6-2011

An Environmental Economic Analysis of Green Building and the Leadership in Energy and Environmental Design Rating System

John A. Manna
Union College - Schenectady, NY

An Environmental Economic Analysis of Green Building and the Leadership in Energy and Environmental Design Rating System

By

John Manna

....

Submitted in partial fulfillment

of the requirements for a major

in Environmental Policy at

Union College

June, 2011

ABSTRACT

MANNA, JOHN. An Environmental Economic Assessment of Green Building and the Leadership in Energy and Environmental Design (LEED) Rating System. Environmental Science, Policy, and Engineering Program, June 2011

Buildings account for over 70% of U.S. energy consumption and produce 30% of the nation's greenhouse gas emissions. With growing concerns over future energy prices, the green building industry and the LEED rating system have made it their goal to produce better performing, more efficient buildings. LEED projects have been implemented in all 50 states, with 46 implementing LEED into public policy. In this study we evaluate the environmental and economic benefits of the LEED certification process.

A cost-benefit analysis provides a framework for assessing the life cycle of a LEED building, incorporating both energy and cost savings, as well as the external benefits of building green. The assessment also looks at inherent external costs and the paternalism impact of the LEED certification process.

We evaluated studies conducted by industry professionals and case studies from California, New York, and Illinois and found that LEED-rated buildings are, on average, 25-30% more energy efficient, and can be built at a small 3% premium compared to conventional buildings. However, these numbers may be questionable due to regional differences of the studies as well as data availability for cost-benefit analysis.

Although LEED has accomplished many of its objectives, the main flaw of the system is that LEED does not require a post project energy audit of its buildings, making lifetime energy and cost estimates uncertain. LEED must continue to adapt to correct such issues, as well as meet regional and policy needs. By improving public education of green building and its economic benefits, the paternalistic nature of public policy may eventually be no longer needed.

Table of Contents

LIST OF EXHIBITS

Chapter I:
Introduction to Green Building and the Leadership in Energy and Environmental Design Rating System

Purpose of the Study

Buildings in the United States account for 71% of electricity consumption, 40% of green house gas (GHG) emissions, and 30% of raw materials used. The current uncertainty and concern over future energy prices has helped create a need and a market for green, or sustainable, building in the US. The term “green building”, however, can have ambiguous connotations. Its exact meaning can best be defined by contrasting it to conventional building practices. Most of the nation’s buildings used traditional building techniques, which in most cases does not account for excessive use of energy, water, inefficient HVAC systems, and materials, especially those made with harmful chemicals that can affect indoor air quality and occupant health. Green building, on the other hand, focuses on using building techniques that reduce a building’s overall energy consumption, including energy inputs into the building process, as well as reducing water consumption, raw materials, and GHG emissions. Green building also focuses on improving the air quality inside of buildings, and thus creating a more comfortable and healthy environment for its occupants. While it currently only accounts for a little over 10% of the building industry’s projects, green building is the industry’s fastest growing trend. As the green building industry grows, it is quickly becoming the new standard and the future “traditional” building technique.

The United States Green Building Council (USGBC) set out in 1993 to create a system that would allow project teams to build and realize green projects at a time when green design methods were largely unknown. The Leadership in Energy and

Environmental Design (LEED) rating system was created as a template for project teams to learn and implement sustainable design into their projects and differentiate them from conventionally built buildings. The multiple objectives of LEED are synonymous with green building. These objectives have the goals of reducing the lifetime costs of a building, reducing external costs to society and building occupants, and creating a product that reduces a building's environmental impacts. LEED's most important objective is to expand the green building market and the knowledge of the general public to create a green culture that is more sensitive to both the environmental and economic issues in the building industry**.**

The purpose of this study is to evaluate the net benefits of the green building process. The LEED rating system, considered the premier and most recognized green building rating system in the country, sets the standard for what green building should incorporate. Project teams would likely use many of the energy and cost-saving techniques included in the LEED rating system even if a certification system did not exist. This study will aim to show how the LEED rating system has influenced the building industry and what effect it has had on project team decision-making. In addition, this study aims to show why the LEED rating system is needed in the green building industry and to estimate the extent to which it has achieved net beneficial objectives, such as cost and energy saving.

With the growing adoption of LEED standards nationwide, the study also aims to show what merits the need for LEED to be included in public policy initiatives. The larger question, from a policy standpoint, is if LEED has achieved a more cost effective way of building, be it through the initial capital investment, lifetime maintenance of the building, or the external costs to society. The policy question also begs whether people know the best option for themselves, whether they fully understand the benefits, and if they are able to make the correct decisions in the building process.

LEED's dynamic make up and evolution since its creation in 1993 has created both support and criticism from environmentalists and building industry professionals alike. Yet it is important not to view the LEED rating system as a means to a single faceted-result. The certain tangible aspects of construction, documentation fees, and other hard costs are too often the only considered costs of a project, and their perceived higher costs can make investment into a LEED project undesirable. However, an understanding of the overall cost saving and energy saving benefits that a LEED project can create is critical when deciding to take on a green project.

Outline of the Study

In Chapter Two, we first examine the evolution of the green building movement through the creation of LEED. We then provide an overview of the LEED certification process. We will also focus on LEED's place and impact in the national setting by examining how it has affected the industry nationwide. We will conclude with relevant public issues concerning the rating system.

In Chapter Three, we first address the issue of sustainability and its meaning for green building. We then develop the analytical framework for a cost-benefit analysis, including initial capital investments, lifetime operation and maintenance costs, discounting, and external benefits, as well as any potential uncertainties that can arise. Next, we focus on the paternalism impact of the LEED certification process, followed by the role that education plays for the general public. We end by focusing on the relationship between a rating system's points and how they translate to energy and cost savings, as well as the inherent uncertainties that a rating system can bring.

