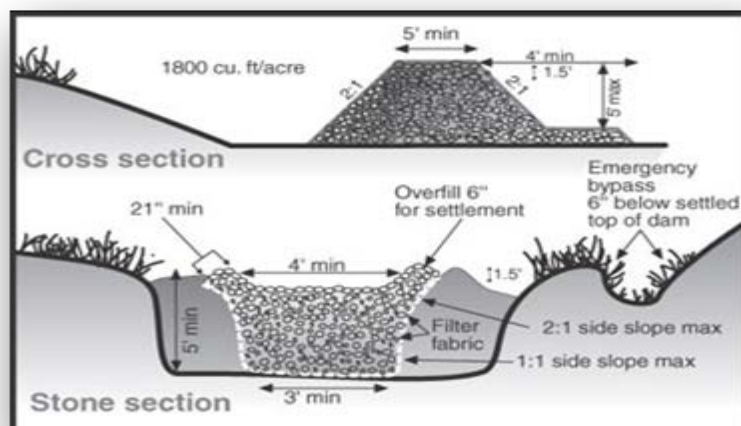
**The following are the structural strategies to reduce erosion and sedimentation:**

**Silt fencing:** Construction post with fabric filter media to remove sediments from storm water runoff.

**The figure below shows a typical Silt Fence in a construction site.**



**Sediment Traps:** A cavity where sediments from storm water are allowed to settle down.



**Sediment Basins:** Similar to sediment traps but bigger in size. A pond with controlled water release structure to allow settling of sediments from the runoff

**Figure below shows a sediment basin in a construction site.**



**Earth Dikes:** Construct a mound of stabilized soil to divert the run off through the desired direction (ideally through sediment traps and basins)

**Figure below shows a typical Earth Dike.**



## **Terminologies:**

**Erosion:** Erosion is the process by which solid particles on the surface (soil and stones) are moved.

Erosion in construction site is because of storm water runoff, wind, foot traffic, construction vehicle traffic, steep slopes etc.

**Storm water runoff:** The storm water that flows out of the project site boundary through the surface is called as storm water runoff.

**Sedimentation:** Sedimentation is the process of addition of solid particles in water bodies. Sedimentation decreases the water quality and affects the aquatic life.

## **References/Standards:**

Project team should prepare a Erosion and Sedimentation control plan to comply with **EPA 2003 Construction General Permit** and **NPDES (National Pollutant Discharge elimination Scheme) standards**.

Or **Applicable Local standards** whichever is stringent

## **2.2 Site Selection**

### **Why? – The significance:**

Development of appropriate sites preserves these areas for wild life, recreational purpose and maintains ecological balance

## **How? – The Strategies:**

### **Do not develop:**

1. A farm land (identified by Department of Agriculture)
2. Land close to water bodies (Previously undeveloped Land within 50' from water bodies such as lake, sea, river that could support aquatic life and recreational purpose.)
3. Land which has history of flood. (Previously undeveloped land whose elevation is lower than 5' above the elevation of 100 year flood) – Identified by FEMA (Federal Emergency Management Agency)
4. Land close to wetland (within 100' from wetland).
5. Land which is identified as land for endangered species.
6. Land which is public parkland prior to development

### **Terminologies:**

**Farm land:** Agricultural land which will be able to produce food.

**100 year flood:** A one-hundred-year flood is calculated to be the level of flood water expected to be equaled or exceeded every 100 years on average.

**Endangered Species:** An endangered species is a population of organisms which is at risk of becoming extinct because it is either few in numbers, or threatened by changing environmental parameters

**Wetland:** A wetland is an area of land whose soil is saturated with moisture either permanently or seasonally. Such areas may also be covered partially or completely by shallow pools of water.

**Picture below are examples for wetland.**



**Previously Developed Sites:** Sites which once had buildings, parking lots, road ways or graded or altered by any human activities.

### **Reference Standards:**

FEMA (Federal Emergency Management Agency) – Identifies flood prone areas

## 2.3 Development Density & Community

### Connectivity

To be eligible for this credit the project should be developed in previously developed or graded site.

**Graded Site:** Graded sites are sites are not completely developed but are previously disturbed by human activity (like grading/leveling)

**Development Density:** It is the ratio between developed floor areas (sq. ft) within a specific area (acre). LEED encourages high dense developments. For LEED requirements both the project and the surroundings should have a minimum development density of 60,000sq.ft/acre.

**Community Connectivity:** Community connectivity refers to the connection of the project with basic services and residential neighborhood. For LEED requirements the project should have at least 10 basic services and a residential neighborhood within 1/2 mile radius. The services and residential neighborhood should have pedestrian access.

### Why? – The Significance

- Development of previously developed site takes the load from undeveloped green field sites.
- Infrastructure facilities like road and other amenities already available.



- High density development reduces the requirement of land compared to an equivalent low density development.
- Storm water runoff from high density development is comparatively lesser than an equivalent low density development.
- Development of a site close to basic services reduces the automobile use to a larger extent thereby reducing pollution caused by automobiles.
- In a development close to basic services occupants are more likely to walk to the services thereby increasing their physical activity and well being.

## **Terminologies:**

**Basic Services:** The following are the list of basic services listed in LEED BD & C 2009

- |                          |                               |               |
|--------------------------|-------------------------------|---------------|
| • Place of<br>Worship    | • Laundry                     | • Restaurant  |
| • Convenience<br>Grocery | • Library                     | • School      |
| • Day Care Center        | • Medical or<br>Dental Office | • Supermarket |

- Cleaners
- Senior Care Facility
- Theater
- Fire Station
- Park
- Community Center
- Beauty Salon
- Pharmacy
- Fitness Center
- Hardware
- Post Office
- Museum

**Proximity to basic Services:** LEED BD & C specifies proximity to basic services as ½ mile of pedestrian access from the project entrance.

**Greenfield Sites:** Greenfield Sites are undisturbed by human activity and remains in its natural state. Even a undisturbed desert without vegetation is considered as Greenfield site.

**Reference Standard:** None

## 2.4 Brownfield Redevelopment

**Brownfield:** A Brownfield is a property whose use may be complicated by the presence or possible presence of a hazardous substance, a pollutant or a contaminant. These sites can be remediated and redeveloped.

**Picture below is an abandoned factory with potential contaminants which is an example for Brownfield.**

Brownfield sites are identified by Government agencies, Local voluntary cleanup programs or by Environmental Site Assessment in accordance to ASTM 1903



### **Why? – The significance:**

- Redevelopment of Brownfield sites provide an alternative to developing Greenfield sites thereby preserving undeveloped sites for future generations
- Brownfield often have existing infrastructure that makes the construction of new utilities and roads unnecessary.

## **Terminologies:**

**Remediation:** Remediation is the process of removing hazardous material from sites soil and underground water thereby reducing the

## **Reference standard:**

ASTM 1903 -97 Phase 2 Environmental Site Assessments

## **2.5 Alternate Transportation**

### **Why? – The Significance**

- Reduces single occupancy vehicles and their associated pollution and energy demand
- Reduces the requirement for parking space thereby potential increase in landscape, reduction in storm water runoff.
- Transportation is a biggest contributor to air pollution

### **How? The Strategies**

- In site selection stage of the project consider development of a site which has public transportation access.
- Provide campus bus or private bus or shuttle service incase public transportation is not available.

- Encourage bicycle use by providing bicycle storage in residential projects, bicycle storage, shower and changing room for commercial projects.
- Encourage carpool; vanpool by providing preferred parking for them.
- Encourage low emission / fuel efficient vehicles by providing preferred parking, providing fuelling stations.
- Limit the number of parking not to exceed the minimum zoning requirement.

## **Terminologies:**

**Public Transport:** Public transport includes bus, rail or other transit services that is available for general public that operates on regular and continual basis

**Campus bus or Private bus or Shuttle service:** Campus bus or private bus or Shuttle service is privately operated and not available to general public.

**Low Emitting:** Low emitting are vehicles that are classified as Zero Emission Vehicles by California air resource board.

**Fuel Efficient Vehicles:** Fuel Efficient Vehicles are vehicles which have achieved a minimum green score of 40 on the American Council for an Energy Efficient Economy (ACEEE) annual vehicle rating guide.

**Carpool/Vanpool:** A carpool/vanpool is an arrangement by which 2 or more people share a vehicle for transportation.

**Preferred Parking:** Preferred parking includes designated parking spaces close to the building entrance, designated covered spaces & discounted parking passes.

### **Reference Standard:**

- American Council for Energy Efficient Economy (ACEEE) – Fuel Efficient Vehicles
- California air resource board – Zero Emission Vehicle

## **2.6 Site Development – Maximizing Open Space & Restoring Habitat**

### **Why? – The Significance**

- Construction of buildings often damages site ecology, indigenous plants and habitat.
- Restore the habitat by encouraging native and adaptive vegetation.
- To preserve the Greenfield areas in the construction site

### **How? The strategies:**

- Reduce the building footprint. Achieve the required gross floor area by increasing the number of floors.

- Reduce the hardscape area.
- Restrict the disturbance during the construction process within a minimum area from the development foot print.
- Preserve the undisturbed Greenfield area.
- Use native or adaptive vegetation.
- Increase the open space of the project beyond the zoning(municipality or corporation) requirements

## **Terminologies:**

**Native Plants:** Native plants are plants that have developed naturally in a geological location for many years.

**Adaptive Plants:** Adaptive plants are not native for a particular geological location but can be adapted in the location without significant use of fertilizers, pesticides or irrigation requirements

**Invasive plants:** Invasive plants are not native for a particular geological location and require significant effort in maintaining them.

Use of native or adaptive plants is a good practice in Green buildings. Invasive plants should always be avoided.

**Building footprint:** Building foot print is the area of the project site used by the building structure, defined by the perimeter of the building plan.



Landscape, access roads, parking lots and non building facilities are excluded from the building foot print.

