Abstract

An important environmental problem today, is the depleting energy resources and the increasing levels of pollution in the environment. The reason behind exhausting natural resources is the fact that they are limited. The increase in the level of pollution is because of the growth in the economy, which in turn triggers the industry. Thus, several agencies are striving to regulate the growth process in an economical (in terms of resources) and in an eco-friendly manner.

Buildings account for 39.4 percent of total energy consumption, 67.9 percent of the total electricity consumption, and 60 percent of the total non-industrial waste in the United States (USEPA 2004). Thus, improving energy efficiency and reducing waste will have significant contribution towards improving the environment quality. The United States Green Building Council (USGBC) is one of the organizations, which is a leader in implementing environment friendly and economical energy utilization solutions to the building industry in the form of systems like LEED™. Leadership in Energy and Environmental Design (LEED) is a grading system to acknowledge and promote the construction conforming to the green building guidelines. This final exam will try to briefly give an overview of the implementation of LEED system in the industry.

Keywords: LEED, USGBC, Green Buildings, Overview

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1. Introduction

The construction industry has shown a sustained growth over the years. It grew by 4.7% in the year 2006 as compared to 2005, reaching a total gross value of $1,180 billion (Datamonitor 2007). The construction industry has a significant representation in the US economy. Turning construction industry green will result in an industry–wide impact. The United States Green Building Council is an agency which has successfully established its leadership in promotion of green buildings by introduction of LEED rating system (USGBC 2007). LEED is a rating system based on apportioning points for satisfactory execution of set guidelines. The system has to be adopted from the design phase and throughout the execution phase. It addresses various environmentally harmful and energy consuming activities and utilities. LEED influences the optimum utilization of the natural resources. It encourages re-use or proper disposal of waste materials without affecting the surroundings. Human factors also play an important role in design of green buildings. LEED certification includes provision of pleasant and suitable environment for personnel to enhance vigil and enthusiasm (USGBC 2003b). Thus, it increases productivity in terms of energy efficiency and labor.

This final exam will provide an overview on the LEED system, its requirements and benefits. It will explain the function and structure of LEED rating system. It will briefly enlist various types of LEED based on the level of compliance to the guidelines and industry-type classification. It will focus primarily on the guidelines for “LEED for New Construction or Major Renovation” to give an idea of the functional requirements of LEED. It will then conclude with a first cost meta-analysis, benefits, and a look at the future prospects of LEED.

Background

To understand the origin of USGBC and LEED one must learn about the need for the green buildings and authorities governing the rules for declaring a structure to be sustainable in terms of energy and environmental design. The statistics show the impact of the building industry on the total resource consumption and waste byproduct contribution towards the environment.

This is a single segment of the industry consuming and contributing the major portion of the resources and waste products respectively. The significant representation by the building industry brings the spotlight on itself whenever resource depletion and environmental degradation concerns are raised. The result is the formation of bodies that promote and regulate environment friendly buildings, termed as green buildings. The United States Green Building Council (USGBC), founded in 1993, is one of the non-profit organizations providing the construction industry with the platform to bring about a change in the profile of the construction industry. USGBC and similar organizations play the role of guiding the elements of the industry to build green buildings. The success of the organization is reflected through the growth in its member companies and member organizations. The commanding principles of this organization are governed by the industry leaders in all the fields through participation in the USGBC committee for the LEED rating system (USGBC 2007).

Table 1: Resource consumption and waste generation from buildings

Resource	Percent consumption
Electricity	68%
Fresh water supplies	12%
Potable water supplies	88%
Raw materials	40%

Waste byproducts	Percent contribution
Municipal solid waste stream	33%
Carbon dioxide emissions	36%
Sulfur dioxide emissions	46%
Nitrogen oxide emissions	19%
Particulate matter generation	10%

Source: (USGBC 2003a)

A consortium of construction industry elements viz., builders, material suppliers, architects, engineers, and other role players came forward to support the origin of a formal guiding structure for the implementation of green building certification. The building codes originally compelled most regulations and some guidelines were from systems like Energy Star[1], or ASHRAE[2] guidelines; which were already functioning in the industry. The drawback of some of the systems was that they focused on individual elements of various industries. For instance Energy Star rating was concerned only with the efficiency in the use of energy in all types of structure. The group felt the need for an all encompassing structured system in order to focus primarily on the construction industry. In the year 1998 the first LEED pilot program was launched. Originally the program was suited for only new construction but it is addressing various other aspects of the industry.

What is LEED® rating system?

[1] Energy Star is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy helping us all save money and protect the environment through energy efficient products and practices. Source: Energy Star
Website: http://www.energystar.gov/index.cfm?c=about.ab_index

[2] ASHRAE – The American Society of Heating, Refrigeration, and Air-conditioning Engineers

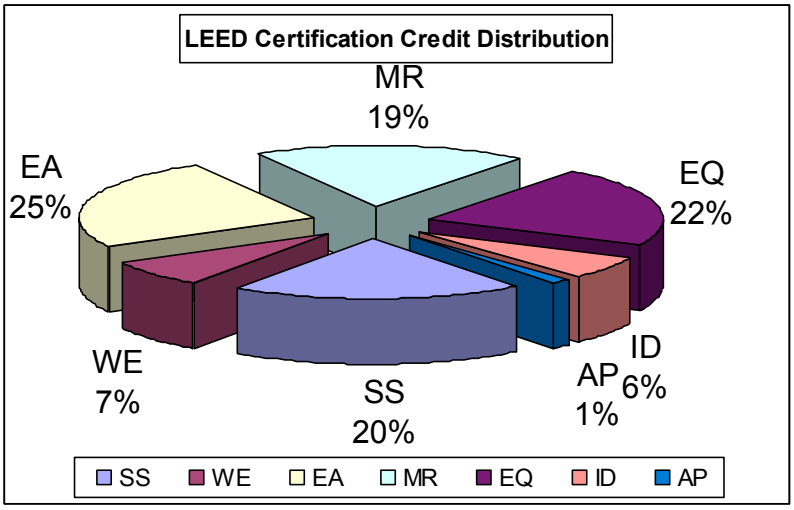
Leadership is Energy and Environmental Design (LEED™) is a certification system to provide the industry elements with a measuring system to define their projects as Green Buildings. USGBC defines green buildings as follows: "*Green buildings are designed to significantly reduce or eliminate the negative impact of buildings on the environment and on the building occupants, green building design and construction practices address: sustainable site planning, safeguarding water and water efficiency, energy efficiency, conservation of materials and resources, and indoor environmental quality"* – (USGBC 2003b). It offers economical efficiency in the long term for an initial investment. Although it is true that not all green building implementations require an initial cost. LEED is a great tool to grade the quality of a green building. It is a cradle to the grave approach in terms of judging the efficiency of energy utilization and conservation of surroundings. The above statement justifies itself due to the LEED certification is an all encompassing criterion to fulfill its grade point system. It begins with the designing and site selection phase into the execution phase and oversees the operation phase. Detailed instructions are provided in the LEED reference packages for every criteria.

Following are the LEED credit categories are quoted from the "*LEED Reference Package For New Construction & Major Renovations*":

- Sustainable Sites (SS)
- Water Efficiency (WE)
- Energy and Atmosphere (EA)
- Materials and Resources (MR)
- Indoor Environment Quality (EQ)
- Innovation in Design Process (ID)

The section "Requirements of LEED" will provide a summary of LEED guidelines from the evaluation aspect of LEED certification. Figure 1 shows the distribution of points among the categories of LEED rating system.

Figure 1: LEED Certification Credit Distribution for LEED – NC



Source: (USGBC 2005)

The buildings are classified on the basis of a points system. The rank is conferred upon a building according to the score achieved by the project. LEED certification system has credit categories which groups together various guidelines or requirements with similar focus. Individual requirements have points associated with them. Each point is achieved by fulfilling the expectations of the guidelines set out by the LEED certification system. Table 2 lists the certification levels and the required score range to satisfactorily achieve LEED certification.