In Chapter Four, we present and evaluate evidence of the overall cost and energy saving of the LEED rating system. We review studies performed by Romm (1999), Kats (2003), Langdon (2007), Blackburne (2009), and Melaver and Mueller (2009), and institutions such as USGBC and the New Buildings Institute. We examine costs per sq/ft for LEED projects and non-LEED projects, as well as studies on green premiums and education costs. Next, we examine studies on the external benefits that LEED can create, followed by examples of LEED points that create uncertainty on how they translate to overall building performance with regards to energy use or other environmental impacts. We then focus on a case study of a cost-benefit simulation conducted by Blackburne (2009). Finally, we look at public zoning and building policy initiatives taken on by various cities and states in the past decade, as well as case study from the City of Boston.

In Chapter Five, we conclude that the LEED rating system has achieved many of its net beneficial objectives by creating more energy efficient, cost effective buildings. LEED has also raised public awareness and brought to attention issues surrounding the uncertainty of future energy prices and the importance of renewable energy research. The biggest problem with the system is that it does not put more weight into post project auditing, making lifetime energy and cost estimates uncertain. However, LEED's place in public policy seems to be justified by the hundreds of policy initiatives enacted nationwide. LEED must continue to adapt to correct its faults, as well as meet regional and policy needs. By improving public education of green building and its economic benefits, the paternalistic nature of public policy may eventually be no longer needed.

Chapter II:
History of LEED and the Green Building Movement

In this chapter, we focus on the historical background of the green building movement from its beginnings and move to the creation and evolution of LEED. We create a historical and structural overview of the LEED rating system, providing the necessary information to understand the key components that go into the process of LEED certification. We will also focus on LEED's place and impact in the national setting, and will conclude with relevant public issues concerning the rating system.

Foundation of Green Building

Beginnings

The green building movement is a relatively recent phenomenon whose beginning can be traced back to the 1980s with events such as the Montreal Protocol, which limited the use of chlorofluorocarbons, and the 1987 United Nations' World Commission on Environment and Development, the first committee to define sustainability (Yudelson 2008, 2). Following suit from the environmental movements of the 1980s, the concept of green building can be credited to the American Institute of Architects (AIA), which has been one of the biggest professional architecture organizations in the United States for over one hundred and fifty years (AIA 2010). AIA's creation of the Committee on the Environment (COTE) in 1990 is largely seen as the catalyst that spurred the movement for green building and, since its creation, has been greatly impacting AIA's push toward more sustainable building practices (Gould 2008). The early 1990s also saw two events that would further precipitate the future progression of the green building industry. In the United States, the 20th anniversary of the original Earth Day took place in 1990; in Brazil, the U.N. Conference on Environment and Development took place in 1992 (Yudelson

2008, 2). Following these events, the United States Green Building Council (USGBC) was created in 1993 in coordination with the United States Department of Energy (DOE) to further promote the progression of sustainable building practices within the industry. The original committee was composed of architects, real estate agents, a building owner, a lawyer, an environmentalist, and several industry representatives (LEED #2).

Terminology

The USGBC defines a "green building" as a building that uses less energy, water and natural resources, creates less waste, and is healthier and more comfortable for the occupants (LEED #2). Green building is the practice of designing, constructing, operating, maintaining, and removing buildings in ways that have lower environmental impacts than traditionally constructed buildings (Silberman 2008). The concept of integrated design, or pre-building designing and planning by green building designers, is an integral part of this definition because it assures that the structure to be built will be as green as possible. Green building construction is therefore considerably different from traditional building practices because it strives for a more environmentally aware product.

The LEED Rating System

Creation of the Rating System

The green building movement saw almost immediate growth in the 1990s, but USGBC realized it needed a system to define and measure "green buildings" in the building industry. In coordination with the US Department of Energy, USGBC designed a rating system that would evaluate what goes into a green building project. USGBC's Leadership in Energy and Environmental Design (LEED) rating system was developed in the mid 1990's, and was created to define "green building" by:

- Establishing a common standard of measurement,
- Promoting integrated, whole building design practices,
- Recognizing environmental leadership in the industry,
- Stimulating green competition,
- Raising consumer awareness of green building benefits,
- and transforming the building market.

The first LEED Pilot Project Program, referred to as LEED Version 1.0, launched at the USGBC Membership Summit in August 1998. After in-depth modifications and testing, LEED Green Building Rating System Version 2.0 released in March 2000, Version 2.1 in 2002, and Version 2.2 in 2005 with the addition of LEED New Construction (NC). All information for this section was found in LEED Document #2.

LEED Version 3.0

The creation of the LEED rating system opened up a new market for the green building industry and had profound effects in raising consumer awareness (Higgins, LEED AP). To continue its growth and push into the future, LEED recently came out with Version 3.0 in April 2009, which contains multiple additions to Version 2.2 and different categories of building types that can gain LEED certification based on the type of project being undertaken. All new projects that desire LEED certification must use Version 3.0 because of the many additions it contains over its last version. LEED 3.0 incorporates Innovation in Design/Operations (ID/O) and Regional Priority (RP) as its newest components in order to address concerns about buildings in different climatic regions and to promote the use of new green technology. These new components also expand the scoring criteria by offering ten bonus points between the categories. LEED 3.0 focuses not only on building operational and maintenance issues, but also project development and delivery processes in the US building design and construction market by making rating systems for specific building typologies, sectors, and project scopes.

Based on the type of project, LEED 3.0 allows one to apply for any of the following types of LEED certification:

Exhibit 2.1: LEED certification types based on project type (LEED #2).