**Development footprint:** Development foot print includes all the area affected because of the development of the building. It includes building footprint, hardscape, access roads, parking lots and non building facilities within the project site area.

**Open Space:** Project site area- development footprint = Open Space  
Vegetated Roof can be counted for the credit calculation if it the project satisfies the requirement for the credit Development Density & Community Connectivity

**Reference Standard:** None

## 2.7 Storm water – Quantity & Quality Control

LEED addresses Storm water control under two categories namely  
Quantity Control – Controlling the velocity and volume of runoff from the project site

Quality Control – Controlling the pollutants and contaminants from the runoff.

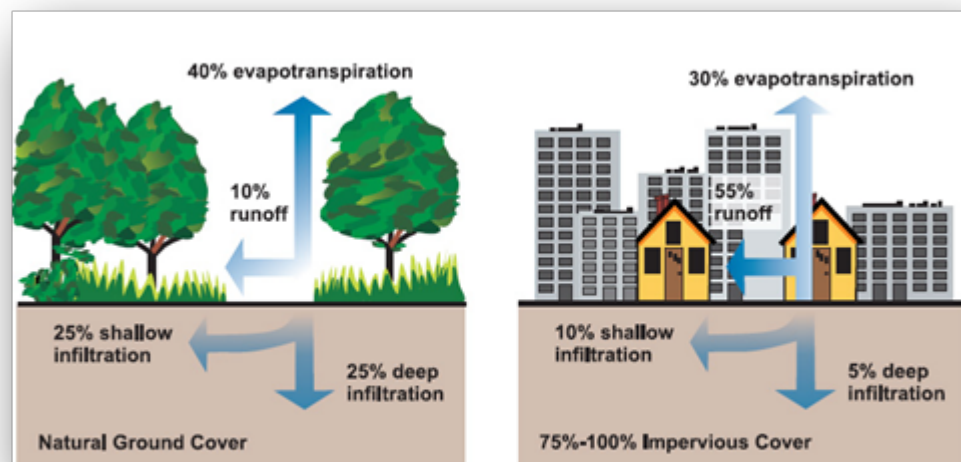
### Why? The Significance:

- In many cities storm water and sewage treatment are combined. Sewage treatment is an energy intensive process, when storm water

mixes with sewage it overloads the sewage treatment plant and hence consuming more energy.

- Storm water runoff from hardscape areas, industrial areas, fertilized landscape etc are rich in contaminants and hence pollutes receiving water streams.
- Reducing storm water runoff helps maintain the natural aquifer recharge cycle.
- Storm water runoff from fertilized land results in Eutrophication (refer to definitions).

**The figure below explains how development increases storm water runoff and decreases natural infiltration.**



### How? The Strategies:

- Reduce impervious area and increase infiltration. Cluster developments to reduce paved surfaces such as roads and sidewalks.

- Rainwater harvesting. Treated storm water can be used for irrigation and toilet flushing.
- Use pervious paving materials
- Use Vegetated roof, vegetated filter strips, Bioswales, Retention ponds

### **Terminologies:**

**Aquifer:** An aquifer is underground water bearing permeable rock from where underground water can be extracted usefully.

**Impervious Surface:** Impervious surface has less than 50% of perviousness and promotes storm water runoff instead of infiltrating into the subsurface.

### **Rain Gardens:**

A rain garden is a planted depression that allows rainwater runoff from impervious urban areas like roofs, driveways, walkways, parking lots, to be absorbed



## **Eutrophication:**

Eutrophication is the enrichment of inorganic plant nutrients (e.g. nitrate, phosphate) in fresh water bodies. It may occur naturally but can also be the result of human activity (cultural eutrophication from fertilizer runoff and sewage discharge)



## **Vegetated Filter Strips:**

Vegetated filter strips (grassed filter strips, filter strips, and grassed filters) are vegetated surfaces that are designed to treat flow from adjacent surfaces. Filter strips function by slowing runoff velocities and filtering out sediment and other pollutants, and by providing some infiltration into underlying soils

## **Retention Ponds/Sediment Basins:**

Retention ponds or sediment basins stores the storm water runoff temporarily and release it at very less velocity provide sufficient time for the sediments to settle down and storm water to infiltrate.

## **Bioswales:**

Bioswales are landscape elements designed to remove silt and pollution from surface runoff water. They consist of a swaled drainage course with gently sloped sides (less than six percent) and filled with vegetation, compost and/or riprap.



## **Pervious Paving/Open Grid Paving:**

Pervious paving materials allow water to infiltrate as compared to impervious surfaces. There are a variety of pervious paving materials available in the market.

**Figure below shows an indicative example of pervious paving.**



**Reference Standards:** None

## **2.8 Heat Island Roof & Non Roof**

### **Why? The Significance:**

- Heat Island is the phenomenon by which hard surfaces absorb radiation, store it, and radiate it with a time delay. Heat Island increases the temperature in urban areas compared to the nearest rural area from 2 to 10 deg F. This increases the heat gain of the building, resulting in bigger HVAC equipment and higher energy consumption and related greenhouse gas emissions.
- Increase in temperature because of heat island also affects the site habitat.

### **How? The Strategies:**

- Reduce impervious surface area
- Use vegetated roof
- Use high SRI coating materials on impervious surfaces
- Provide underground parking to reduce the impervious area due to parking lot and drive ways
- Shade hardscape areas with trees, canopies, etc.
- Use open grid pavement (permeable pavement) with at least 50% permeable.

## Terminologies:

**Solar Reflectance or Albedo:** Solar Reflectance or Albedo is the measure of ability of a surface to reflect solar radiation

**Solar Reflective Index (SRI):** Solar Reflective index is the measure of a materials ability to reject.

Higher the SRI value, lower the heat island effect.

SRI is calculated based on Reflectance (reflectivity) and emittance (emissivity). For a material to have a higher SRI both reflectance and emittance should be high

**The table below gives an idea how the reflectance and emittance affect the SRI.**

| SRI Values for Solar Infrared Temperatures  | Solar Reflectance | Infrared Emittance | Temperature Rise | SRI |
|---|-------------------|--------------------|------------------|-----|
| Gray EPDM   | 0.23              | 0.87               | 68°F             | 21  |
| Gray asphalt shingle  | 0.22              | 0.91               | 67°F             | 22  |
| Unpainted cement tile   | 0.25              | 0.9                | 65°F             | 25  |
| White granular surface bitumen  | 0.26              | 0.92               | 63°F             | 28  |
| Red clay tile   | 0.33              | 0.9                | 58°F             | 36  |
| Light gravel on built-up roof   | 0.34              | 0.9                | 57°F             | 37  |
| Aluminum coating  | 0.61              | 0.25               | 48°F             | 50  |
| White-coated gravel on built-up roof  | 0.65              | 0.9                | 28°F             | 79  |
| White coating on metal roof   | 0.67              | 0.85               | 28°F             | 82  |
| White EPDM  | 0.69              | 0.87               | 25F              | 84  |
| White cement tile   | 0.73              | 0.9                | 21F              | 90  |
| White coating, 1 coat, 8 mils   | 0.8               | 0.91               | 14F              | 100 |
| PVC white   | 0.83              | 0.92               | 11F              | 104 |
| White coating, 2 coats, 20 mils   | 0.85              | 0.91               | 9F               | 107 |
| Source: Lawrence Berkeley National Laboratory Cool Roofing Materials Database. These values are for reference only and are not for use as substitutes for actual manufacturer data. |                   |                    |                  |     |

## 2.9 Light Pollution Reduction

### Why? The Significance:

- Excess light comes at the cost of energy.
- Light trespass may cause sleep deprivation or may block an evening view in one's property.
- Light Clutter may cause accidents.
- Light pollution disturbs nocturnal life of habitats.
- Sky glow disturbs the night sky view for astronomers.

### How? The Strategies:

- Use timers, occupancy sensors and daylight sensors to switch off unnecessary lights.
- Use lighting simulation software to optimize lighting design.
- Do not exceed the Lighting Power Densities specified by ASHRAE/IESNA 90.1 2007.
- Control Light trespass from transparent surfaces by proper positioning and selection of lighting fixture or automatically closing the transparent openings after specified time.
- Use full cutoff fixtures in external lighting. Full cutoff fixtures reduce the chance of light escape above the horizontal plane and hence reduces sky glow.



## **Terminologies:**

**Light Pollution:** Light pollution is the alteration of light levels in the outdoor environment (from those present naturally) due to man-made sources of light.

**Light trespass:** Light trespass occurs when unwanted light enters one's property, for example, by shining over a neighbor's fence.

**Light clutter:** Light clutter refers to excessive groupings of lights. Groupings of lights may generate confusion, distract from obstacles (including those that they may be intended to illuminate), and potentially cause accidents.

**Skyglow:** Skyglow refers to the “glow” effect due to excess external light that can be seen over populated areas.

**Lighting Power Density:** Lighting Power Density (LPD) is measured in w/sq.m or w/sq.ft. It is the measure of power input per unit floor area for lighting.

## **Reference Standards:**

ASHRAE/IESNA 90.1-2007 – Energy Standard for buildings except low rise residential buildings.

The free online version of this chapter is available at:

<http://learning-green.com/sustainable-sites/>

Candidates can clarify their doubts in this chapter by asking questions in the comments section. Download the Worksheet at the end of the chapter and complete them as an Assignment.

## **Chapter 3 – Water Efficiency**

### **3.1 Water Efficient – Landscaping**

#### **Why? The significance:**

- Landscape irrigation practices consume large quantities of potable water.
- Improved landscaping practices can dramatically reduce and even eliminate irrigation needs.
- Native or adapted plants tend to require less fertilizer and pesticides, minimizing water quality degradation and other negative environmental impacts.
- Water-efficient landscaping helps conserve local and regional potable water resources.