Table 2: Certification Levels for LEED – NC based on points

Certification Level	Points
Certified	26 – 32
Silver	33 – 38
Gold	39 – 51
Platinum	52 – 69[4]

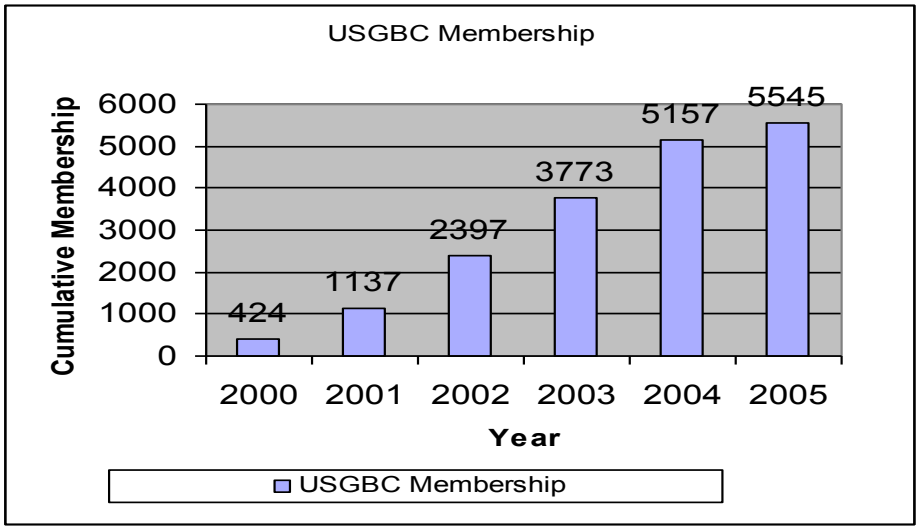
Source: (USGBC 2007)

[4] The maximum points possible according to the LEED NC certification system is sixty nine points

Current Scenario

USGBC has seen a constant growth in its membership. This reinforces the fact that green buildings are being accepted and confirms the industry support through participation of diverse elements. Figure 2 shows the cumulative growth of USGBC membership over the past few years.

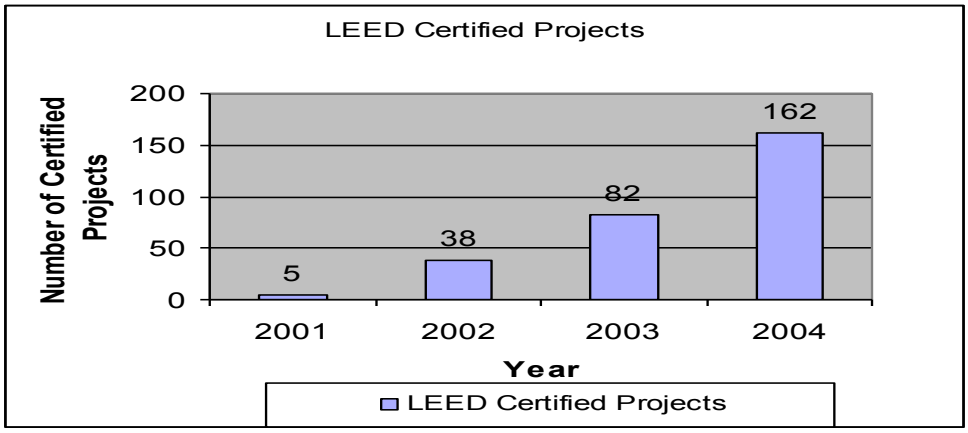
Figure 2: Growth of the USGBC Membership



Source: (Cassidy 2003; USGBC 2006)

Any project to aiming to get LEED certification must be registered with USGBC. Registration initiates the certification process by allowing access to the LEED's online support and credit interpretation database, along with project review and record for future reference. LEED certification means the satisfactory completion of the requirements for the obtained level of certification. There has been a rapid increase in the number of LEED certified projects which only shows increasing industry awareness. Figure 3 shows the increase in the number of certified project from the year 2001 to 2004. But, it is not a supporting evidence of the increase in the number of green buildings as a registered building does not necessarily get certified. For instance, in the year 2004 the number of registered project is about ten times the number of the certified projects (USGBC 2006).

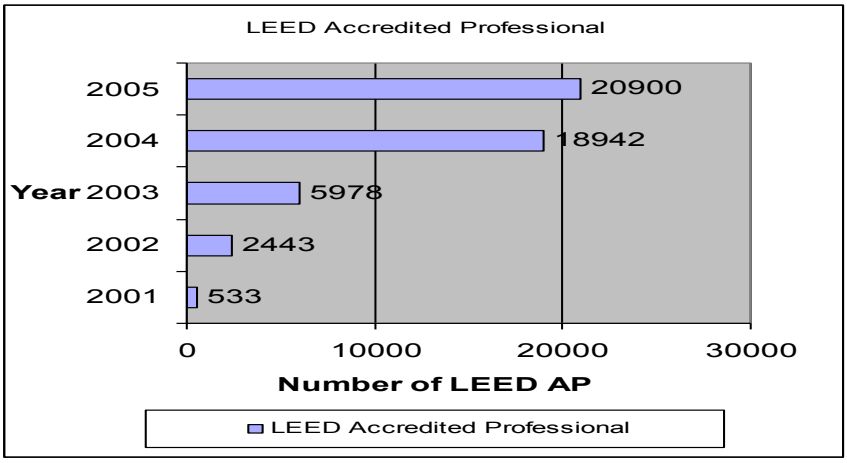
Figure 3: Increase in the number of LEED Certified projects



Source: (Cassidy 2003)

Figure 4 shows the cumulative number of LEED accredited professionals from the year 2001 to 2005. The significant rise in the number of LEED Accredited Professionals shows the acceptance of the LEED system amongst construction professionals. The number of LEED AP may also be increasing to satisfy the credit for having a LEED AP on the project team.

Figure 4: Rapid increase in the number of LEED Accredited Professionals



Source: (Cassidy 2003; USGBC 2006)

Types of LEED rating systems

Primarily building construction industry is composed of residential, commercial and industrial segments. Construction, operation, maintenance, and repairs are the phases of the lifecycle of a building that physically produce waste and consume resources. LEED system attempts to implement green building principles right from the conceptualization phase to reduce or eliminate environmental impacts. The first product launched by USGBC is LEED for New Construction & Major Renovations (LEED–NC). It is specifically designed for new projects being registered to be acknowledged as green buildings.

In order to cater to the differences in various sectors of the construction industry, USGBC has introduced different types of LEED rating system. Each system attempts to best suit the industry requirements it has been designed for (Nilson 2005; USGBC 2007). Although, most developed and oldest among them is LEED-NC, which is a primary reason for this final exam to focus on it. The currently marketed rating systems and pilot programs are as follows (USGBC 2007).

- New Construction & Major Renovations: LEED-NC (Version 2.2)
- Existing Buildings: LEED-EB (Version 2.0)
- Commercial Interiors: LEED-CI (Version 2.0)
- Core & Shell: LEED-CS (Version 2.0)
- Homes: LEED-H (Pilot Rating System Version 1.72)
- Neighborhood Development: LEED-ND (Pilot[5] Program to be launched)

Each system has different set of credit requirements specific to the type of structure being addressed. This final exam will discuss LEED NC requirements in order to give an idea of the expectations of LEED system and the environmental benefits associated with it. LEED NC is the oldest and the most developed among the LEED rating systems.