LEED Rating Systems
• Core & Shell (CS) • New Construction (NC) • Schools (S) • Existing Buildings: Operations & Maintenance (EB) • Retail (R) • Healthcare (HC) • Homes (H) • Commercial Interiors (CI)

LEED 3.0 criteria for Homes (H) incorporates an additional component of Awareness & Education for Homes, which stresses the importance of education to all members involved in the building process to create the most environmentally sound structure. With this idea, USGBC has created a green building design training program designed as a platform of education and encouragement of sustainable building practices as well as adding support to the real estate industry (LEED #2). Version 3.0 has created a new user-friendly LEED online database to allow for a better user experience that provides better and faster information and guidance on the USGBC website. It also improved its third-party building certification infrastructure, carried out by the US Green Building Certification Institute (GBCI), which will help streamline the certification process (Holowka 2009). Version 3.0 also contains an updated credit structure, a new LEED online database, and an updated certification administration (LEED #9).

LEED Credit Structure

Since its creation and throughout its evolution, the LEED rating system has focused its credit structure on what it sees as the five major areas of environmental concern in regards to green building (LEED #2):

1. Sustainable Sites (SS)
2. Water Efficiency (WE)
3. Energy and Atmosphere (EA)
4. Materials and Resources (MR)
5. Indoor Environmental Quality (IEQ)

These five core credits have remained in every version of LEED that has been released, although newer versions contain additional credits. Each area is composed of multiple credits that can be awarded for their implementation into the building, and each credit within the five components is worth one point. A project that wishes to achieve LEED certification has free range to pick and choose which credits it wants to implement into its construction after it undergoes an in-depth pre-development design process to ensure that each credit chosen will produce the most environmentally sound product for that specific project (LEED #2).

Core Credit Content

Each of the five areas contains two types of credits: prerequisite credits and core credits. Prerequisite credits are required elements of each area that are not awarded any points. All prerequisite credits must be met before a project can be considered for LEED certification. Core credits are specific actions a project may take in the categories listed above. All core credits are voluntary, but each level of LEED certification requires that certain thresholds of credits used must be met (LEED #2). Each of the five areas contain different amounts of points that can be awarded, and prerequisites that range from one to three depending on the category. The full list of LEED 3.0 prerequisites and core credits, including Innovation in Design (ID) and Regional Priority (RP), is located in LEED Document #7.

Credit Weightings

The allocation of points between credits is based on the potential environmental impacts and human benefits of each credit with respect to a set of impact categories. These impact categories are defined as the environmental or human impacts of the design, construction, operation, and maintenance of the building, such as greenhouse gas emissions, fossil fuel use, and air and water pollutants (LEED #7). Based on the United States Environmental Protection Agency's (EPA) TRACI environmental impact categories, LEED creates a basis for its Credit Weightings to allocate more points to certain credits within the five main categories that create more environmental and economic benefit based on these categories. A complete description of the LEED Credit Weightings is located in LEED Document #7.

LEED 3.0 Prioritization- Energy and Atmosphere Credits

While achieving LEED certification requires that certain thresholds of credits in each of the five main areas be met, LEED 3.0 prioritizes which core credits it believes to be the most important by giving Energy and Atmosphere (EA) thirty-five possible points, many more than any other category. This is because LEED 3.0 has made energy efficiency and CO_2 emissions reductions a priority (LEED #9). EA contains three required prerequisites (LEED #7):

1. *Fundamental Commissioning of Building Energy Systems*- intended to ensure that a project's energy-related systems are installed, and calibrated to perform according to the owner's project requirements to operate as designed.

2. *Minimum Energy Performance*- intended to establish the minimum level of energy efficiency for the proposed building and systems to reduce environmental and economic impacts associated with excessive energy use.

3. *Fundamental Refrigerant Management*- intended to reduce stratospheric ozone depletion by requiring zero use of chlorofluorocarbon (CFC)- based refrigerants in new base building HVAC systems, and the completion of a comprehensive CFC phase-out conversion for existing base building HVAC equipment.

The prerequisites encourage the use of new technologies and strategies to achieve these goals, such as renewable energy systems, state of the art HVAC systems, and domestic hot water systems (LEED #7). EA's core credits are comprised of six sections and contain different amounts of possible points for each section:

Exhibit 2.2: Core Credit make up of LEED 3.0 Energy and Atmosphere Credits (LEED #7).

1. Optimize Energy Performance	up to 19 points
2. On-site Renewable Energy	up to 7 points
3. Enhanced Commissioning	up to 2 points
4. Enhanced Refrigerant Management	up to 2 points
5. Measurement and Verification	up to 2 points
6. Green Power	up to 2 points

Each section is meant to reduce overall energy use and decrease the level of CO2 emissions that the building creates. The full list of EA's prerequisites and core credits is located in LEED Document #7.

<u>LEED Awards</u>

Based on the core credit points that can be awarded, projects undergoing LEED 3.0 can receive any of the following LEED awards:

- Certified: 40-49 Points

- Silver- 50-59 Points
- Gold- 60-79 Points
- Platinum- 80+ Points

Once a building project is completed, documentation by the owner is provided to LEED third-party rating officials who review it (in a process known as commissioning) to ensure that all desired credits of the project are properly incorporated into the building. The project must pay a fee to LEED to ensure credit compliance and receive certification. All information for this section can be found in LEED Document #2.

US Federal Adoption of LEED

LEED Chosen Most Credible Rating System

As the green building marketplace began to expand into the new millennia, various other rating systems began to emerge to join the green building movement and compete with LEED. Executive Order 13123 of the 2005 Energy Policy Act enacted by the US Government helped define the criteria for assessing green building rating systems by focusing on "greening the government through efficient energy management" (LEED #5). To determine which available green building rating system would be the preferred choice of the US government for future projects, the government's largest construction owner, the General Services Administration (GSA), set out in 2006 to choose the most credible green building rating system. The GSA selected the US Energy Department's Pacific Northwest National Laboratory (PNNL) to conduct the study and analyzed the following five most popular rating systems: (1) Building Research Establishment's Environmental Assessment Method (BREEAM), (2) Comprehensive Assessment System for Building Environmental Efficiency (CASBEE), (3) GBTool, (4) Green Globes US, and (5) LEED (LEED #5).