#### **How? The Strategies:**

- Water consumption for irrigation depends of parameters namely species factor(nature of plants to consume low, moderate or high quantity of water), plantation density, microclimate and irrigation efficiency
- Consider Xeriscaping

- Native and Adaptive plants tend to consume less water (low species factor) compared to invasive plants. Consider use of native and adaptive plants in the irrigation system.
- Use efficient irrigation system. Drip irrigation has better efficiency compared to sprinkler.
- Reduce turf/grass area. Grass/turf requires more maintenance and consumes more water
- Use irrigation system with moisture sensors to irrigate the landscape on demand only
- Use non potable water sources like treated grey water, treated storm water for irrigation.

### **Terminologies:**

**Xeriscaping:** Xeriscaping and xerogardening refers to landscaping that does not require irrigation after initial establishment. Irrigation system can be removed for such landscapes after 1 year.

**Potable Water:** Water with acceptable quality to drink

**Black Water:** Definition of black water varies with different plumbing codes but wastewater from toilets and urinals is always considered black water.

Wastewater from kitchen sinks are classified as black water in many plumbing codes.

**Grey Water:** Gray water is defined by the Uniform Plumbing Code (UPC) as untreated wastewater that has not come in contact with toilet waste. This includes water from showers, sinks, bathtubs, washbasins and clothes washers.

**Irrigation Efficiency:** The amount of water (expressed as a percentage) used in irrigation that does not get evaporated.

The irrigation efficiency of drip irrigation (90%) is higher than that of sprinkler system (65%).

**Base Case Consumption:** Base case consumption is calculated based on standard practice of irrigation.

**Design Case Consumption:** Design case consumption is calculated based on actual design practice. To demonstrate water efficient landscaping project teams should prove that the water consumption in design case is less than that of base case.

Details of calculation are beyond the scope of Green Associate exam

## 3.2 Water Efficiency – Indoor

### Why? The significance:

- Protect natural water resources.
- Reduce the load on municipal water supply and sewage treatment plants. Sewage treatment is highly energy intensive process compared to conventional water supply system.

- Increase energy efficiency within the building by reducing the load on water heating and pumping systems.

## How? The Strategies:

| S.No | Description         | Baseline water flow rate | Strategies   |
|------|---------------------|--------------------------|--|
| 1    | Toilets             | 1.6 gpf                  | High Efficient Toilets(1.28 gpf), Dual flush toilets, Composting toilets, treated grey water for flush |
| 2    | Urinal              | 1 gpf                    | Low flow urinals(0.5 gpf), waterless urinals, treated grey water for flush                             |
| 3    | Showers             | 2.5 gpm                  | Low flow shower 1.8 gpm or less  |
| 4    | Faucets - Private   | 2.2 gpm                  | Low flow faucets 1.5 gpm or less   |
| 5    | Faucets- commercial | 0.5 gpm                  |  |
| 6    | Kitchen Sink        | 2.2 gpm                  | Low flow faucet 1.5 gpm or less  |

- Treat the waste water onsite to tertiary levels and reuse it or infiltrate it to reduce the load on sewage treatment plant.

**Note:** For projects to get LEED Certified, the project team should use fixtures efficient than EP Act standards. 20% water use reduction is a prerequisite.

## Terminologies:

**Gallons Per Minute:** Gallons Per Minute (GPM) is the unit of flow rate measurement for flow fixtures like faucets, showers.

**Gallons Per Flush:** Gallons per Flush (GPF) is the unit of flow rate measurement for flush fixtures such as WCs and Urinals.

1 US Gallon = 3.78 liters

**Baseline water consumption:** Baseline water consumption is water consumed in the proposed project considering standard practices are followed in the project.

For water efficiency in indoor the standard consumption is calculated based on Energy Policy Act 1992.

Baseline water consumption depends on FTE of the project and base line flow rates of the fixtures.

**Design Case Water consumption:** Design case water consumption is the calculated water consumed in the project considering actual performance of the fixtures. Design case water consumption depends on FTE of the project, actual flow rates of the fixtures used in the project and not potable water used in the project (example treated grey water or treated storm water for toilet flush)

**Metering Faucets:** Metering faucets dispense water for a pre-determined period of time and deliver a pre-defined volume of water.

**Non water (or composting) toilet systems:** Non water (or composting) toilet systems are dry plumbing fixtures and fittings that contain and treat human waste via microbiological processes.

**Non water (or dry) urinal:** A non water (or dry) urinal, replaces water flush with a trap containing a layer of buoyant liquid that floats above the urine, blocking sewer gas and odors.

**Dual flush Toilets:** Dual flush toilets have two buttons one for half flush and the other for full flush depending on the requirement. Dual flush toilets can save around 2/3rd of water used for flushes

**Water sense:** Water sense is a third party certification for water efficient faucets, showers and water closets

### **Reference Standard:**

Energy Policy Act 1992 with addenda 2005

International Plumbing Code and Uniform Plumbing Code 2006

## **3.3 Water Efficiency – Process**

### **How? The strategy:**

Use treated grey water/storm water or reclaimed water wherever the process allows

### **Terminologies:**

**Process Water:** Water used for business, comfort and commercial operations can be termed as process water.

**Example:** Dishwashers, Commercial Laundry, Cooling tower, Car wash etc



**Reference Standard:** None

### **3.4 Water Efficiency – Existing Buildings**

**Why? The significance:**

- There is huge stock of existing buildings contributing significant consumption of water.
- Existing buildings has enormous scope of water conservation. Older fixtures are highly inefficient.

**How? The strategies:**

- Perform an audit to explore the opportunities for water conservation.
- Lot of retrofit fixtures available in market like aerators and showers can be replaced with very less cost.
- Submeter the water supply for different utilities like landscape, indoor and process water use
- Schedule a routine maintenance for irrigation equipments. For instance if the nozzles of the sprinkler is blocked, water from it will not directed to the target it will run into hardscape areas. If grey water is used there may be a risk of grey water getting contact with human skin.
- Maintain an optimum height of lawns. If they are too short. The roots are exposed to sun which will increase the rate of evaporation.

- Do not dispose the clippings of the landscape. Consider using it as mulch or biofertilizer. This will lead to sustainable site management.

**Reference Standard:** None

The free online version of this chapter is available at:

<http://learning-green.com/water-efficiency/>

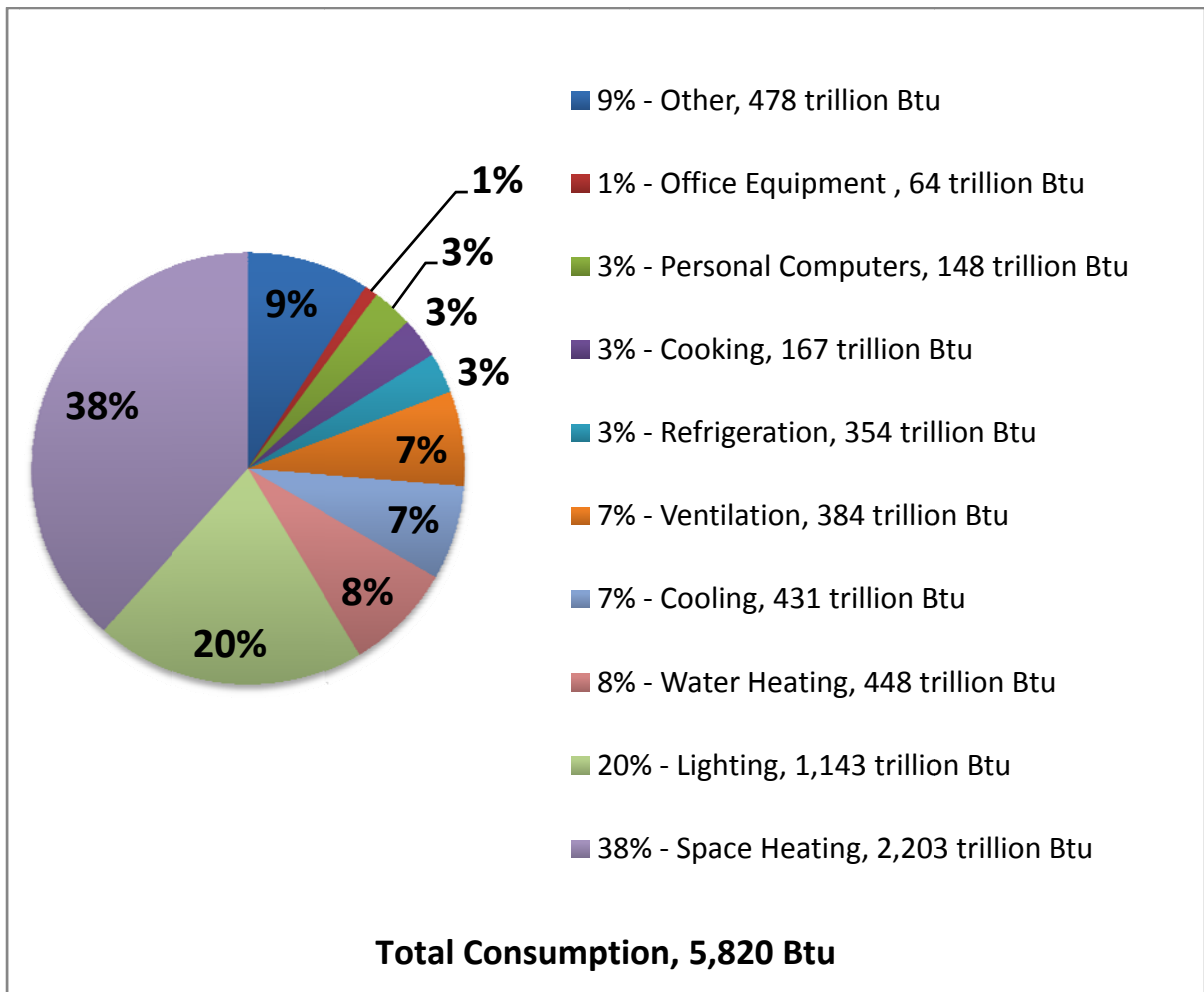
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## Chapter 4 – Energy & Atmosphere

### 4.1 Minimum & Optimize Energy Performance

#### Introduction:

Buildings are the major consumers of Energy. The following chart provides distribution of energy use in US.