[5] Pilot program is the initial phase of launching a LEED rating system and is a test run for selected new participants for that system

2. Requirements of LEED

LEED certification is not a mandatory system that has to be followed by every individual project. An owner and/or contractor, who is constructing or maintaining a facility and has a policy to construct a green building, have to volunteer to get LEED certified. Some buildings are exception to this as the owner mandates construction of LEED certified building viz., U.S. Army and many government agency buildings. To obtain a LEED certification there is a set of guidelines that must be observed, documented, and submitted for review. On approval of satisfactory completion of the project in terms of addressing the attempted credits by USGBC, certification is granted.

Initially, a project has to be registered with the USGBC, which is mandatory if the project aims to be LEED certified (USGBC 2007). Applicable list of requirements must be obtained from USGBC which will be observed in the project. Points are conferred upon the project on the complete review of the submitted documents. Although, there are no points imparted for the implementation of pre-requisites but it is mandatory to fulfill them in order to attempt specific credits. The sum of the points obtained defines the type of certification viz., Certified, Silver, Gold, and Platinum. Refer to Table 2 for the grading range for the various levels of certification. It is also required that a specified documentation format should be followed and the documentation be submitted to the authorized professional for the review, which is USGBC.

This section will attempt to give a brief idea of the individual credits that can be achieved for LEED certification. The following tables (from pages 10 – 18) list the credits and their intent, to show the environmental impact and resource consumption by a building, addressed by LEED certification process. This section does not attempt to provide a manual for LEED NC. It only attempts to give an introduction to the credits for LEED NC certification. To learn about the detailed requirements for LEED certification it is recommended that the USGBC published online document must be referred to at following URL:
(https://www.usgbc.org/FileHandling/show_general_file.asp?DocumentID=1095.)

Sustainable Sites (SS)

This category of credits has a prerequisite[7] that must be fulfilled in order to attempt any points from the SS category. SS criterion is worth 14 points which is more than one-fifth the total points possible. Please refer to Table 3 for the list of credits, associated points, and the intent of each credit.

Table 3: Sustainable Sites for LEED NC

No.	Title	Points	Intent
Prereq 1	Construction Activity Pollution Prevention	Required	Reduction in the pollution due to the construction activities by controlling erosion of soil, sedimentation in drainage and dust in air
Credit 1	Site Selection	1	Avoid the development of an inappropriate site and reduction in the environmental impact due to the location of a building on a site
Credit 2	Development Density & Community Connectivity	1	Guide the development towards urban areas with existing infrastructure in order to preserve greenfields and natural habitats
Credit 3	Brownfield[8] Redevelopment	1	Rehabilitate the sites that are contaminated or used to preserve greenfields
Credit 4.1	Alternative Transportation, Public Transportation Access	1	Reduce the impact of automobile usage in the form of pollution and land development
Credit 4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	1	
Credit 4.3	Alternative Transportation, Low-Emitting and Fuel-Efficient Vehicles	1	
Credit 4.4	Alternative Transportation, Parking Capacity	1	Reduce the impact of single occupancy vehicle usage in the form of pollution and land development

[7] Prerequisite is a requirement that must be fulfilled but no points are awarded towards its completion
[8] `brownfield site' means real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant (definition by Environmental Protection Agency from the website http://www.epa.gov/brownfields/glossary.htm)

Table 3: Sustainable Sites for LEED NC (continued)

No.	Title	Points	Intent
Credit 5.1	Site Development, Protect of Restore Habitat	1	Preserve greenfields and restore damaged areas to provide a natural habitat
Credit 5.2	Site Development, Maximize Open Space	1	Provide a high ratio of vegetated open space to promote natural habitat
Credit 6.1	Stormwater Design, Quantity Control	1	Promotes the increase in the onsite infiltration and use of the stormwater and reduction in the stormwater runoff to prevent pollution and eliminate contaminants
Credit 6.2	Stormwater Design, Quality Control	1	
Credit 7.1	Heat Island Effect, Non-Roof	1	Reduce the heat islands to minimize the effect of temperature gradients between developed and undeveloped areas on the surrounding environment and its inhabitants for non-roof surfaces.
Credit 7.2	Heat Island Effect, Roof	1	Reduce the heat islands to minimize the effect of temperature gradients between developed and undeveloped areas on the surrounding environment and its inhabitants for roof surfaces
Credit 8	Light Pollution Reduction	1	Minimize the impact of light from the building and the site on the surrounding in terms of sky-glow reduction, impact on night-time visibility due to glare and impacts on the nocturnal environments

Source: (USGBC 2005)

Water Efficiency (WE)

Water efficiency has a total of 5 points. All these points are awarded towards the efficient utilization or the conservation of the use of potable water. Please refer to Table 4 for the list of credits and their respective points and intent.

Table 4: Water Efficiency (WE)

No.	Title	Points	Intent
Credit 1.1	Water Efficient Landscaping, Reduce by 50%	1	Reduce the use of potable or other natural resources of water available on the site for the purpose of landscape irrigation
Credit 1.2	Water Efficient Landscaping, No Potable Use or No Irrigation	1	Eliminate the use of potable or other natural resources of water available on or near the site for the purpose of landscape irrigation
Credit 2	Innovative Wastewater Technologies	1	Reduce the consumption of potable water for sewage conveyance by using water efficient systems or by reuse of treated sewage water
Credit 3.1	Water Use Reduction, 20% Reduction	1	Improve the efficient use of water within buildings to reduce the consumption of municipal water supply and reduce the waste water generation.
Credit 3.2	Water Use Reduction, 30% Reduction	1	

Source: (USGBC 2005)

Energy and Atmosphere (EA)

EA category is worth 17 points; which is almost 25% of the total points possible. Please refer to Table 5 for the list of credits and their respective points and intent.

Table 5: Energy and Atmosphere (EA)

No.	Title	Points	Intent
Prereq 1	Fundamental Commissioning of the Building Energy Systems	Required	Verification of the conformance of installation, calibration and performance of the energy related systems to the owner's requirements, basis of design, and construction documents.
Prereq 2	Minimum Energy Performance	Required	To achieve the minimum level of efficiency in energy consumption for the proposed building and systems installed
Prereq 3	Fundamental Refrigerant Management	Required	Eliminate the use of CFC-based refrigerants and
Credit 1	Optimize Energy Performance (Refer to Table 13for the detailed points schedule in Appendix 2)	1 to 10	Increasing the level of efficiency of energy use above the prerequisite standard in order to reduce the impact of excessive energy use on the environment and economy
Credit 2	On-Site Renewable Energy (Refer to Table 14for the detailed points schedule in Appendix 2)	1 to 3	Promoting the increase in the use of renewable energy resources to reduce the impact of fossil fuel energy resources
Credit 3	Enhanced Commissioning	1	To commence the commissioning early in the design process
Credit 4	Enhanced Refrigerant Management	1	To reduce the ozone layer depletion and early compliance to Montreal protocol to minimize the direct contribution of the building to the global warming
Credit 5	Measurement & Verification	1	To measure and verify the energy consumption by the building over time
Credit 6	Green Power	1	To promote the use of renewable energy to partially replace conventional energy by Green power

Source: (USGBC 2005)

Materials and Resources (MR)

There are 13 possible points that can be earned under the MR category. Please refer to Table 6 for the list of credits and their respective points and intent.