To analyze the five rating systems, the GSA evaluated each based on four specific criteria (Doan 2006):

1. Applicability or relevance to the large scale and complexity of Federal buildings.
2. Stability of the rating system over time.
3. Objectivity as it measures quantifiable aspects of sustainable design and its ratings verified by qualified third parties.
4. Availability of the system, whether it is widely used and has broad practitioner awareness.

After conducting the study, the GSA issued a report on Sept. 15, 2006 that found LEED to be the most credible green building rating system among the five systems evaluated. The GSA pointed out that LEED was applicable to all federal building projects, was quantifiable in all aspects of sustainable design and performance, incorporated trained professionals that verify LEED, and is the most widely used rating system in the US market. Through this report and the government's recognition, LEED became the standard for green building rating systems in the US.

National Adoption of LEED

Since federal adoption in 2006, LEED membership has grown to 19,957 members, and has more than quadrupled since 2000. There have been almost 5,000 certified projects in the United States, and over 27,000 projects registered with LEED either waiting to be completed or waiting to be certified. LEED initiatives including legislation, executive orders, resolutions, ordinances, policies, and incentives can be found in all 50 states, including 442 localities (384 cities/towns and 58 counties), 35 state governments, 14 federal agencies or departments, and numerous public school jurisdictions and institutions of higher education across the US. Since 2009, LEED for

New Construction (NC) represents the majority of all registered and certified projects undertaken by various state governments. All information for this section was found in LEED Document #4.

Policy Adoption

With growing trends in the industry and LEED as the national standard for green building certification, many state and local governments have enacted laws requiring LEED certification for all new construction and major renovations. The United States federal government, in coordination with the GSA, also requires LEED certification for all new construction and substantial renovations. As LEED continues to find its place in public policy, there are still many issues that have yet to be worked out. These are largely due to the requirements applying strictly to owners who are undertaking these projects, rather than the design professionals or contractors. While it is clear that an owner that fails to meet these obligations will be in violation, policy can became problematic when considering both how these laws will be enforced and what the consequences of such violations will be. The enforcement issue can be seen in California Executive Order S-20-04, which requires that state agencies specify LEED-certified projects, but specifically states that it "does not create any rights or benefits, substantive or procedural, enforceable at law or in equity, against the State…or any other person."

Contracts specifying green requirements intend to simplify the process, but more policy complication can arise due to the flexible criteria for LEED certification levels that are somewhat open to interpretation. Compliance issues may arise when designers believe they have designed or built a compliant building that still fails to receive the LEED certification specified in the contract. Owners also specify green requirements to benefit from future cost savings anticipated over the life of the building; unless the contract says otherwise, contractors in breach of those requirements can be liable for these costs. However, this is usually hard to prove because they occur over the life of the building. Policy complications will likely be worked out as green building and LEED continue to grow, educate, and find their place in public policy. All information for this section was found in Silberman 2008.

Criticisms of the LEED System

While the overall goal of LEED is to minimize the environmental impact that buildings have and to raise consumer awareness, there have been many criticisms of the system. One criticism is that green buildings can actually use more energy and produce more emissions than traditionally constructed buildings. This uncertainty arises because the LEED rating system rewards points to designers for anticipated levels of energy savings, rather than for proven levels (Gifford 2008). The checklist is effective by motivating designers to build green structures, but the fact that there is no requirement by LEED to monitor how a building is actually performing once it is finished can lead to serious problems when quantifying LEED's merit. Many have pointed out that if annual utility savings are not meeting the pre-project desired goals (as has sometimes been the case), then predicted energy savings lose credibility and the level of certification may become cost-inefficient (Gifford 2008). However, many of the problems that the earlier versions of LEED faced have been worked out as the LEED system has evolved. As LEED goes forward into the future, these problems will likely decease through advancements in the green building industry and greater consumer education and awareness (Higgins, LEED AP).

The purpose of this study is to examine the LEED certification process to evaluate its benefits both environmentally and economically. Justification for investment into green building and the LEED process will be examined by evaluating the extent to which LEED-certification is net beneficial. This evaluation of LEED will also put its place in public policy into context.

Chapter III:
Analyzing Green Building Rating Systems and Projects

In this chapter, we focus on the necessary considerations that must be made when deciding to invest in a green building project and to use a green building rating system. We first put the definition of sustainability into context by focusing on its meaning for green buildings. We then address the necessity of a cost-benefit analysis, including the inherent factors that must go into making such an analysis and the potential uncertainties that can arise. Next, we focus on the business case benefits of green building, followed by the role that paternalism and education play for the general public. We end with a look at the merit of using a green building rating system and address the link between a rating system's points translating to energy and cost savings, as well as the inherent uncertainties that a rating system can bring.

Sustainability in Green Building

The meaning of sustainability pertaining to buildings takes a more sophisticated approach than its traditional definition. Sustainability often pertains to something that is able to be maintained at a certain rate or level, and in an ecologist view, to conserve an ecological balance by avoiding depletion of natural resources. Sustainability in the context of buildings is innately far more complex. People generally place economic costs and environmental costs into two separate categories, whereas green building, or sustainable building, requires that economics and environment be linked. It also incorporates into its definition the notion of social welfare by addressing the issue of externalities. Externalities occur when the welfare of some agent is dependent on activities of its own as well as those out of its control (Tietenberg 2006). The best example of a building's externalities is the amount of CO_2 emissions it creates, imposing costs on society. These three notions of environment, economics, and social welfare create what environmentalists and promoters of green building call the "Triple Bottom Line" for sustainable building (LEED #6)

Sustainability presumes that the future generation will be worse off then the current generation, so the desire of building green must come from the idea that non-sustainable building practices are creating externalities, both presently and in the future. The GHG externality example presumes that future society will be paying for this externality, assuming they will not figure out a way to mitigate it. The triple-bottom line creates a context for sustainability in green building that takes these issues into account. Decisions made must not only be financially beneficial, but environmentally and socially beneficial as well (Melaver and Mueller 2009, 81). For a sustainable building, the triple bottom line expresses the notion that it will have lower maintenance and energy costs than a traditional building, while contributing to social welfare by producing less CO2 gas and other external costs that could accrue to society. The triple bottom line essentially creates the distinction between building sustainably and building traditionally. It is up to the project team and building owner whether it is in their best interest to invest in sustainable building.