LEED gives significant importance to Energy Efficiency and address them as follows

1. Minimum Energy Performance – Prerequisite
2. Optimize Energy Performance – Credit (Offers Maximum number of points in most rating system)

Let us discuss the above in detail

### **Why? The Significance:**

Energy directly related to Global warming, emission, fuel depletion etc.

### **How: The Strategies:**

#### **Minimum Energy Performance:**

- New Buildings should comply with ASHRAE 90.1 2007 requirements
- Existing buildings can evaluate their energy performance by using energy star portfolio manager. To qualify for LEED EB O&M Certification buildings should score a minimum of 69.

**Optimize Energy Performance:** Projects can earn optimize energy performance by energy efficient design beyond ASHRAE 90.1 2007

The following strategies shall be adopted to optimize the energy performance

1. Proper orientation of the building:

- Optimize day light and heat gain/heat loss
- Glazing in appropriate direction to maximize day light and minimize heat gain/loss
- Utilize shading of adjacent structures
- Optimize window the wall ratio

2. Optimized Building Envelope:

- Optimize U(heat transfer coefficient) value for windows, external wall and roof
- Optimize Solar Heat Gain Coefficient of the glazing

3. Efficient HVAC Equipments and pumping system

- Select equipment Coefficient of Performance(COP)/Energy Efficiency Ratio(EER)

4. Efficient Lighting

- Reduce Lighting Power Density

## 5. Intelligent Controls

- Occupancy sensors
- Daylight sensors
- Demand control ventilation
- Shading controls
- Programmable thermostats

The project team shall run an Energy Model (computer simulation) using ASHRAE 90.1 2007 standard as baseline and as designed building as Design Case. Based on the percentage savings on energy consumption the project will be awarded with the points.

### **Standards & References:**

ASHRAE 90.1 2007 – Standard for Energy Efficiency Except low rise residential building

## **4.2 Renewable Energy**

### **Why? The Significance:**

- Energy production from traditional sources (such as coal, natural gas, and other fossil fuels) is a significant contributor to air, releasing such pollutants as sulfur dioxide, nitrogen oxide, and carbon dioxide. These pollutants are primary contributors to acid rain, smog, and climate change.

- The pollutants have widespread and adverse effects on human health, especially respiratory health.
- Using renewable energy generated either on-site or off-site is an excellent way for owners to reduce the negative environmental impacts on air and water associated with a building's energy requirements.
- Renewable energy has a positive impact on rural communities in particular; siting and operating wind farms and biomass conversion facilities in rural areas enhances economic development.

## **Introduction:**

LEED addresses renewable energy in two credits

1. Onsite Renewable Energy – Energy generated within in the site  
example Solar Water heater, Solar Photovoltaic cell, Wind turbine etc
2. Green Power – Green Power is renewable energy purchased from  
utilities or service providers.

The following energy sources are considered renewable

- Photovoltaic Cells
- Wind Energy
- Solar Thermal Energy systems (solar hot water systems, solar powered absorption chillers)

- Geothermal Power (deep earth power generation)
- Low impact hydro-electric power
- Tidal Energy
- Energy from Biomass or biogas or biofuel (agricultural waste, animal waste, wood residue, Landfill gas etc)

LEED does not consider the following as renewable energy

- Fossil Fuel
- Nuclear Energy (Hazards due to radiation)
- Conventional Hydro Power Plant (it disturbs aquatic life)
- Passive Technologies like Day lighting, geothermal heat exchange (these can be considered in optimizing energy performance)
- Energy from forestry biomass (causes deforestation)
- Energy from wood coated with paints or coatings (potential contaminants)
- Energy by burning municipal waste (potential contaminants)

## **Terminologies:**

**Green E:** Green E energy is a voluntary certification and verification program for renewable energy products



**Renewable Energy Certificates (RECs):** Renewable energy certificates are tradable commodities representing proof that a unit of electricity was generated from renewable energy sources

## **How? The strategies**

**Onsite Renewable Energy:** Renewable energy generated within the project can earn Onsite Renewable Energy Credit.

### **Green Power:**

Projects can earn this credit by adapting one of the three compliance path

- Case 1: In closed electricity market, the utility provider has an option for Green E certified Power
- Case 2: In Open electricity market, the consumer can choose for a utility provider who supplies Green E Certified Power
- Case 3: In closed electricity market if the utility provider does not have an option for Green E certified Power. The consumer can purchase Green E accredited Renewable Energy Certificates (REC's) to offset their power consumption from conventional sources.

### **Reference & Standards:**

- Green E
- Renewable Energy Certificates

## 4.3 Refrigerant Management

### Terminologies:

**CFC:** Chloroflouro carbons

**HCFC:** Hydro Chloroflouro carbons

**HFC:** Hydro Flouro Carbons

**Montreal Protocol:** International treaty to prevent damage of ozone layer.

**GWP:** Global Warming Potential

**ODP:** Ozone Depleting Potential (considered more dangerous than Global warming)

**Hallons:** Material used in fire suppression system which has ozone depleting property

### Evolution of Refrigerants:

#### Natural Refrigerants:

Air, CO<sub>2</sub>, H<sub>2</sub>O, ammonia (NH<sub>3</sub>) and Hydrocarbons (Propane, butane etc) are examples of natural refrigerants. These refrigerants are environmentally good but had some disadvantages.

- Air, CO<sub>2</sub>, H<sub>2</sub>O has poor refrigerant properties
- Ammonia is toxic in nature

- Hydrocarbons are explosive in nature particularly at high pressure

## **ChloroFlouro Carbons(CFC)**

Example R11, R12

They have excellent refrigerant properties but have very high Ozone depleting potential and hence Montreal Protocol has decided to phase out CFC production from 1996 and derivatives of CFC are phased by 2010

## **Hydro ChloroFlouro Carbons (HCFC)**

Example: R22, R123

CFC's are replaced by HCFC's. Chlorine which is responsible for damaging the ozone layer is partially replaced by hydrogen atoms. Environmental impact of HCFC's is lesser than CFCs but still has a impact.

Montreal protocol has targeted to phase out HCFC's by 2030

## **HFC (Hydrofluoro Carbons)**

Example: R143, R 407c, R 410a

HFC's are replacement of HCFC's. As HFC's are chlorine free, it has zero Ozone Depleting Potential but has a Global Warming potential. Most of the air-conditioning manufacturers are presently using HFC as the refrigerants.

## **LEED Requirements on Refrigerants:**

Fundamental Refrigerant Management (Prerequisite)

In new buildings:

- No CFCs

### In renovation of Existing buildings:

- No CFCs

Or

Phase-out plan prior to the completion of the project

Or

- Prove that replacement of CFC's are commercially not feasible(provide third party certificate that simple payback period of replacement would be more than 10 years) and Reduce the leakage rate of CFC based refrigerants to 5% or less using EPA Clean Air Act Procedures

### Enhanced Refrigerant Management:

- No hallons, CFC and HCFC in fire suppression system
- Reduce overall environmental impact caused by refrigerants by selection zero ODP refrigerants and refrigerants with lesser Global warming potential
- Reduce the leakage rate of refrigerants
- Select equipment with higher life

### Standards & References:

Montreal Protocol: International treaty on protection of ozone layer.

EPA Clean air act – Reduce the leakage rate of CFC's to less than 5% by EPA clean air act

## Summary:

| Refrigerant Group                             | Example                                | Ozone Depleting Potential (ODP) | Global Warming Potential (GWP) | Environmental Impact      | Requirements of Montreal Protocol   | LEED Requirements  |
|---|--|---------------------------------|--------------------------------|---------------------------|---|--|
| Chloro<br>Fluoro<br>Carbon<br>(CFC)           | R 11<br><br>R 12                       | High                            | Medium                         | Worst                     | CFC Production phased out in 1996<br><br>Derivatives to be phased out by 2010 | No CFC's in new buildings<br><br>In renovation of existing buildings have a phase-out plan prior to completion of the project<br><br>Or<br><br>If the replacement of CFC is not possible provide a third party certificate to prove the simple payback period is greater than 10 years<br><br>Reduce the CFC leakage to less than 5% |
| Hydro<br>Chloro<br>Fluoro<br>Carbon<br>(HCFC) | R22<br><br>R123                        | Medium                          | Low                            | Not as Worst a CFC        | HCFC's to be phased out by 2030   | Use of HCFC's will satisfy the prerequisite but will not earn point for Enhanced Refrigerant Management  |
| Hydro<br>Fluoro<br>Carbon                     | R 23<br><br>R 134a                     | Zero                            | Medium                         | Better                    |   | Use of HFC's with less leakage rate and higher life of equipment shall fetch Enhanced Refrigeration Management credit  |
| Natural Refrigerants                          | Hydrocarbons, air, water, ammonia, CO2 | Zero                            | Low                            | Less Environmental impact |   | Cannot be used due to energy inefficiency and other disadvantages  |
| Natural Ventilation                           | The best if climate condition allows   |                                 |                                |                           |   |  |

## 4.4 Fundamental & Enhanced Commissioning

### Why? The Significance:

- Facilities that do not perform as intended may consume significantly more resources over their lifetimes than they should. Commissioning can minimize the negative impacts buildings have on the environment by helping verify that buildings are designed and constructed to operate as intended and in accordance with the owner's project requirements.
- Improved occupant well-being and productivity are other potential benefits when building systems function as intended. Proper commissioning of building systems can reduce employee illness, tenant turnover and vacancy, and liability related to indoor air quality, and it can avoid premature equipment replacement.

### How? The Strategies

Designate a Commissioning Authority for the project to lead the commissioning process; the scope of commissioning shall include at a minimum of the following energy related systems in the building heating.