Table 6: Materials and Resources (MR)

No.	Title	Points	Intent
Prereq 1	Storage & Collection of Recyclables	Required	Facilitate the collection of recyclable materials and their processing in order to reduce the waste that is dumped into the landfills
Credit 1.1	Building Reuse, Maintain 75% of Existing Walls, Floors & Roof	1	To reuse the structural elements of the building in order to avoid consumption of new resources and its environmental impact, including the impact due to its transportation
Credit 1.2	Building Reuse, Maintain 95% of Existing Walls, Floors & Roof	1	
Credit 1.3	Building Reuse, Maintain 50% of Interior Non-Structural Elements	1	To reuse the non-structural elements of the building in order to avoid consumption of new resources and its environmental impact, including the impact due to its transportation
Credit 2.1	Construction Waste Management, Divert 50% from Disposal	1	Prevent disposal of construction, demolition, and land-clearing debris in landfills by redirecting them to recycling process or material reuse sites
Credit 2.2	Construction Waste Management, Divert 75% from Disposal	1	
Credit 3.1	Materials Reuse, 5%	1	Reuse of material and products in order to avoid the environmental impact of the use of virgin materials and reduction in the waste due to the reusable materials
Credit 3.2	Materials Reuse,10%	1	

Table 6: Materials and Resources (MR) (continued)

No.	Title	Points	Intent
Credit 4.1	Recycled Content, 10% (post-consumer + ½ pre-consumer)	1	Promote the use of recycled materials or materials having recycled content in order to avoid the environmental impacts of the virgin materials
Credit 4.2	Recycled Content, 20% (post-consumer + ½ pre-consumer)	1	
Credit 5.1	Regional Materials, 10% Extracted, Processed & Manufactured Regionally	1	To support the use of indigenous resources and prevent the environmental impact resulting from the transportation of the goods from farther distances
Credit 5.2	Regional Materials, 20% Extracted, Processed & Manufactured Regionally	1	
Credit 6	Rapidly Renewable Materials	1	Promoting rapidly renewable materials to replace depleting resources or resources with finite supply
Credit 7	Certified Wood	1	Promote the use of wood based materials and products which are obtained in conformance with the Forest Stewardship Council's (FSC) principles and criteria.

Source: (USGBC 2005)

Indoor Environmental Quality (EQ)

LEED has imparted to the EQ category a total of 15points; which is more than one-fifth the total points possible. Please refer to Table 7 for the list of credits and their respective points and intent.

Table 7: Indoor Air Quality (EQ)

No.	Title	Points	Intent
Prereq 1	Minimum IAQ Performance	Required	Minimum requirements of building codes and/or ASHRAE 62.1-2004 must be adopted to provide a comforting environment to the occupants
Prereq 2	Environmental Tobacco Smoke (ETS) Control	Required	Minimize the exposure of Environmental Tobacco Smoke (ETS) to the building occupants, indoor surfaces and air ventilation system
Credit 1	Outdoor Air Delivery Monitoring	1	Air ventilation monitoring system to keep a check on the air quality
Credit 2	Increased Ventilation	1	Increase the rate of ventilation to be greater than mandated by the Prerequisite 1 in order to provide better air quality to the occupants
Credit 3.1	Construction IAQ Management Plan, During Construction	1	Reduce the Indoor Air Quality problems during construction or renovation activities to provide a healthier environment to the workers and existing occupants during the construction and occupancy
Credit 3.2	Construction IAQ Management Plan, Before Occupancy	1	
Credit 4.1	Low-Emitting Materials, Adhesives & Sealants	1	The intent of this credit is to reduce the quantity of the indoor air contaminants which are odorous, irritating to the health and comfort of the installers and occupants
Credit 4.2	Low-Emitting Materials, Paints & Coatings	1	
Credit 4.3	Low-Emitting Materials, Carpet Systems	1	
Credit 4.4	Low-Emitting Materials, Composite Wood & Agrifiber Products	1	

Table 7: Indoor Air Quality (EQ) (continued)

No.	Title	Points	Intent
Credit 5	Indoor Chemical & Pollutant Source Control	1	To minimize the exposure of the building occupants to hazardous particulates and chemical pollutants
Credit 6.1	Controllability of Systems, Lighting	1	To allow controllability of the lighting systems for the individual spaces or for multi-occupant spaces to promote the productivity and health of the occupants
Credit 6.2	Controllability of Systems, Thermal Comfort	1	To allow controllability of the thermal comfort systems for the individual spaces or for multi-occupant spaces to promote the productivity and health of the occupants
Credit 7.1	Thermal Comfort, Design	1	To provide a comfortable thermal environment that is conducive to the productivity and health of the building occupants
Credit 7.2	Thermal Comfort, Verification	1	To check the effectiveness of the Credit 7.1 over time to know if there is a need for improvement or correction in the designed system
Credit 8.1	Daylight & Views, Daylight 75% of Spaces	1	To provide occupants with daylight and outdoor views in the regularly occupied areas
Credit 8.2	Daylight & Views, Views for 90% of Spaces	1	

Source: (USGBC 2005)

Innovation and Design Process (ID)

ID bears 5 possible points. Four points are awarded for innovation in design to exceed the requirements of LEED NC and one point is granted if a LEED AP is on the project team. Please refer to Table 8 for the list of credits and their respective points and intent.

Table 8: Innovation in Design (ID)

No.	Title	Points	Intent
Credit 1.1	Innovation in Design	1	To provide an opportunity to reward points for exceptional performance above the requirements set out by LEED NC Green Building Rating System
Credit 1.2	Innovation in Design	1	
Credit 1.3	Innovation in Design	1	
Credit 1.4	Innovation in Design	1	
Credit 2	LEED® Accredited Professional	1	To assist the LEED application, documentation, and certification process and encourage the design integration required by LEED-NC green building project

Source: (USGBC 2005)

3. Cost of LEED

In order to have a LEED certified project, it needs to be registered to the LEED authorities i.e. with the USGBC. LEED certification has some initial cost for registration. Table 9 provides the information about the fees that are involved in registering a project. Companies attempting LEED certification may appoint a third party[15] LEED consultant. Such arrangements add to the cost of implementation of LEED system on a project as there will be a fee associated with consultation services. LEED AP exam registration costs two hundred and fifty dollars for members of USGBC and three hundred and fifty dollars for non-members. Membership fees vary according to the organization category and gross sales of the organization (USGBC 2007). Refer to the Appendix 1 for the detailed sheet of the membership rates to get an idea of their varying nature of membership fees.

Membership has its own set of advanced benefits. Although, everyone does not pursue green building for the stated benefits, as sometimes it is for political or marketing purposes instead. (Schendler and Udall 2005). Although registering a project has its own set of costs and an additional fee must be paid to get the project certified. Table 9 and Table 10 show the rates for the registration and certification of the project respectively. Certification fees vary as per the size of the project.

Significant first costs are involved for a green building project for design, fabrication, and construction. Green buildings are a fairly recognized concept but it still has not become a routine procedure. Most of the green building systems are to be researched and designed before they can be implemented. Since it is only a fraction of the building industry resorting to LEED certification, there is a low demand for green products. Since the demand is low and the systems are not mass produced as compared to their conventional counterparts, they turn out to be expensive. The amount of man-hours spent in the design and installation phase are a major part of the initial cost. Above all there is a significant

[15] Third-party in the above context means an external entity which is not associated with the owner or USGBC but hired by the owner to assist certification process

uncertainty of the materialization of all the investments. For instance, if a design model is prepared to project energy savings in a project. It will require human resources and technology costs. Upon the investment, if it turns out that the model is not acceptable by the commissioning authority then all the time and resources spent in lieu of the same are wasted.