Cost-Benefit Analysis

Life-Cycle Analysis

Investments in green building are made primarily in the hope that the completed structure will be cost saving, or net beneficial, so that there is a positive return on investment. Especially for a building project, it is important that a cost-benefit analysis take into account life-cycle costs, in which the analysis starts at year one and continues to year N, or the life of the building. At year one, we assume that all initial investments have been made, and we can compare those investments by analyzing future costs and benefits from year to year, all the way to year N by taking into account the present value (PV). PV represents the present value of a future stream of financial benefits at the discount rate, and it incorporates time by using the time value of money. This allows the net benefits from one time period to be compared with those of another time period by measuring the costs and benefits. (Tietenberg 2006). For a green building investment to be profitable, the PV of future benefits, primarily of lower operating and maintenance costs, must outweigh the current magnitude of investment. To properly quantify this, the net present value (NPV) of an investment must be found. The NPV reflects a stream of current and future benefits and costs, and results in a value in today's dollars that represents the present value of an investment's future financial benefits minus any initial investment (Kats 2003, 9). NPV can be calculated by using the standard NPV formula in Exhibit 3.1.

Exhibit 3.1: Net Present Value Formula (Kats 2003, 9)

$$NPV = \sum_{i=1}^{n} \frac{values_i}{(1 + rate)^i}$$

where:

- *rate*= the discount rate per period of time.
- n= the number of time periods, or the life of the investment.
- *values*= the net cash flow (the amount of cash inflow from benefits minus outflow from costs) at time *i.*

By conventional rules, an investment should not be made if the NPV is negative. However, calculations might not take into account certain intangible benefits or multiple objectives of a project. A design team might accept projects that emphasize some objectives more than others even if the original NPV is negative. One example is if a project team strives to obtain more green building rating system points, they might accept an initial negative NPV. Decision-making might not be so clear-cut if the NPV is positive as well. A project with a positive NPV is usually a clear-cut opportunity if a design team has unlimited capital or there are no alternative options for the project. However, design teams with limited capital and multiple options for a project should choose the option with the higher NPV to maximize their investment. The discount rate is also important to take into consideration because it can also affect the NPV. By definition, if the discount rate is lower than the rate of return, then the investment can be made back in a reasonable time frame. However, if the discount rate is higher than the rate of return, then the investment will be made back very slowly or not at all. Typically, financial benefits for individual elements are calculated on a present value basis and then combined in the conclusion with net costs to arrive at a NPV estimate (Kats 2003, 9).

In order to properly quantify the costs and benefits of green building, a number of aspects must be considered. Costs and benefits should be split into direct and indirect costs. Direct costs, which are much more tangible, include early investment and post-project completion costs, such as construction costs, documentation fees, pre-construction design fees, education costs, and any other fees that would accrue from using a green building rating system (LEED #11). Direct benefits, such as energy savings, water savings, lower common area costs, and lower configuration costs are tangible cost-saving benefits that are also necessary to incorporate in a cost-benefit analysis (Melaver and Mueller 2009, 204). Indirect benefits are typically seen as much less tangible. These benefits include reduced absenteeism, greater worker health and productivity, higher tenant leasing rates for owners, and reduced social costs from reduced greenhouse gas emissions (Melaver and Mueller 2009). After assembling and considering all of this data together and their effects over time, one could create an accurate life cycle calculation that could be expressed in one of two ways, the Net Present Value (NPV) of Savings or the Return on Investment (ROI) (Yudelson 2007, 110).

Uncertainties with Cost-Benefit

Performing a cost-benefit analysis for a building can be difficult because there are many inherent uncertainties and intangible value creation aspects that are hard to quantify. Many harder to quantify benefits of going green, such as the enhancement of a company's name and reputation, or worker productivity, can make a cost-benefit analysis much trickier. Other uncertainties arise when considering the fact that future prices in energy markets are not certain, which could lead to a calculation at today's utility rates that underestimates the value of an energy saving investment (Yudelson 2007, 110). True costs of some things are also not taken into account, for example, if the energy required to produce a certain feature of construction is not reflected in its cost, it is inefficient both in terms of cost and energy. It is crucial for a cost-benefit analysis to make the distinction or comparison between cost saving and energy saving. These two do not always go together when considering that some investments, such as solar panels on the roof of a building, could only give marginal energy saving while producing higher costs for investment that would not outweigh the cost of energy saved. This becomes more of an issue of cost-effectiveness, in which investments are made based on future benefits that may be inappropriate to monetize. However, energy saving and cost saving could very well go together if investment into an energy saving component, such as a highly efficient HVAC system, leads to future cost saving by a reduction in heating and cooling bills.

Benefits of Building Green

Quantifying Benefits

Other uncertainties with a cost-benefit analysis are created primarily because some costs, such as energy and water savings, are relatively easy to quantify, while there exist many less tangible aspects of a green building project that are not easily monetized. Indeed, some green building projects set out with initial investment plans that may include building components that will not earn back the initial investment. If initial costs are not earned back, why go through with the green project? The answer lies in the fact that there must be other benefits that attract consumers to invest. These benefits can be seen directly by the consumer, but can be realized by society as well. In this sense, some benefits go beyond sources that are purely economic, and play into the notion that investors in green building do so under the selfless assumption that they are bettering the environment and society by doing so.