- HVAC equipments and its associated controls
- Lighting and day lighting controls.
- Domestic hot water systems.
- Renewable energy systems (e.g. wind, solar)

## **Terminologies:**

**Commissioning:** Commissioning (Cx) is the process of verifying and documenting that a building and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the owner's project requirements.

**Fundamental Vs Enhanced Commissioning:** Fundamental Commissioning may start in later design phase and may end before occupancy whereas Enhanced commissioning should start early in the design process and ends after occupancy

Fundamental Commissioning is a prerequisite and Enhanced Commissioning is a credit

**Commissioning Authority:** The commissioning authority (CxA) is the individual designated to organize, lead, and review the completion of commissioning process activities.

**Basis of Design:** Basis of design includes design information necessary to accomplish the owner's project requirements, including system descriptions, indoor environmental quality criteria, design assumptions, and references to applicable codes, standards, regulations, and guidelines

## **4.5 Measurement & Verification**

### **Why? The significance:**

Measurement & verification is an integrated part of Energy Efficiency and Energy management. “You can’t manage, what you don’t measure”

Measurement & Verification is the process by which different energy efficiency measures are evaluated during the operation of the building.

### **How? The strategies:**

The project team should have M&V plan as per International Performance Measurement & Verification Protocol Vol III.

M & V can be done by two methods

1. Sub metering different utilities
2. Simulation

### **Standards & References:**

International Performance Measurement & Verification Protocol Vol III –  
Provide best practices in measurement and verification



The free online version of this chapter is available at:

<http://learning-green.com/energy-atmosphere/>

Candidates can clarify their doubts in this chapter by asking questions in the comments section. Download the Worksheet at the end of the chapter and complete them as an Assignment.

## **Chapter 5 – Materials & Resources**

### **Introduction:**

Buildings are the major contributor for solid waste generation. LEED encourages buildings to follow the policy of Reduce, Reuse and Recycle



### **5.1 Storage of Recyclable Materials (Prerequisite)**

#### **Why? The Significance:**

- By creating convenient recycling opportunities for all building occupants, a significant portion of the solid waste stream can be diverted from landfills.
- Recycling of paper, metals, glass, cardboard and plastics reduces the need to extract virgin natural resources.

- Examples: recycling 1 ton of paper prevents the processing of 17 trees and saves 3 cubic yards of landfill space.
- Recycled aluminum requires only 5% of the energy required to produce virgin aluminum from bauxite. Diverting waste from landfills can help minimize land, water, and air pollution.

### **How? The Strategies:**

Provide a suitable and convenient storage facility for occupants to store recyclable materials and the haulers to periodically collect the recyclable materials.

- The storage facility shall collect minimum paper, cardboard, glass, plastics and metals.
- An occupant education program that addresses the environmental and financial benefits of recycling can encourage occupants to participate in preserving the environment
- Proper signage to indicate storage place of recyclable materials
- Signage for “not be contaminate”
- Security for high valued materials

### **Terminologies:**

**Landfills:** Landfills are waste disposal sites for solid waste from human activities

**Tipping Fee:** Tipping fees are charged by a landfill for disposal of waste, typically quoted per ton

**Hauler:** Hauler is a person or company which collects the recyclable materials and sends it to recycling facilities

**Comingled Recycling:** Comingled recycling is the term used when all recyclable materials (paper, metal, plastics, cardboard, glass etc) are collected in a single storage place. The hauler separates the materials and sends it for respective recycling facilities.

## 5.2 Construction Waste Management

### Why? The significance:

- Most of construction waste are recyclable (metal, cardboard, concrete, wood, asphalt etc)
- Recycling of construction and demolition debris reduces demand for virgin resources and reduces the environmental impacts associated with resource extraction, processing and, in many cases, transportation.
- Extends the lifetime of existing landfills through effective and can avoid the need for expansion or new landfill sites.

## **How? The Strategies:**

- Prepare a construction waste management plan.
- Identify recyclable construction waste and source haulers for recycling
- Identify convenient storage place for recyclable material.

## **5.3 Building Reuse**

### **Why? The Significance:**

- There is a huge stock of existing buildings with a potential to refurbish, rather than redevelopment. Building reuse is a very effective strategy for reducing the overall environmental impact of construction.
- Reusing existing buildings significantly reduces the energy use associated with the demolition process as well as construction waste.
- Reuse strategies also reduce environmental impacts associated with raw material extraction, manufacturing, and transportation.
- Reduces the requirement for construction materials and hence reduces the environmental impact associated with extracting, manufacturing, transporting of the materials
- Infrastructure is already available

## **How? The Strategies:**

- Maintain the existing building structure (including structural floor and roof decking) and envelope (the exterior skin and framing, excluding window assemblies and nonstructural roofing material)
- Use existing interior nonstructural elements (e.g., interior walls, doors, floor coverings and ceiling systems)
- Hazardous materials that are remediated as a part of the project must be excluded from the calculation of the percentage maintained.
  - If the project includes an addition of more than 2 times the square footage of the existing building, this credit is not applicable.

## **5.4 Material Reuse**

### **Refurbished Materials:**

Refurbished materials products have completed their life cycle as consumer items and are then refurbished for reuse without substantial alteration of their form. Refurbishing includes renovating, repairing, restoring, or generally improving the appearance, performance, quality, functionality, or value of a product.

### **Salvaged Materials:**

Salvaged materials are construction materials recovered from existing buildings or construction sites and reused. Common salvaged materials include structural beams and posts, flooring, doors, cabinetry, brick, and decorative items.

### **Why? The Significance:**

- Reuse strategies divert material from the construction waste stream, reducing the need for landfill space and environmental impacts from associated water and air contamination.
- Use of salvaged materials also avoids the environmental impacts of producing new construction products and materials.

### **How? The Strategies:**

Identify potential materials that can be reused in the locality of the project in design stage and specify them in construction documents.

## **5.5 Materials with Recycled Content**

### **Why? The Significance:**

- Products with recycled content reduce virgin materials use and solid waste volumes.

- As the number of building products containing recycled content grows, the marketplace for recycled materials develops.

## **How? The Strategies:**

Identify potential materials with recyclable materials that can be used in the project and specify them in construction documents.

## **Terminologies:**

### **Recycled Content:**

Recycled content is the proportion, by mass, of preconsumer or postconsumer recycled material

### **Post Consumer Recycled Content:**

The recycled material was generated by household, commercial, industrial, or institutional end-users and can no longer be used for its intended purpose. It includes returns of materials from the distribution chain (ISO 14021). Examples include construction and demolition debris, materials collected through recycling programs, discarded products (e.g., furniture, cabinetry, decking), and landscaping waste (e.g., leaves, grass clippings, tree trimmings).



### **Pre consumed recycled content:**

Preconsumer recycled content, formerly known as postindustrial content, is the percentage of material in a product that is recycled from manufacturing waste. Examples include planer shavings, sawdust, bagasse, walnut shells, culls, trimmed materials, over issue publications, and obsolete inventories. Excluded are reworks, regrind, or scrap materials capable of being reclaimed within the same process that generated them (as stated in ISO 14021)

### **Fly Ash:**

Fly ash is the solid residue derived from incineration processes. Fly ash can be used as a substitute for Portland cement in concrete.

### **Assembly Recycled Content:**

Assembly recycled content is the percentage of material in a product that is either postconsumer or preconsumer recycled content. It is determined by dividing the weight of the recycled content by the overall weight of the assembly.

### **Reference Standards:**

ISO 14021

## 5.6 Rapidly Renewable Materials

### **Rapidly Renewable Materials:**

Rapidly renewable materials are agricultural products, both fiber and animal, that takes 10 years or less.

Examples of rapidly renewable materials include bamboo flooring and plywood, cotton ball insulation, linoleum flooring, sunflower seed board panels, wheatboard cabinetry, wool carpeting, cork flooring, bio-based paints, geotextile fabrics such as coir and jute, soy-based insulation and form-release agent, and straw bales.

### **Why? The significance:**

- Many conventional building materials require large inputs of land, natural resources, capital, and time to produce. Conversely, rapidly renewable materials generally require fewer of these inputs and are likely to have fewer environmental impacts.
- Sourcing rapidly renewable materials reduces the use of raw materials whose extraction and processing have greater environmental impacts.
- Because of their intensive production and shorter growing cycles, rapidly renewable crops also require significantly less land to produce the same amount of end product; some are byproducts that are otherwise considered waste.

## **How? The Strategies:**

- Assess the potential rapidly renewable materials that can be used in the project and specify the same in construction documents

## **5.7 Certified Wood**

### **Why? The Significance:**

- The negative environmental impacts of irresponsible forest practices can include forest destruction, wildlife habitat loss, soil erosion and stream sedimentation, water and air pollution and waste generation.
- Encourages sustainable forestry

### **How? The strategies:**

- Assess the potential wooden products that can be used in the project and specify FSC certified wood for the same.

## **Terminologies:**

### **Chain-of-custody (COC):**

Chain of Custody is a tracking procedure for a product from the point of harvest or extraction to its end use, including all successive stages of processing, transformation, manufacturing, and distribution.

### **Sustainable forestry:**

Sustainable forestry is the practice of managing forest resources to meet the long-term forest product needs of humans while maintaining the biodiversity of forested landscapes.

### **FSC Certified Wood:**

Principles and Criteria Certification by the Forest Stewardship Council (FSC) is a seal of approval awarded to forest managers who adopt environmentally and socially responsible forest management practices and to companies that manufacture and sell products made from certified wood.

Sustainable Forestry is the practice of managing forest resources to meet the long-term forest product needs of humans while maintaining the biodiversity of forested landscapes.