Table 9: LEED registration fees

Registration Fees

Charges	**Fixed Rate**
Members	$450
Non-Members	$600

Source: (USGBC 2007)

Table 10: LEED certification fees

Type of Certification	**Less than 50,000 Square Feet**	**50,000 - 500,000 Square Feet**	**More than 500,000 Square Feet**
LEED-NC, LEED-CI, & LEED-CS	**Fixed Rate**	**Based on Sq. Ft.**	**Fixed Rate**
Design Review			
Members	$1250	$0.025/Square Ft.	$12500
Non-Members	$1500	$0.03/Square Ft.	$15000
Construction Review			
Members	$500	$0.01/Square Ft.	$5000
Non-Members	$750	$0.015/Square Ft.	$7500
LEED-NC, LEED-CI, & LEED-CS	**Fixed Rate**	**Based on Sq. Ft.**	**Fixed Rate**
Combined Design & Construction Review			
Members	$1750	$0.035/Square Ft.	$17500
Non-Members	$2250	$0.045/Square Ft.	$22500
LEED-EB	**Fixed Rate**	**Based on Sq. Ft.**	**Fixed Rate**
Initial Certification Review			
Members	$1250	$0.025/Square Ft.	$12500
Non-Members	$1500	$0.030/Square Ft.	$15000

Source: (USGBC 2007)

Classification based on capital costs

There are variable costs associated with LEED credits and not all the credits actually demand any initial or long term costs. The LEED points can be divided into three categories based on the demand of investment for achieving points (Graham 2005). According to HO+K[16], the three categories can be termed as no or minimal capital cost, possible capital costs and probable capital cost. Minimal or no capital cost requirements do not demand a high initial investment. It can be achieved by good initial planning and design. Some points can be achieved by simply conforming to code. Possible and probable categories usually demand an initial cost for either design or fabrication. Possible cost category has a possibility for the mitigation of the capital costs. Knowledge of the increase in the capital cost is an essential factor that governs the feasibility of the project. The problem with variance costs is that many firms attempt to achieve the least cost implying credits first without the focus on the green impacts.

Minimal or no capital cost

The minimal or no initial cost credits are those which can be claimed merely by active designing and employing nominal cost equipment to serve the credit requirements. Credits can be claimed for selection of a sustainable site for location and even for proximity to public transports. Facilities like bicycle stand and shower rooms do not demand a high cost but award one credit. Thoughtful placement of light systems in order to avoid light pollution only involves initial planning. Improving the efficiency landscape irrigation system does not imply a high cost, instead it is beneficial by reducing the potable water consumption and the cost associated with it. Fulfilling some of the building code requirements are a pre-requisite for some of the credits. Even if they might endure any cost, it needs to be done with or without the aim of achieving LEED certification. Thus, the cost associated with such requirements should not be apportioned towards the LEED certification costs. Using existing materials and resources either from the vicinity

[16] Hellmuth Obata + Kassabaum (HO+K) is a design firm which recently won the commendation of being the organizational leader in sustainable design from USGBC

and or reusing materials from the site itself awards points. Reuse improves the efficiency of the project in terms of new material cost saving. The use of green materials such as low-emitting paints, carpets and other materials lead to certification of easily attainable points for minimal cost escalation of the project. The most common point in the LEED projects is appointment of a LEED AP[17] for the project registered for LEED certification (Cassidy 2003). These low-cost or no-cost certifications account for about 17 points and 3 prerequisites (Cassidy 2003; Graham 2005).

Possible capital cost

These credits pose a possibility of initial capital cost to obtain the points under this category. About 31 credits fall under this category. The rating that may fall into this category as per the various rating categories of LEED are illustrated below (Graham 2005).

- Sustainable Sites (SS)
  - Erosion and sedimentation control may incur procedural treatment costs.
  - Site selection in a high density area may incur higher premium on the land costs and even the construction cost due to site space constraints
  - Selecting a Brownfield site may cost demolition, hauling and cleanup costs. The site may even require treatment due to the changes in the surroundings after the construction of the previous structure.
  - Storm water management may incur additional storage space and construction costs. It will also require design cost to estimate volume of storage and its effective utilization.

- Energy and Atmosphere (EA)
  - The cost of installing new HVAC and safely disposing existing CFC may prove to be significant.

[17] LEED AP – LEED Accredited Professional

- Materials and Resources (MR)
  - Building core and wall reuse saves the cost and damage to environment from new material but it has its own treatment costs. Working with existing structure also poses a cost for time and custom designing.
  - Reuse of material may have storage, refurnishing and repair cost affiliated to it.
  - Recycling of goods may require a storage and dispatch system
  - Product research and demand premium is associated with the selection of regional resources and renewable materials subjected to its availability.

- Indoor Environment Quality (EQ)
  - In order to achieve maximum day light, additional expenses may be incurred in the design phase, material costs and installation costs. Usually glazing is the alternative to maximize natural light which may lead to a major cost escalation as compared to conventional design.

- Innovation in Design (ID)
  - It can lead to a myriad of reasons for costs due to research, design, material, fabrication, testing, modeling, legal certification, etc.,

Probable capital cost

These credits pose a probability of initial capital cost to obtain the points falling under this category. The reason for the uncertainty in capital cost is the fact that there are significant savings associated with the implementation of these credits. The credits that may very well fit in this section are illustrated below as per their LEED rating category classification (Graham 2005).

- Sustainable Sites (SS)
  - Installation of bike stands and shower rooms consume space. Costs can be associated with the use of space. The pay-off can be the savings in potential vehicle parking spaces and saving precious fuel.
  - Special roofing systems increase the capital cost in design, fabrication and installation. The future revenues generated are savings in the energy due to reduction in cooling need.

- Water Efficiency (WE)
  - Water use economization and waste water reuse require innovative systems which bear a research, design, testing and implementation cost. The payback is the reduction in the use of potable water resource.

- Energy and Atmosphere (EA)
  - Energy savings can be achieved by using energy efficient equipment or using alternative renewable resources. Both of the alternatives demand design and implementation costs. The only revenue being produced is the savings in the energy.
  - A credit point is achieved by monitoring of the use of energy which actually proves the effectiveness of the energy saving systems. It comes with design, installation and maintenance cost.
  - Using renewable resources and using the energy from green power resources has its unique premium costs.

- Indoor Environment Quality (EQ)
  - Carbon dioxide monitoring system has equipment cost associated with it.
  - Installing customizable controls for all the public and private spaces in order to provide controllable ambient environment for the individuals. This credit truly improves worker productivity but has planning, design and equipment cost associated with it.
  - Pollutant source monitoring and control system bring in the equipment and maintenance cost. It improves the worker health and productivity.

Meta-analysis of the Cost premium

This section will do a retrospective analysis of various LEED projects in order to analyze the cost of implementation of the certification criterion. It attempts to perform a Meta-analysis on the available data. The methodology for the study includes finding resources that represent the industry value of cost of LEED. Many articles are usually composed of the percent premium associated with LEED. The methodology for LEED cost data META-analysis can be summarized as follows:

- Find cost premium data and segregate them as per their level of certification
- Attempt to find the method of cost analysis
- State the base of the statistical analysis
- Post the cost premium in the form of percentage, if the data is not readily available in the percent form of cost premium
- Comment about the data

Following studies were observed to Meta-analyze the first cost data.

1. Green Building Costs and Financial Benefits (Kats 2003)

This is a report which aims to portray the average first cost premium of 25 office buildings and 8 school buildings. The first cost premium findings of this report are stated in Table 11 below. This study claims that earlier the green building principles are employed in the project the lower will be the first costs.

2. Green Building Costs and Financial Benefits (Kats 2004)

This is an updated report of (Kats 2003); wherein the study incorporates 40 buildings and analyses its first cost. The first cost findings are similar but slightly on the higher side.

3. GSA LEED Cost Study (SWA 2004)

This is a study by U. S. General Services Administration (GSA) for government buildings. This study is a hypothesis of the additional cost incurred for building green. This is an excellent resource as the baseline costs are of the conventional buildings whose data is readily available with GSA. The primary finding of this study is that there is no direct correlation between cost premium and number of points due to the presence of low cost or no cost achievable points. The study also reflects the first cost premium of the major renovation category of project but it is not used in the Meta-analysis of this final exam, keeping the prime focus on the new construction projects.

4. Greening America's Schools: Costs and Benefit (Kats 2006)

This study reports the cost data associated with thirty green built schools over ten states. The cost data has been collected from the actual construction for old construction and for new building modeling and design data has been obtained from the Architects and Engineers to find the cost premium. This study concludes that green buildings are more cost effective than going with the conventional option. Another important aspect of this study is that it incorporates the effect of time and location of the project when aggregating the findings.