The Business Case for Going Green

Positive public sentiments have been created by the image of green building, which has attributed much to the industry's rapid growth in the past twenty years. Green certified companies are able to attract better public relations through green brand marketing, bringing in positive reviews, more customers, and increased revenues. Green companies also see benefits through altruism and the "warm glow" effect, sentiments felt by people who invest in green building because they know it is the right thing to do, regardless of whether there is a positive net return. This warm glow effect serves to improve company morale and boost worker satisfaction, productivity, and promote worker health, which can all lead to future revenue creation benefits not initially taken into account (Kats Oct. 2003, 54). Benefits may be realized in the real estate markets for green buildings because owners can set higher tenant leasing rates per sq ft, or higher property values (Miller 2010, 1). However, current tenant leasing contracts may need to be restructured, moving to a new "green" leasing structure that allows landlords, who put up the initial capital investment for green components, to realize benefits of overall lower utility costs, despite the fact that leasing rates might be higher (Melaver and Mueller 2009).

Benefits can also be seen for companies who wish to keep with the competitive trends that have been created. A new green marketplace has been opened up, and major companies and corporations in the past decade have become well versed on the topic of green building certification and what it can do for companies, both internally and externally (Higgins, LEED AP). It has become commonplace for businesses to demand that other companies follow some kind of green building guideline, or they will not work with them. Certification offers proof to businesses that companies have made significant efforts to become sustainable, allowing business to continue.

Society as a whole may also experience benefits of green building through a reduction in external costs. Green buildings focus heavily on decreased pollution through the reduction of green house gas (GHG) emissions. While a green building project itself may experience a benefit by using renewable energy, the cost of which could certainly be quantified, society could also experience benefits by avoiding any negative externalities, such as health issues or clean up efforts that could be created by air pollution. This is particularly important when considering implementing green statutes for policy because it concerns the general public.

Paternalism and Education

<u>Paternalism</u>

The need for there to be public policy focused on incorporating green building initiatives stems from the notion that people do not realize what is in their best interests and they make decisions without fully knowing the consequences (Meyer 2008). It is worth noting that even with its increased acceptance and usage in the building industry, green building still only accounts for a small portion of new projects in the US. For example, only 10% of commercial construction starts in 2009 were green projects (LEED #4). If society continues to use the conventional methods for building, accruing increased external costs to itself, it seems necessary that governmental agencies take on a paternalistic role to force the public to adopt new regulations requiring green building as the new standard in the industry.

In addition to avoiding negative externalities, the public may also not be realizing the added benefits that come from building green. If government agencies create policy forcing green building practices to be used, society will be forced not only to take on these new regulations but also to increase their knowledge of green building. This lack of knowledge has been shown to be one of the biggest inhibitors to the progression of green building in the US. Therefore, paternalism and the role of government can not only better society by forcing green regulations on the building industry, but can also increase public education of the green building process, further enhancing its potential to become the new building standard.

Education Issues

In order to carry out a successful green building project, education at some level must be given to all members involved in the project, which again adds more uncertainty to a cost-benefit analysis for green building investment. Considerable amounts of time and money must be put into getting around the learning curve associated with changing from the traditional linear approach to development to an integrated design approach of a green building program (Melaver and Mueller 2009, 111). This integrated approach involves all major players of the building process, from contractors and architects, to consultants, builders, and owners. Everyone must be in harmony for such a collaborative process to be managed creatively and efficiently. However, with an overall lack of public knowledge concerning sustainable building practices, more money and time must be allocated into putting professionals through training to operate and maintain a green building. Educational costs must be considered when laying out the initial costs for green building investment.

Merit of Certification

Certification Issue

The costs and benefits of green building initiatives, among other things, must be net beneficial so as to make consumers want to choose sustainable building practices over traditional building practices. In many cases, the cost differences between building designs that wish to achieve green certification and building designs that do not have certification in mind are not very significant (Langdon 2007, 3). However, there are many cost-efficient building components available on the market that in today's industry have become commonplace. If it is more cost-efficient for a contractor to implement certain building components, it can be assumed that contractors would use them regardless of whether they are seeking green certification. This begs the question as for why certification is necessary at all. Many of the points that green certification projects would gain are for building components that any contractor would implement into the project because they are sensible with today's building standards. For example, using double-glazed windows to conserve heat has become commonplace in building design, whereas triple-glazed windows would earn an extra point by LEED, regardless of the fact that double-glazed is cheaper and its energy saving effectiveness is only marginally less depending on the climatic location of the building. This notion of excessive installation of energy efficient building components can create cynicism to whether green certification is necessary and can call its cost-effectiveness into question.

Correlation between Points and Performance

Green certification checklists, like the one used by LEED, offer different levels of certification that are designed to give more points to projects that take further steps in creating a more sustainable and energy efficient building (LEED #2). Therefore, different levels of certification assumes that a building that holds a higher level of certification will perform at a higher level and be more cost efficient to operate. However, the framework gives the building designer the flexibility to control the outcome of the project with specific goals in mind, which can create clout when quantifying how individual buildings contribute to overall energy and cost saving.

The score sheet infers that there is a correlation between the number of points awarded and the amount of economic return. Yet the complexity of a building system itself creates uncertainty when considering the interaction between points and cost and energy savings. Buildings have interconnected systems that depend on one another, meaning their interior and exterior components are constantly interacting. Going through the checklist and attempting to outfit a building with every possible energy-efficient feature by incurring higher initial costs not only does not guarantee a more sustainable and cost-efficient return on investment, but could create a building that is inefficient both in terms of cost and energy. Building designers must take many aspects of the project into account, such as climate, location, and overall building design. For example, a building that is constructed in Arizona with double-glazed windows and a high-efficiency gas furnace to conserve heat would not make economic sense in a region where annual temperatures are very high. While both features alone would provide energy efficient outcomes, having both together could result in an unnecessary amount of initial investment and energy used to incorporate both features when only one would suffice for this region. This example shows one of the many uncertainties inherent in a green certification system in that a checklist does not take into account the interaction of its features within a building that could produce inefficient outcomes.