## **5.8 Regional Materials**

### **Regional Material:**

Materials extracted, manufactured and assembled within 500 miles of radius from the project location

## Why? The Significance:

- The use of regional building materials reduces transportation activities and associated pollution. Trucks, trains, ships, and other vehicles deplete finite reserves of fossil fuels and generate air pollution.
- Encourages and strengthen local economies

## How? The Strategies:

Assess the potential regional materials that can be used in the project and specify the same in construction documents

## 5.9 Materials & Resources Summary

| S.No | Credit                          | Credit Calculation based on:  |
|------|---------------------------------|---|
| 1    | Storage of recyclable materials | No calculation. Storage to be provided for recyclable materials to facilitate recycling.  |
| 2    | Building reuse                  | Surface area reused. Window assemblies to be excluded from calculation  |
| 3    | Material Reuse                  | Cost of reused/recycled content/regional materials against the total materials cost of the project. If an assembly of the particular material |
| 4    | Recycled Content                |   |
| 5    | Regional Materials              |   |

|   |                               |  |
|---|-------------------------------|--|
|   |                               | contributes to the credit, consider the fraction of the assembly for credit calculation. Example, if 75% of a product of cost \$ 1000 qualifies for regional material, then \$ 750 contributes to the credit calculation |
| 6 | Certified Wood                | Cost of FSC certified wood against the cost of total wood based products in the project.   |
| 7 | Construction waste management | Amount of construction waste diverted from landfill. Weight/Volume may be used for calculation but should be consistent.   |

**Note:**

1. For all credits MEP materials are excluded from the calculation
2. Furniture may be included for credit calculations but should be included consistently in all credit calculations
3. Contaminated materials are excluded from calculation

The free online version of this chapter is available at:

<http://learning-green.com/materials-resources/>

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## **Chapter 6 – Indoor Environmental Quality**

### **6.1 Introduction**

#### **What constitute Indoor Environment?:**

- Air Quality
- Thermal comfort
- Lighting comfort
- Acoustics (significant only for schools)

#### **Why is IEQ Important?:**

- We spend 90% of our time indoor
- Indoor 2-5 times more polluted compared to outdoors
- Improvement in indoor environment improves productivity and reduces absenteeism

### **6.2 Air Quality**

**Following are the credits/prerequisites which addresses Indoor Air Quality:**

- Ventilation
  - Minimum Indoor Air Quality Performance (prerequisite)
  - Increased Ventilation

- **Environmental Tobacco smoke control (prerequisite)**
- Outdoor air monitoring
- Indoor Air Quality Management
  - During Construction
  - Before occupancy
- Low Emitting Materials

## **6.2.1 Ventilation**

### **Why? The Significance:**

- Ventilation is the key to improve indoor air quality and provide sufficient oxygen for occupants

### **How? The Strategies:**

#### **Minimum Indoor Air Quality Performance:**

- Ventilation design should comply with ASHRAE 62.1-2007

#### **Increased Ventilation:**

- Provide 30% excess fresh air from minimum requirements of ASHRAE 62.1- 2007
- Achievement of this credit has a negative implication on energy performance
- Energy recovery systems can be used to reduce the negative impact of increased ventilation.



## **Standards/References:**

ASHRAE 62.1 -2007 – Standard for Indoor Air Quality

## **6.2.2 Environmental Tobacco smoke control**

### **Why? The Significance:**

- Protect occupants from second hand smoke
- Occupants exposed to second hand smoke risk lung cancer

### **How? The Strategies:**

#### **Commercial Projects:**

- Prohibit Smoking
- Provide designated smoking room

#### **Residential Projects:**

- Prohibit smoking in common areas
- Ensure air tightness in the unit by blower test
- Weather seal Window and door frames

### **Interior Smoking areas shall be:**

- Directly exhausted to the outdoors
- Enclosed with impermeable deck-to-deck partitions
- Negatively pressurized (average 5 Pa, minimum 1 Pa)

### **Exterior Smoking areas shall be:**

- At least 25' away from windows, doors or air intake points

## **6.2.3 Outdoor air delivery monitoring**

### **Why? The Significance:**

- Ensure occupants get sufficient fresh air
- In adequate fresh air leads to headaches, dizziness and increased heart rate.

### **How? The Strategies:**

- Measure the outdoor air flowing into the FAHU, provide an alarm if the air quantity is less than the minimum requirement
- Provide CO2 sensors in densely occupied areas. Occupants shall be warned by alarm if the CO2 levels are higher than recommended levels. Densely occupied spaces are spaces which have population of more than 25 person/1000 sq.ft.
- CO2 Sensors can also be used for demand controlled ventilation

## **6.2.4 Indoor Air Quality Management**

### **Why? The significance:**

- Protect construction workers and occupants from IAQ problems resulting from construction

- Pollutants from synthetic materials, construction process, finishing materials etc pose serious IAQ problems.

### **How? The Strategies – during construction:**

- Develop a IAQ Management Plan as per Sheet Metal and Air-conditioning National Contractors Association
- SMACNA addresses IAQ Management in 5 areas as follows
  - Protection of HVAC equipment
  - Source control
  - Housekeeping
  - Pathway interruption
  - Scheduling
- If permanently installed air handlers are used during construction, provide MERV (Mechanical Efficiency Reporting Value) rated filters in all return grills.

### **How? The Strategies – Before occupancy:**

- Replace all AC filters if HVAC equipment is used during construction
- Flush the building by supplying outdoor air
- Conduct an IAQ test prior to occupancy

### **Standards & References:**

- ASHRAE 52.2 provides methodology to MERV filters

## 6.2.5 Low Emitting Materials

### Why? The significance:

- Finishing materials have high concentration of pollutants such as Volatile Organic Compounds (VOCs), Formaldehyde etc
- These pollutants pose serious problems on IAQ and also contribute to smog

### How? The Strategies

#### Adhesives & Sealants:

- All adhesives, sealants and sealant primers used in interiors of the building should comply with VOC requirements of [South Coast Air Quality Management \(SCAQMD\) District Rule 1168](#)

#### Paints & Coatings:

- All paints, coatings and primers shall comply with [Green Seal standard GS -11](#)
- Anticorrosive and antirust coatings should comply with [Green Seal Standard GC 03](#)
- Wood finishes, floor coatings, stains and shellacs shall comply with [SCAQMD Rule #1113](#)

## **Carpet & Flooring System:**

- All interior carpet must comply with [Carpet and Rug Institute's Green Label Plus program](#).
- Carpet cushions must comply with [Green Label](#) Program.
- Hard surface flooring must be [FloorScore](#) certified or more stringent

## **Wood & Agrifiber Products:**

- Composite wood and agrifiber products used on the interior of the building must not contain added urea-formaldehyde resins

## **Terminologies:**

### **VOC Budget:**

- If a small amount of a product non-compliant with the VOC limits of the standards, the project team may opt to perform a VOC Budget calculation.
- The VOC Budget is a weighted average calculation which can be used to show that the majority of the products comply.

## **Standards & References:**

- SCAQMD
- Green Seal
- Green Label Plus
- Green Label
- FloorScore

## **6.2.6 Indoor Chemical & Pollutant Control**

### **Why? The significance:**

- Protect the occupants from potentially hazardous particulates and chemical pollutants

### **How? The Strategies:**

- Use entryway systems 10 feet long at all regular entrances
- Directly exhaust chemical mixing areas such as copy room, janitor rooms, chemical storage rooms etc
- In mechanically ventilated buildings, use MERV rated filters in accordance with ASHRAE 52.2.

### **Standards & References:**

- ASHRAE 52.2 provides methodology to test MERV filters

## **6.3 Lighting**

### **Following are the credits which address Lighting:**

- Controllability of systems – Lighting
- Daylight & Views

### **6.3.1 Controllability of Systems – Lighting**

#### **Why? The significance:**

- To provide the occupants with control their lighting according to their requirement
- Increases productivity
- May provide an opportunity for save energy

#### **How? The Strategies:**

- Provide individual lighting control for a percentage of occupants
- Provide lighting system controllability for all shared multi occupant spaces (meeting room, conference halls etc)

### **6.3.2 Day light & Views**

#### **Why? The significance:**

- Provide daylight and views to connect the occupants with outdoor
- Research proves that children studied at daylight class rooms perform better than other children consistently

#### **How? The Strategies:**

- In early design phase optimize the glazing orientation to optimize between heat gain and daylight
- Daylight strategies shall be implemented with Glare control.

- Automated shading devices shall be used to control operation of the shading devices in different time of the day

## **6.4 Thermal Comfort**

**Following are the credits which address Thermal Comfort:**

- Thermal Comfort Design
- Thermal Comfort Verification
- Controllability of systems – Thermal comfort

### **6.4.1 Thermal Comfort- Design, verification and controllability**

**Why? The significance:**

- Reduce occupant complaints
- Reduce absenteeism, Increases productivity, Increased occupant satisfaction

**How? The strategies:**

- Thermal Comfort Design- Comply with ASHRAE standard 55 for thermal comfort.
- Thermal comfort depends on parameters such as temperature, humidity, air velocity etc



- Thermal comfort – controllability: Provide controls for the occupants to set their comfort levels.
- Thermostats, operable windows, accessible control dampers are considered as controls
- Thermal comfort verification – Agree to conduct a thermal comfort verification.
- Agree to take corrective action if more than 20% of occupants are not satisfied

## **Standards & References:**

- ASHRAE standard 55 for thermal comfort

The free online version of this chapter is available at:

<http://learning-green.com/indoor-environmental-quality/>

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## **Chapter 7 – Innovation in Design and Regional Priority**

### **7.1 Introduction**

Innovation in Design points are awarded to projects which achieve exceptional performance in sustainability above the requirements set by the LEED Green Building Rating System. Project Team can earn Innovation in Design by two paths namely

#### **Exemplary performance and Innovation in Design**

### **7.2 Exemplary Performance**

#### **Exemplary Performance:**

Exemplary performance points are awarded if the project outperforms the requirements **specifically addressed by the LEED rating system.**

Exemplary Performance can be earned by exceeding the requirements of the credit to next threshold or achieving double the credit requirements.