5. Quantifying the Cost Impacts of LEED-NC Gold Const. in NYC (Nilson 2005)

This thesis is a comparison of two buildings in similar setting one of which procures a LEED gold certification and other is just built to code. The second building is used as a baseline to find the cost premium associated with LEED Gold certification. This thesis analyses the cost premium on the total cost of the entire project and also based only on the activities that involve green building principles. This thesis claims that the

premium of 0.82 percent over the guaranteed maximum price is small in magnitude and consistent with the other studies mentioned in the thesis.

Apart from the above studies there are several other studies that are available which show the cost benefit analysis of the projects. They have not been included in this final exam to limit the scope of this exam to an overview. This final exam only attempts to show the aggregate cost premiums associated with various levels of certification.

Please refer to Table 11 for the Meta-analysis data on page 28.

Meta-analysis Findings

- Platinum level certified buildings are very few in number and this may mislead the cost premium conclusions due to the scarcity of the data available.

- Office buildings show a cost premium for certified level of certification of around 0.66% for office buildings.

- The premium associated with the school buildings shoots up to twice that of office buildings for certified level buildings.

- LEED silver and gold show variation in the cost premiums which truly means that there are unique factors influencing even similar type of buildings to reflect on the cost premium. The Cost premium is a function of the associated green costs and the cost of conventional design. The two factors vary with time, place and size of the project. The listed projects in Table 11 have no similarities in terms of size, place and in most cases even time.

Inference

To draw any conclusions the congruence and substantial amount of data is required. The quantity of data available is extremely scarce in number to make firm conclusions. Apart from that it is required to apply corrections for time of construction, location and size of construction which are not considered in most of the studies used for Meta-analysis. To compare the above findings corrections will have to be applied to all the data available, which is beyond the scope of this final exam. The meta-analysis shows the characteristics of the possible research in the field of cost benefit analysis.

4. Benefits of LEED

LEED certification has numerous benefits that can be broadly classified as tangible and non-tangible benefits. Tangible benefits are quantifiable and usually reward the owner of the facility. The non-tangible assets may not be directly beneficial to the owner itself but it is a benefit associated with the people using the facility. Non-tangible benefits can be advantageous to the owner in case the owner itself is using the facility. For instance if a software firm owns and uses a facility which is LEED certified, the improved personnel productivity can be apportioned directly to the owner. In case an owner rents out such a facility, the non-tangible benefits will not be attributed towards the owner but it is very likely that the owner will charge a premium on the rent for such a facility. It should be noted that all the costs and direct or indirect benefits are considered over the lifespan of the building; unlike the initial cost premium associated with LEED certified buildings.

Tangible

Resource and, or monetary savings associated with LEED certified buildings can be termed as tangible benefits. Primary benefits observed in this category are energy, material and potable water savings. There is a direct cost associated with all the above resources and any savings not only benefit the consumer but it actually contributes towards a reduction in the use of non-renewable resources.

Energy Savings

LEED certified buildings reduce the energy consumption by at least 25-30% than conventional buildings which are built to code (Kats 2003; USGBC 2003a). Since LEED certification awards points directly for any design that increases the energy efficiency of the building and also requires minimum energy performance by complying to building

codes (USGBC 2005). Following criterion contribute to the energy savings in green buildings:

- Compliance to minimum energy consumption conforming to building codes
- Exceeding the energy consumption recommended by the code
- Use of renewable energy as an alternative for non-renewable energy
- Incentive associated with usage of green energy instead of conventional source of energy (Kats 2003; Payne and Dyer 2006)
- Lighting and temperature control reduces the wastage but involves an initial technology and equipment cost (USGBC 2003b; USGBC 2005)

Material Cost Savings

Satisfying credit requirements in Materials and resources category contribute to cost savings. Following strategies contribute to cost savings in the LEED certified projects:

- Construction waste management increases the salvage value of the project as it helps accrue the scrap metal and reusable material which have significant salvage value.
- Stress on the reuse of existing material reduces in the material procurement costs. Although there are costs associated in treatment and repair of the existing materials, for which an economical trade off has to be evaluated.
- Procuring materials from the local area reduces the cost of transportation and possible taxes

Potable water savings

Reducing the consumption of potable water by using renewable water resources or recycling water or improving water use efficiency leads to savings in the cost associated with the consumption of fresh municipal water supply.

Incentives

U.S. Government is very supportive of the concept and practice of Green buildings(Cassidy 2003; Payne and Dyer 2006). Many states try to promote green building initiative by offering benefits which are directly or indirectly monetary in nature(Cassidy 2003). Following are the forms of incentives provided by the government:

- Several local authorities confer a cash incentive to any LEED certified project; partially upfront and rest assigned when the certification process complete.
- Reduction in government fees for complying with specific level of certification viz., energy fee
- Tax credits are issued to LEED certified buildings subject to the significant in reduction of energy and resource consumption
- Bonus FAR ratio: (Arlington County, VA offers additional 0.25 FAR for LEED certification greater than Silver Level.)

Source: (Cassidy 2003)

Non-tangible

All the environmental benefits of LEED are non-tangible. The core motive of LEED certification of building is to reduce the impact building on the environment. Any reduction in consumption of non-renewable resources and pollution of the environment in

a direct or indirect manner which may not produce quantifiable benefits can be considered as non-tangible benefits. Major benefits under this category are as follows.

Environmental improvement

LEED is only a tool to distinguish green buildings from general buildings. There always have been green buildings even before LEED system was thought of. LEED acts as a point of reference for comparing environmental performance of different buildings. Savings today will ensure resource availability for tomorrow (Tseng et al. 2002). The section "Requirements of LEED" clearly enlists the environmental benefits LEED system provides. But, it is necessary to discuss the improvement in the work environment as well as a resultant rise in worker productivity.

Healthy environment

LEED certification requires elimination and safe decommissioning of CFC[18] in HVAC&R[19]. It reduces the ozone layer depletion. This is a global benefit of LEED. For this section the focus is on the benefits imparted to the actual owners and occupants of the facility. Following criterion are embedded in the fulfillment of LEED rating system that improves the internal environment of the building to benefit its inhabitants.

- Prerequisite demands for the Indoor Air Quality requirements be fulfilled as per the ASHRAE standards. Installation of regulation ventilation system provides the occupants with better air quality and healthy environment.
- Tobacco smoke impact is reduced by the LEED credit which attempts to block the ETS from entering the common areas and ventilation systems.
- Carbon Dioxide monitoring system warns about the composition of CO_2 in the air. Absence of fresh air causes uneasiness and general dissatisfaction. Monitoring

[18] Chlorofluorocarbons (CFC) are widely used in building industry as refrigerants and it causes ozone layer depletion
[19] HVAC&R is an acronym for heating, ventilating, air-conditioning, and refrigerating

carbon dioxide levels notifies the need for improving ventilation to maintain pleasant environment (Kats 2003; USGBC 2005).

- Use of low emitting materials viz., carpets, paints, etc. to prevent contamination of the indoor air.
- Customizable environment by using light and temperature control to best suit the workers preference.
- Exposure to daylight and outdoor view to avid claustrophobic atmosphere and induce a pleasant feeling by exposing individuals to the external via visual interface.

Improved productivity

All the above factors provide the individuals with comfortable environment leading to the improvement in their work efficiency (USGBC 2005). Good environment keeps people healthy. Healthy people are productive. Regular employee attendance results in streamlined flow of work which helps improve the productivity.

Human resource is the major part of the lifecycle cost of the building in an office setting (Cassidy 2003). Improvement in the efficiency of the employees directly influences the improved productivity of the company.

Problems in measurement

LEED is a voluntary system which has some exceptions like the GSA, U. S. Army, USEPA, etc., where they are mandated to obtain LEED certification on their buildings by the government. To propagate the use of LEED system industry wide it is necessary that the benefits be quantified. Monetary benefits in turn attract owners to pursue green buildings. As more and more development will become sustainable the cost premium will drop due to experience and transition of the services from specialized to routine.