Chapter IV:
Energy and Cost Saving from Green Building and LEED

In this chapter, we first examine examples of energy savings realized from building green and using the LEED rating system. We then examine costs per sq/ft for LEED projects and non-LEED projects, as well as studies on green premiums and education costs. Next, we examine studies on external benefits for green building, followed by the relationship between LEED points and how they reflect to cost and energy savings. We then focus on a cost-benefit analysis simulation conducted by Blackburne (2009) , and end with a look at public policy initiatives taken on by various cities and states in the past decade.

Realized Energy Savings of Green Building

Early Examples of Green Renovations

Romm (1999) presents numerous case studies in which companies in the 1990s went about reducing their energy consumption and overall costs without the use of a rating system, primarily because green building rating systems, specifically LEED, had not caught on yet in the public domain or within the industry. One case is a project undertaken by BlueCross/BlueShield of Oregon in 1993, which upgraded its 106,000ft2 corporate headquarters to boost employee productivity and cut energy costs. They carried out a number of improvements to the facility, including energy efficient lighting, improved insulation, and a high-efficiency HVAC system to lower energy costs and improve indoor air quality. Post-project estimates found that overall energy consumption was reduced 61%, saving the company $130,000 a year, 57% lower than pre-retrofit energy costs (Romm 1999, 52).

Another example can be seen in the mid-1990s when the San Diego Environmental Services Department (ESD) renovated the Ridgehaven, an existing three-story, 73,000ft2 office building. The Ridgehaven project focused on indoor air quality improvement by using products that minimized the emission of noxious volatile organic compounds, and energy savings from installation of a new high-efficiency HVAC system. Energy consumption in the Ridgehaven was reduced by 70%, with annual savings of about $80,000. Data on construction and initial investment costs was not presented, making a cost-benefit analysis unquantifiable. However, the building was found to be 60% more energy efficient than an identical office building next door (Romm 1999, 51). Importantly, the renovation included a monitoring system to track energy savings over time (a feature that LEED projects do not commonly incorporate) and its predicted 3-yr return on investment was seen almost immediately due to its financing aspects. Both of these projects were undertaken in a time when the LEED rating system had only just been released, keeping their motivations for renovation separated from federal or public influence and more strictly focused on energy and cost savings.

Energy Savings From Using LEED

A detailed review performed by Gregory Kats in 2003 of 60 LEED-rated buildings in California demonstrates that green buildings are, on average, 25-30% more energy efficient compared to conventionally built or renovated buildings, which by today's standard are more advanced than the pre-renovated buildings examined by Romm (1999). This finding is based on peak electricity consumption, use of renewable energy on-site, and purchase of grid power generated from renewable energy sources, such as green power and/or renewable certificates (Kats Oct. 2003, 19). On average, Kats' study found that green buildings are 36% more efficient then conventional buildings, while renewable resources account for 2% of their power (Exhibit 4.1). Calculating costs for this assessment depends heavily on the cost of energy and peak power costs, which can vary depending upon location and the utility provider. Hard data for a cost-benefit analysis to compute cost savings from reducing energy was therefore difficult to quantify for Kats' study (Kats Oct. 2003, 26).

Exhibit 4.1: Reduced Energy Use in Green Buildings as Compared with Conventional Buildings (Kats Oct. 2003, 24).

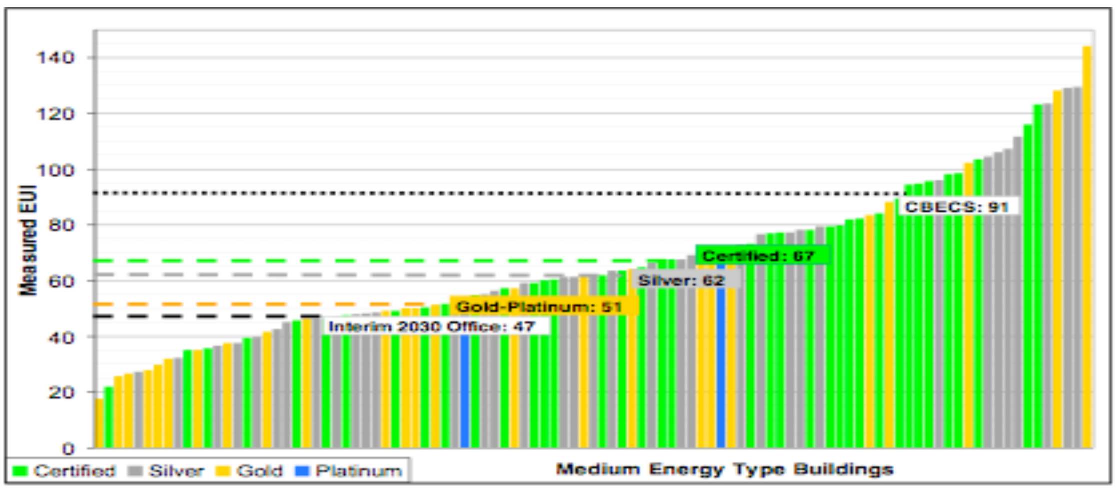
Reduced Energy Use in Green Buildings as Compared with Conventional Buildings

	Certified	Silver	Gold	Average
Energy Efficiency (above standard code)	18%	30%	37%	28%
On-Site Renewable Energy	0%	0%	4%	2%
Green Power	10%	0%	7%	6%
Total	**28%**	**30%**	**48%**	**36%**