## Examples:

1. **Rating System:** LEED for New Construction and Major Renovation

Credit Category: Sustainable Site

Credit: Development Density & Community Connectivity

**Exemplary Performance:** 1 Bonus point under Innovation in Design if the project meets double the credit requirements (achieve 120,000 sq.ft/acre against 60,000sq.ft/acre)

2. **Rating System:** LEED for New Construction and Major Renovation

Credit Category: Water Efficiency

Credit: Water use reduction

**Exemplary Performance:** 1 Bonus point under Innovation in Design if the project exceeds the credit requirement to the next threshold (achieves 40% reduction of water use – 4points, achieve 45% reduction of water use – 4 points + 1 point under Innovation in Design)

## 7.3 Innovation in Design

**(Same as the name of the credit category)**

ID credits for innovative performance are awarded for comprehensive strategies which demonstrate quantifiable environmental benefits which is **not specifically addressed in the LEED rating system.**

A representative list of innovative performance ID credits awarded to LEED certified projects is outlined below.

- Educational Outreach Program
- Green Housekeeping
- High Volume Fly Ash
- Low-Emitting Furniture & Furnishings
- Organic Landscaping / Integrated Pest Management Program

The following Points are worth noting in relation to Innovation in Design

- LEED ID Credits are evaluated for each project award of an ID Credit for one project at a specific point in time does not constitute automatic approval for a similar strategy in a future project.
- Innovation credits are not awarded for the use of a particular product or design strategy if the technology aids in the achievement of an existing LEED credit.
- Approved ID credits may be pursued by any LEED project, but the project team must sufficiently document the achievement using the LEED credit equivalence process. This process includes identifying the proposed innovation credit intent, the proposed requirement(s) for compliance, the proposed submittal(s) to demonstrate compliance, and a summary of potential design approaches that may be used to meet the requirements.

## 7.4 LEED AP

- One point shall be awarded if the project team has one principal participant who is a LEED AP
- The project can receive only one point regardless on the number of LEED AP's in the project team.
- LEED AP helps streamlining the application and certification process.
- In LEED AP Credit is a construction submittal and hence participation of LEED AP is required throughout the project

## 7.5 Regional Priority

- Regional Priority credits are included in latest version of the rating system(2009) as an incentive for the achievement of credits that address geographically-specific environmental priorities.
- Regional Priority credits has been listed by state and zipcode in usgbc website

### Example:

In Arizona, Zip code – 85003. The following credits are designated as regional priority credit

- Development Density & Community Connectivity
- Alternate Transportation – Parking capacity
- Heat Island Effect- Non Roof
- Water Efficient Landscaping – No potable water for irrigation

- Water use reduction – 30%
- Onsite Renewable Energy – 3%

Projects in zip-85003, Arizona can earn 4 Bonus points if they achieve any 4 of the above credits.

The database for Regional priority credit can be accessed from the database below

<http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1984>

The free online version of this chapter is available at:  
<http://learning-green.com/innovation-in-design-and-regional-priority/>

Candidates can clarify their doubts in this chapter by asking questions in the comments section. Download the Worksheet at the end of the chapter and complete them as an Assignment.

## **Chapter 8 – LEED Administration Process**

### **8.1 Certification Process for LEED NC, CS, Schools and O&M**

**Following are the stages of certification:**

1. Project Registration
2. Application (Design Phase & Construction Phase can be separated by project team except for LEED O & M)
3. Preliminary review
4. Preliminary review response (clarification)
5. Final review
6. Accept or appeal
7. Appeal review (if applicable)
8. Certification or denial

#### **Project Registration:**

- Projects registered using online application through [www.leedonline.com](http://www.leedonline.com)
- Registration is done by Project Administrator who will be the point of contact between gbci and project team.

- Registration fee:\$900 for member companies & \$1200 for non member companies
- Registration during pre design is recommended.
- The following information are required to register the project
  - Project type
  - Project Administrator Contact information
  - Registration fees (through card)
  - Project Owner information
  - Project Details- scope, square footage, condition of the site, budget etc

### **Application:**

- On completion of registration project team gets access to leed online which has online credit templates.
- Project Administrator assigns credit responsibilities for team members.
- Team members get access to corresponding credit templates for which they are responsible
- Project team will collect information for credit submittals
- Each rating system has its own set of forms to be completed and submitted for documentation and verification.
- Dynamic pdf to be filled out and then uploaded directly back to LEED Online



- Project team can opt for split application & review for design and construction submittals(Not applicable of O&M, O&M projects has to submit application in single phase )

## **Split Vs Combined Application/Review**

### **Split review**

- Allows submitting project documentation of some credits during Design phase
- Helps to anticipate what credits are possible for certification.

### **Combined design and construction application/review**

- All documentation is submitted and reviewed at one time. Advantageous only if project has commenced.

## **Design Application Review:**

### **On Design Review:**

- GBCI will mark as credit anticipated or denied(No points awarded at this stage)
- On receipt of final design review, the project can accept or make an appeal (USD 500 for each credit)

## **Construction Application Review:**

### **On construction application review:**

- (GBCI review both design & construction documents at this stage)
- GBCI will mark as credit awarded or denied
- On receipt of final construction review, the project can accept or make an appeal (USD 500 for each credit)
- When to project team accepts the review the project will be Certified or denied

## **8.2 Certification Process of LEED ND**

- LEED ND is significantly different from other projects as it involves longer construction period than buildings.
- LEED ND has options of getting conditional approval at early stages.
- LEED ND projects can get conditional approval of ND Plans at entitlement stage
- Precertified LEED ND projects has to submit all required documentation to get the final certification on completion.

## **8.3 LEED Homes Certification Process**

Unlike other LEED certification process, USGBC/GBCI does not involve directly in LEED for Homes Certification.

LEED for Homes is facilitated by LEED for Homes providers & Green Rater. LEED for Homes providers are contracted by USGBC/GBCI to provide administrative & Technical support to the project team. Green Raters are part of project team who connects the project team with LEED for Homes provider by site inspections and verification.

### **Steps in LEED Homes Certification:**

1. Contact LEED for Homes provider. LEED for Homes providers are listed in usgbc website
2. Project team holds preliminary meeting with LEED for homes provider to discuss the project certification. The project certification goals are set and responsibilities are assigned to the project team members. The project team may include LEED AP (Homes specialty) to guide the members.
3. On receipt of go ahead signal from LEED for Homes provider the project team can register the project with GBCI.
4. Project team proceeds with the project to meet the targeted goals.
5. Green Rater performs inspections and required tests to ensure the required performance targets are met.
6. Green Rater completes the project documentation and submits it to LEED for Homes provider
7. LEED for Homes provides reviews the documentation and submits it to GBCI for Review
8. GBCI reviews and provide the certification.

Reference: <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=147>

## 8.4 Credit Interpretation Request/Ruling (CIR)

- The Project Credit Interpretation Request (CIR) and ruling process is designed to allow Project Teams to obtain technical and administrative guidance on how LEED requirements including Minimum Program Requirements, Prerequisites, and Credits pertain to their projects.
- A CIR may be submitted at any time after the point in which a project is registered.
- CIR to be submitted through LEEDONLINE by selecting a particular credit or prerequisite.
- Standalone CIR can also be submitted but should pertain to any specific requirement of LEED rating system
- Each CIR shall address only one credit or prerequisite or LEED requirement.
- CIR should not be in letter format, project teams should not give project information. Project Information is already available through LEEDONLINE.
- Project teams need not submit drawings or cut sheets or specifications etc. Only specific background information is sufficient.
- CIR should not exceed 600 words
- Project Teams must submit the CIR inquiry and the ruling with their LEED application in order to ensure a complete review.

- Project Teams should note that neither the credit language nor the minimum achievement thresholds can be changed through the CIR process.
- CIR rulings do not in any way guarantee that a LEED MPR, prerequisite or credit will be satisfied or achieved. The project Applicant must still demonstrate and document satisfaction of all LEED requirements during the LEED certification process.
- CIR rulings of Pre LEED 2009 rating system are applicable to other projects under same circumstances
- CIR rulings of LEED 2009 rating system are project specific

## 8.5 LEED Volume Programme

The LEED Volume Program is for organizations planning to certify a large number of design and construction projects or existing buildings. It works by establishing verifiable guidelines that streamline the certification process without compromising LEED's rigorous standards. This new program dramatically increases the efficiency of LEED certification and lowers the associated costs.

**Example:** Marriot – a hotel chain in different countries can opt for LEED volume program for all their facilities

The free online version of this chapter is available at:  
<http://learning-green.com/leed-administration-process-and-green-building-project-management/>

Candidates can clarify their doubts in this chapter by asking questions in the comments section. Download the Worksheet at the end of the chapter and complete them as an Assignment.

## **Chapter 9 – Green Building Project Management**

### **9.1 Cost of Green Buildings**

#### **Definitions:**

**Hard Costs:** The physical costs for the construction of a Project, including all building and landscaping materials.

**Soft Costs:** The non-physical costs that go into a project. This includes architectural, engineering and legal fees, as well as other pre- and post-construction expenses.

**Operation & Maintenance cost:** Cost associated with operating the facility throughout its life. It includes utility bills, minor upgrades, maintenance of equipment etc.

**Life-Cycle Costs:** The sum of all costs over the full life span (or specific period) of the building. This includes purchase price, installation, operation, maintenance and upgrade costs.

## **Points to be considered while evaluating the cost of Green**

### **Buildings:**

- The best practice to evaluate various sustainability measures is to perform a Life Cycle cost analysis. For example solar water heater may add an initial cost but will reduce the energy bills over the life of the solar water system.
- Have sufficient contingencies for R&D to evaluate various options
- Have an experienced sustainability or Green Building consultant. Often fee paid Green Building consultants are only a small portion of savings they have generated.