Another problem that can be identified with quantification of benefits is that the costs are usually involved initially and benefits are achieved in terms of savings and non-tangible assets in time. Hence quantification requires life cycle costs. Since most of the buildings are recent, the benefits can only be calculated on a hypothetical basis assuming future savings. Yet another problem associated with the same is that the person investing is not necessarily the person benefited by the cost savings.

5. Conclusion and Future Recommendations

The previous chapters have described the foundation principles and expectations of LEED certification. It has also exposed the cost involved in the LEED certification which involves the registration fees and cost premium associated with the LEED credit compliance. This final exam has also pointed out the tangible and non-tangible benefits that can be gained by LEED certification. This chapter attempts to propose the future trends and make recommendations based on the literature review carried out for this final exam.

The future of LEED depends upon the industry acceptance of its guidelines. As per the findings of chapter one, there is a significant growth in the number of member organizations, LEED accredited professionals, registered, and certified projects. These statistics show that LEED has shown an incremental growth.

The increasing consumption and advanced research in the field of green materials and sustainable designs will eventually reduce or eliminate the cost premium associated with LEED certification. The research will provide proof that the green buildings pay for the cost premiums and more than that in terms of resource savings and resource productivity. This will influence an increase in the membership of LEED certified projects.

To prevent the failure of LEED certification system, it must adapt to the changing environment. It must remove the credit requirements that are becoming obsolete viz., appointing a LEED AP on the project and instead make it a prerequisite; credit conferred for a bike stand must be employed based on the reduction in the use of motor vehicles. Based on such instances the author of this final exam has listed the following recommendations

- Make the certification requirements to award points for the impact
- Make the certification process quicker and easier
- Eliminate obsolete credit requirements

- Certification process should not be susceptible to point mongering
- Points must be weighted based on their impact on the environment

To better predict the future of LEED it is necessary to better understand the factors associated with the certification process. According to this final exam, it is safe to state that first cost associated with the projects for LEED certification can be a driving force for selecting LEED certification for any project. The available data in this regards can be quite misleading based on the findings of the meta-analysis in Table 11.

Based on the finding of the meta-analysis following recommendations are made:

- The data must be have "time value of money" principles incorporated in order to compare it.
- Size and location corrections must be applied to the cost premiums to make them comparable.
- The first cost data shall be categorized based on the achieved credit instead of the level of certification. Cost premium associated with the certification vary as per the number of points and the type of credits achieved. Hence it is only logical to ascertain the cost data for individual credits (This type of data analysis can get complicated if the cost is associated to multiple credits).
- Large number of cases must be analyzed to ascertain more accurate cost premium generalization.

LEED is a developing green building certification system. It needs to be updated with respect to the system structure and implementation process in order to stay useful to the market. There is also a need for research in the field of Impact of LEED to study the various benefits due the LEED certification. The findings of such a research will determine the actual usability of LEED certification system.

Author's Reflections

LEED is a green building rating system which provides a reference to show the difference in the buildings essentially built to code to the building that undergo the certification process. Although, It does not mean that only LEED certified buildings are green; there are green buildings that are not certified. LEED certification process involves a significant amount of paperwork which may become a reason for project teams to avoid the process of certification. Another issue is that LEED imparts points only on satisfactory completion of requirements. Hence, there is a risk in attempting LEED certification that one may not get all the points attempted.

There is a concern about rating points that can be achieved for various credits. Each point requires varying levels of investment in terms of time, manpower and initial costs. This may lead to project teams attempting to get the maximum points from the least cost and efforts irrespective of the impact on the environment. This may not serve the primary purpose of a system like LEED. Although LEED is a developing system with a conscious efforts to be effective and better serve the environmental concern. USGBC updates the LEED version in order to serve the above purpose.

First costs are associated with the fulfillment of LEED certification requirements. But green buildings also have benefits associated with them. Life cycle analysis must be carried out to show that the future benefits overshadow the first costs. It is necessary that such facts must be verified and conveyed to the industry to gain a consensus on the green buildings.

In general, the author believes that this is a good rating system and a lot more can be achieved from it if specific concerns are effectively addressed as and when they arise. Adaptation is the key for keeping LEED certification system effective in future.

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Note: For detailed information about the resources please refer to the Annotated Bibliography on page number 42 of this final exam.

Appendix 1: Membership Rates

Table 12: USGBC membership rates

ORGANIZATIONAL CATEGORY	LEVEL	GROSS ANNUAL SALES*	ANNUAL DUES
Product Manufacturers	1	Less than $1 million	$500
Building Controls and	2	$1 - $5 million	$1,500
Service Contractors	3	$5 - $25 million	$2,500
Distributors	4	$25 - $50 million	$3,500
	5	$50 - $250 million	$5,000
	6	$250 million - $5 billion	$7,500
	7	$5 - $10 billion	$8,500
	8	More than $10 billion	$12,500
Corporate and Retail	1	Less than $50 million	$1,000
	2	$50 - $250 million	$2,500
	3	$250 million - $5 billion	$3,500
	4	More than $5 billion	$5,000
Utilities / Energy Service Companies	1	Less than $10 million	$750
	2	$10 - $50 million	$1,500
	3	$50 - $250 million	$2,500
	4	More than $250 million	$3,500
Real Estate / Real Estate Service Providers	1	Less than $5 million	$750
(Building Owners, Facility Managers,	2	$5 - $25 million	$1,500
Developers, Brokers, Property Managers, Appraisers)	3	$25 - $50 million	$2,500
	4	$50 - $250 million	$3,500
	5	More than $250 million	$4,000
Nonprofit & Environmental Organizations	501-C (3)	Less than $15 million	$300
		$15 - $250 million	$500
		More than $250 million	$750
Professional Societies and Trade Associations	1	Less than $1 million	$500
	2	$1 - $5 million	$1500
	3	$5 - $25 million	$2500
	4	$25 - $50 million	$3500
	5	More then $50 million	$5000
State & Local Governments	1	Population under 500,000	$500
	2	Pop. 500,000 to 1 million	$750
	3	Pop. more than 1 million	$1,000
Professional Firms	1	Less than $250,000	$300
(Accountants, Architects,	2	$250,000-$1 million	$750
Attorneys, Commissioning Providers,	3	$1 - $5 million	$1,000
Consultants, Engineers, Planners,	4	$5 - $25 million	$1,500
Interior Designers, Landscape Architects, Press)	5	$25 - $50 million	$2,500
	6	More than $50 million	$3,500
Contractors, Builders	1	Less than $250,000	$300
by construction volume	2	$250,000 - $1 million	$500
	3	$1-$5 million	$750
	4	$5 - $25 million	$1,500
	5	$25 - $50 million	$2,500
	6	$50 - $250 million	$3,500
	7	$250 million - $5 billion	$4,000
	8	More than $5 billion	$5,000
Insurance Companies / Financial Institutions	1	Less than $250 million	$2,500
(Lenders, Institutional Investors by asset base)	2	More than $250 million	$3,500
Educational Institutions	1	Individual K-12 School	$300
(K-12 School Systems, Universities and	2	District K-12 School Systems	$500
Research Institutes)	3	1 - 2 University/Institute Campuses	$750
	4	3 - 5 University/Institute Campuses	$1,000
	5	5 - 20 University/Institute Campuses	$1,500
	6	More than 20 University/Institute Campuses	$2,000
Federal Government	1	Federal Agency	$1,000
GOCOs	2	GOCO	$750
(Government Owned Contractor Operated Laboratories)			

**Parent firm or subsidiary only. (Subsidiary files separate tax return.)*

Source: (USGBC 2007)

Appendix 2: Points distribution of EA Credit 1 & 2

Table 13: EA credit 1 point distribution

Percent improvement in energy efficiency		
New Construction	Existing Buildings	Points
10.5%	3.5%	1
14.0%	7.0%	2
17.5%	10.5%	3
21.0%	14.0%	4
24.5%	17.5%	5
28.0%	21.0%	6
31.5%	24.5%	7
35.0%	28.0%	8
38.5%	31.5%	9
42.0%	35.0%	10

Source:(USGBC 2005)

Table 14: EA Credit 2 Point Distribution Schedule

Percent Use of Renewable Energy	Points
2.5%	1
7.5%	2
12.5%	3

Source:(USGBC 2005)

Appendix 3: Annotated Bibliography

Buckley, B. (2007). "Washington D.C. Goes Green." Engineering News-Record (ENR), Vol. 1.