### **The following are key findings of David Langdon in his paper**

***“Cost of Green Revisited: Reexamining the Feasibility and Cost Impact of Sustainable Design in the Light of Increased Market Adoption”:***

1. Many projects are achieving LEED within their budgets and in the same cost range as non-LEED projects.
2. Construction costs have risen dramatically, but projects are still achieving LEED.
3. The idea that green is an added feature continues to be a problem.



## 9.2 Integrated Project Delivery

### Integrated Vs Conventional Project Delivery:

|                | Integrated Project Delivery  | Conventional Project Delivery  |
|----------------|--|--|
| Team           | Collaborative team: All the project team members work integrated to achieve the project sustainability goals   | Hierarchical: Team members work independently as required  |
| Project Phases | <p>Pre-design<br/>Design<br/>Bidding<br/>Construction<br/>Commissioning<br/>recommissioning</p> <p>All members of the project are involved from pre-design phase</p> <p>The project sustainability goals are identified in predefined and reviewed in each phase</p> <p>During recommissioning the systems are fine tuned to achieved to desired goals</p> | <p>Design<br/>Bidding<br/>Construction<br/>Commissioning</p> <p>Only required members are involved</p> |

## 9.3 LEED/ Green Building Chartee

LEED or Green Building Chartee is a type of workshop where the project team members brain storm, collaborate and set project goals, discuss strategies to sustainability goals. Strategies for each prerequisite/credit their synergies and tradeoff are discussed by project team in LEED Chartee to arrive at a final decision.

The free online version of this chapter is available at:  
<http://learning-green.com/chapter-9-green-building-project-management/>

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## List of Standards & Reference – A quick review chart

| Standard / Reference  | Related Credit / Prerequisite     | Description  |
|---|-----------------------------------|--|
| <b>Sustainable Site</b>   |                                   |  |
| EPA(Environmental Protection Agency)2003                        | Construction Pollution Prevention | Provides Guidelines for preparation of Erosion and Sedimentation Control plan to comply with <b>National Pollutant Discharge Elimination Scheme(NPDES)</b> |
| U.S. Department of Agriculture(USDA)                            | Site Selection                    | Defines Prime Agricultural Land  |
| Federal Emergency Management Agency, (FEMA)                     |                                   | Addresses flood elevation  |
| U.S. Code of Federal Regulations - Definition of Wetlands (CFR) |                                   | Defines Wet land   |
| California Air Resources Board (CARB)                           | Alternate Transportation          | Defines Zero-Emission Vehicle (ZEV)  |

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| American Council for an Energy-Efficient Economy (ACEEE)                       |   | Defines Fuel Efficient Vehicle  |
| ANSI/ASHRAE/IESNA Standard 90.1-2007   | Light Pollution   | Standard for Energy Efficiency except low rise residential buildings                          |
| Water Efficiency   |   |   |
| Energy Policy Act (EPA) of 1992  | Water use reduction and innovative waste water technologies | Provides the baseline flow rate for fixtures.   |
| Energy Policy Act (EPA) of 2005  |   | EPA Act became a law  |
| IPC/UPC 2006   |   | Provides the baseline flow rate for commercial faucets  |
| Water Sense  |   | Third Party Certification of water efficient fixtures   |
| Energy & Atmosphere  |   |   |
| ANSI/ASHRAE/IESNA Standard 90.1-2007   | Fundamental and Optimize Energy Performance                 | Standard for Energy Efficiency except low rise residential buildings                          |
| Center for Resource Solutions, Green-e Product Verification Requirements (CRS) | Green Energy  | Green e is the voluntary certification and verification program for Renewable energy products |
| Montreal Protocol  | Fundamental & Enhanced Refrigerant Management               | International Protocol to reduce Ozone Depletion  |
| International Performance Measurement for Verification Protocol,               | Measurement and Verification                                | IPMVP provides concise description of best practice techniques for                            |

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| Jan. 2006 (IPMVP)  |  | verifying energy performance  |
| <b>Materials &amp; Resources</b>   |  |   |
| International Organization for Standardization (ISO) 14021-1999            | Recycled Content                                   | Recycled content is defined in accordance with the International Organization of Standards document, ISO 14021  |
| Forest Stewardship Council FSC Certified Wood                              | Certified Wood                                     | FSC is a seal of approval awarded to forest managers who adopt environmentally and socially responsible forest management practices and to companies that manufacture and sell products made from certified wood. |
| ASHRAE Standard 62.1-2007<br>Ventilation for Acceptable Indoor Air Quality | Minimum Indoor Air Quality & Increased Ventilation | This standard specifies minimum ventilation rates and IAQ levels so as to reduce the potential for adverse health effects.  |
| Sheet Metal and Air Conditioning Contractors Notional Association (SMACNA) | Indoor Air Quality Management                      | SMACNA is an international organization that developed guidelines for maintaining healthful   |

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|  |   | indoor air quality during demolitions, renovations, and construction.   |
| ANSI / ASHRAE 52.2-1999  | Indoor Air Quality Management & Indoor Pollutant & Source Control | This standard presents methods for testing air cleaners for 2 performance characteristics: the device's capacity for removing particles from the air stream and the device's resistance to airflow. |
| ANSI / ASHRAE 55-2004  | Thermal Comfort   | ASHRAE 55–2004 identifies the factors of thermal comfort and the process for developing comfort criteria for a building space and its occupants   |
| South Coast Air Quality Management District (SCAQMD) Rule 1168, Jan. 2005                            | Low Emitting Materials  | Sets VOC limits for sealants and adhesives  |
| Carpet and Rug Institute (CRI) Green Label – Carpet Cushion & adhesives<br>Green Label Plus – Carpet |   | CRI has established the Green Label program to test for VOCs in cushion used under carpet<br>Green Label Plus is an independent testing program that identifies                                     |

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|   |  | carpet and carpet adhesive with very low emissions of VOCs to help improve indoor air quality   |
| <p>Green Seal Standard GS-36 sets VOC limits for commercial adhesives</p> <p>GS -11 Commercial flat and non flat Paints</p> <p>GC-03 sets VOC limits for anti-corrosive and anti-rust paints.</p> |  | <p>Green Seal is an independent, nonprofit organization that strives to achieve a healthier and cleaner environment by identifying and promoting products and services that cause less toxic pollution and waste, conserve resources and habitats, and minimize global warming and ozone depletion.</p> |
| FloorScore Program  |  | <p>FloorScore is a voluntary, independent certification program that tests and certifies hard surface flooring and associated products for compliance with criteria adopted in California for indoor air emissions of VOCs with potential health effects</p>  |

## List of Prerequisites & Credits eligible for Exemplary Performance

There are few questions in Green Associate exam on prerequisites exemplary performance the table below summarizes the list of prerequisites and list of credits eligible for exemplary performance

| S. No                    | Credit/ Prerequisite                                    | Prerequisite | Exemplary Performance |
|--------------------------|---|--------------|-----------------------|
| <b>Sustainable Sites</b> |   |              |                       |
| <b>1</b>                 | <b>Construction Pollution Prevention</b>                | ✓            |                       |
| 2                        | Site Selection  |              |                       |
| <b>3</b>                 | <b>Development Density &amp; Community Connectivity</b> |              | ✓                     |
| <b>4</b>                 | <b>Brownfield Development</b>                           |              | ✓                     |
| <b>5</b>                 | <b>Alternate Transportation</b>                         |              | ✓                     |
| <b>6</b>                 | <b>Storm water Quantity and Quality Control</b>         |              | ✓                     |
| <b>7</b>                 | <b>Heat Island Roof &amp; Non Roof</b>                  |              | ✓                     |



|                                |                                    |   |   |
|--------------------------------|------------------------------------|---|---|
| 8                              | Light Pollution Reduction          |   |   |
| <b>Water Efficiency</b>        |                                    |   |   |
| 1                              | Water use reduction – 20%          | ✓ |   |
| 2                              | Water efficient landscaping        |   |   |
| 3                              | Water use reduction                |   | ✓ |
| 4                              | Innovative waste water technology  |   | ✓ |
| <b>Energy &amp; Atmosphere</b> |                                    |   |   |
| 1                              | Fundamental Commissioning          | ✓ |   |
| 2                              | Minimum Energy Performance         | ✓ |   |
| 3                              | Fundamental Refrigerant Management | ✓ |   |
| 4                              | Optimize Energy Performance        |   | ✓ |
| 5                              | Enhanced Commissioning             |   | ✓ |
| 6                              | Enhanced Refrigerant Management    |   |   |
| 7                              | Onsite Renewable Energy            |   | ✓ |

|                                     |  |   |   |
|-------------------------------------|--|---|---|
| 8                                   | Measurement & Verification                     |   |   |
| 9                                   | Green Energy                                   |   | ✓ |
| <b>Materials &amp; Resources</b>    |  |   |   |
| 1                                   | Storage and Collection of Recyclable Materials | ✓ |   |
| 2                                   | Building Reuse                                 |   |   |
| 3                                   | Construction Waste Management                  |   | ✓ |
| 4                                   | Material Reuse                                 |   | ✓ |
| 5                                   | Recycled Content                               |   | ✓ |
| 6                                   | Regional Materials                             |   | ✓ |
| 7                                   | Rapidly Renewable Materials                    |   | ✓ |
| 8                                   | FSC Certified Wood                             |   | ✓ |
| <b>Indoor Environmental Quality</b> |  |   |   |
| 1                                   | Minimum Ventilation                            | ✓ |   |
| 2                                   | Environmental Tobacco Smoke Control            | ✓ |   |
| 3                                   | Outdoor Air Monitoring                         |   |   |

|   |  |  |   |
|---|--|--|---|
| 4 | IAQ Management – During Construction & Before occupancy  |  |   |
| 5 | Indoor Pollutant Source Control                          |  |   |
| 6 | Low Emitting Materials                                   |  |   |
| 7 | Thermal Comfort – Design, Verification & Controllability |  |   |
| 8 | Controllability of Systems – Lighting                    |  |   |
| 9 | <b>Day Light &amp; Views</b>                             |  | ✓ |