This article states that Washington DC is the first major city to require all non-residential buildings to be green. It shows the federal initiative to put forth LEED as its adopted standard for green buildings.
URL: http://enr.construction.com/news/finance/archives/070106.asp

Cassidy, R. (2003). "White paper on sustainability: A report on the green building movement." *Building Design and Construction Magazine*, Vol. 3(issue no. 11), 47

This report presents the history of green buildings and review of a survey regarding the trends, awareness, and problems in sustainable development. This whitepaper concludes with recommendation on improvement in research on green buildings.
URL: http://www.bdcnetwork.com/contents/pdfs/BDCWhitePaperR2.pdf

Graham, S. (2005). "Summary of HOK's research and experience on the potential impact of first capital cost by LEED 2.1 credit along with potential savings that can offset or go beyond the initial costs." LEED Capital Cost Potential by Credits, HOK Sustainable sites, USA.

This is a summary of a report classifying all the LEED credit based on the first costs involved in complying with the requirements.
URL: http://www.hoksustainabledesign.com/doc/HOK_LEED_Capital_Cost_Analysis_By_Credit.doc

Hoover, J., and Crocker, S. J. (2006). "U.S. transit agencies bring LEED on board." Public Transport International, 55(4), 24.

This article shows the initiatives taken by the U.S. transit agencies to adopt sustainable behavior. It states that LEED is only applicable to the buildings of the agency but it reinforces federal commitment towards LEED.
URL: http://www.uitp-pti.com/back_iss/pti4_2006.htm (ILL resource)

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URL: http://www.efswest.org/resource_center/pdf/pspr/kats.pdf

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URL: http://www.1800arkansas.com/Energy/files/9-06Kats.pdf

Kats, G. H. (2006). "Greening America's Schools Costs and Benefits." *A Capital E Report*, Capital E (www.cap-e.com).

This is a summary report of the cost benefit studies carried out by Capital E on the schools in United States which have secured LEED certification from the year 2000 till date.
URL: http://www.cap-e.com/ewebeditpro/items/O59F9819.pdf

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This is a comparative study of cost impact of LEED gold certification. It involves the calculation of the cost premium for a commercial building based on a reference building to find the base cost.
URL: http://www.mnilson.com/michael/thesis.pdf

Payne, C., and Dyer, B. "Federal Participation in LEED in 2005." *Conference: Greenbuild Expo 2005, Atlanta, GA, November 9-11,2005*, United States, 10p.

This article gives an overview of the Federal Government initiatives taken in 2005 towards its commitment to sustainability. It shows how the government is leading the industry by setting an example of implementing LEED certification in all the government undertaken buildings.
URL: http://www.osti.gov/energycitations/servlets/purl/883112-MWfrFe/883112.PDF

Schendler, A., and Udall, R. (2005). "LEED is broken..... let's fix it." Aspen Skiing Company, U.S.A., 18 pages.

This article lists the problems of LEED. The problems listed by the author are high first cost, priority to points than environment, suspected bureaucracy and overrated benefits of green building.
URL: http://www.igreenbuild.com/cd_1706.aspx

SWA. (2004). "GSA LEED Cost Study: Final Report." GS–11P–99–MAD–0565, GSA.

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Environmental Design)." (US Green Building Council's Leadership in Energy and Environmental Design), 74(2), 38(6)

This article gives a perspective on the role and the procedures of commissioning authorities for LEED certification. It concludes that commissioning provides a professional solution and keeps track of the objectives of the project.
URL: http://find.galegroup.com/itx/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T003&prodId=ITOF&docId=A97115035&source=gale&srcprod=ITOF&userGroupName=viva_vpi&version=1.0

USGBC. "Building Momentum: National Trends And Prospects For High Performance Green Buildings." April 2002 Green Building Roundtable, Washington DC.

This is a report on the proceedings of the 2002 Green building roundtable. The roundtable discussed the health and economic benefits of LEED. It pointed out the problems in industry wide acceptance of LEED. It concludes with suggestions to improve the Federal propaganda to promote green buildings
URL: http://www.usgbc.org/Docs/Resources/043003_hpgb_whitepaper.pdf

USGBC. (2003). LEED Reference Package for New construction and Major Renovation (LEED - NC), USGBC.

Above resource is a document by USGBC to enlist procedures and requirements for LEED certification (LEED NC Version 2.1)

USGBC. (2005). LEED Reference Package for New construction and Major Renovation (LEED - NC), USGBC.

Above resource is a document by USGBC reference guide to enlist procedures and requirements for LEED certification (LEED NC Version 2.2)

USGBC. (2006). "Green Building SmartMarket Report." Design & Construction Intelligence, McGraw Hill Construction.

This document provides information on the current and future market trends of the green building industry. It is a document helpful for all the peripherals of the industry to ascertain the current market scenarion.

USGBC. (2007). "About USGBC." U. S. Green Building Council, USGBC, ed., USGBC, Washington D.C.

It is the USGBC official website. It has extensive information about LEED certification and green buildings in general. It also posts publications and industry data relevant to LEED certification. It is also a medium to facilitate the LEDD certification process.
URL: http://www.usgbc.org

Table 11: Cost Premium for LEED Certification

Study (Source)	Statement	Base	Cost Premium				Comments
			Certified	Silver	Gold	Platinum	
Green Building Costs and Financial Benefits (Kats 2003)	Study of 25 office buildings 8 school projects	8	0.66%				This study had the first costs data for LEED certification building design and conventional building design for individual projects (2003)
		18		2.11%			
		6			1.82%		
		1				6.50%	
Green Building Costs and Financial Benefits (Kats 2004)	Study of 40green building projects	8	0.66%				It is an update of the above report (2004).
		21		1.91%			
		9			2.23%		
		2				6.80%	
GSA LEED Cost Study (SWA 2004)	New Construction estimated projections	1	0.65%				This is a hypothesis of the projected cost of LEED for a new court house construction and major renovation of commercial buildings prepared by SWA Inc. Each level of LEED certification has been accounted for two extra points than minimum required. This is a general practice for ensuring certification. A weighted average for the two posted types is calculated in order to suit the format of our analysis.
		1		3.29%			
		1			7.63%		
	Major Renovation estimated projections	1	1.9%				
		1		3.9%			
		1			7.9%		

Table 11: Cost Premium for LEED Certification (Continued)

Study (Source)	Statement	Base	Cost Premium				Comments
			Certified	Silver	Gold	Platinum	
Greening America's Schools: Costs and Benefit (Kats 2006)	Cost Benefit analysis of green schools in America	4	1.17%				This analysis involves comparing the conventional building costs to the actual costs of building green schools. The conventional costs have been calculated by the architects who have designed the original buildings.
		8		1.03%			
		6			2.15%		
Quantifying the Cost Impacts of LEED-NC Gold Const. in NYC (Nilson 2005)	1 Gold based on **GMP** and **LEED affected contracts only**	1			0.82% & 1.56%		This study compares two buildings with cost and area data available; one of them is not LEED but satisfies all NYC regulations while the other seeks LEED Gold. This final exam will consider the value based on total GMP as that is the true premium calculated for all the other data available (2005).