Source: USGBC, Capital E Analysis

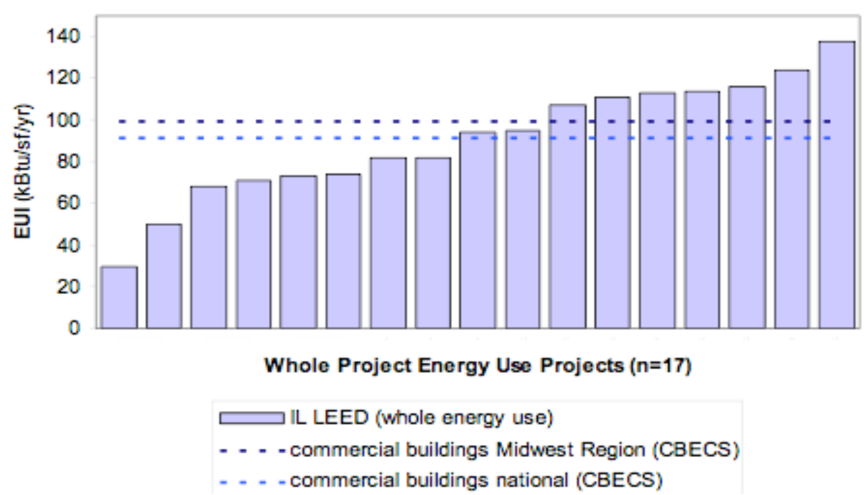
A report by the New Buildings Institute in 2008 measured the energy performance for 121 LEED New Construction (NC) buildings and found that their average energy savings were 28% when compared to code baselines, which was slightly higher than the average 25% savings predicted by energy modeling in the LEED submittals (NBI 2008, 3). The report analyzed whole-building energy usage by using three different energy metrics: (1) Energy Use Intensity (EUI), (2) Energy Star ratings, and (3) Measured results compared to initial design and baseline modeling (NBI 2008, 2). The most basic metric of the three, EUIs compares LEED building energy use intensity (in kBtu/sf/yr) to data from all national building stock. This data comes from the Commercial Building Energy Consumption Survey (CBECS), a national survey of building energy characteristics completed every four years by the federal Energy Information Administration. The median measured EUI was 69,000 Btu/sf for all 121 LEED buildings in the study, 24% below (better than) the CBECS national average for all buildings. The report also shows that the median EUIs for all levels of LEED certification beat the CBECS median (Exhibit 4.2).

Exhibit 4.2: Median Energy Use Intensities (EUI) by certification level of LEED Buildings (NBI 2008, 2).



Although there are many examples of energy efficiency in LEED-certified buildings, a 2009 case study by USGBC's Chicago chapter, which also utilized energy use intensity as a metric for measuring LEED building energy reductions and compared their energy data to CBECS, found slight discrepancies. The study analyzed the post-occupancy performance of 25 LEED projects in Illinois. Seventeen whole project energy use projects were examined and reported with median EUIs of 94,000 Btu/sf, coming out slightly higher (3,000 Btu/sf) than the EUIs reported by the national CBECS median, although it is noted that these projects performed 5% better than the Midwest CBECS average, shown in Exhibit 4.3 (LEED #1, 10). The remaining eight partial use energy projects had median EUIs of 38,000 Btu/sf, significantly beating the CBECS levels. The report points out that although the median EUI for whole project energy use projects was slightly higher, 47% of the Illinois LEED study whole project energy use projects performed better than the CBECS National median EUI (LEED #1, 10). Fifteen of the twenty-five buildings in the study submitted total project costs, putting the median green premium (after grants and incentives) cost per sq/ft at $7.26. Unfortunately, the study does not present costs per sq/ft of the CBECS national or Midwest stock, nor does it incorporate other benefits, such as worker productivity, which makes performing a cost comparison between the LEED and non-LEED building stocks very difficult (LEED #1, 20).

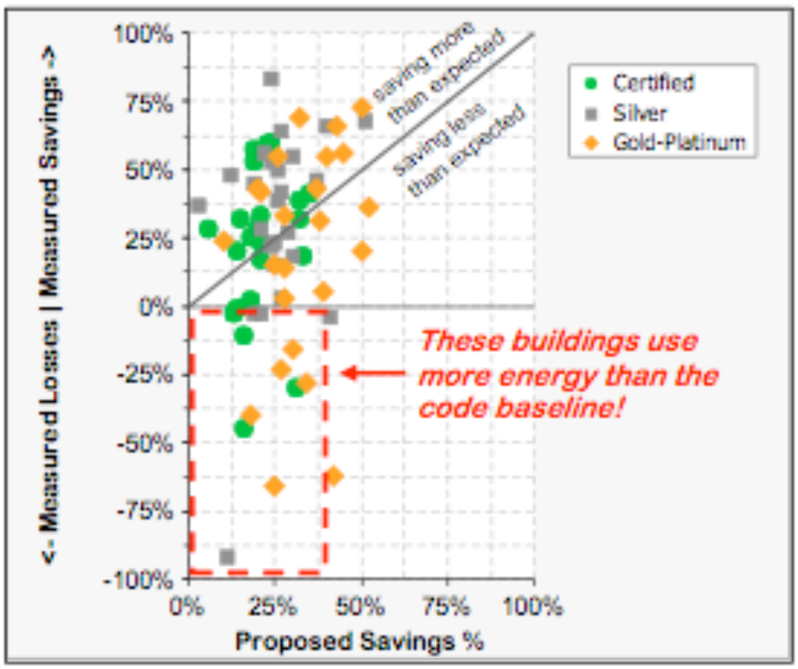
Exhibit 4.3: EUI measurements of 25 IL LEED projects compared to the national and Midwest Regional CBECS medians (LEED #1, 10).



New Buildings Institute in 2008 points out that, program-wide, energy-modeling baselines are good predictors of average building energy performance for individual projects. However, at the extreme, they found that some buildings use more energy than the predicted code baseline modeling, shown in Exhibit 4.4. This data along with the discrepancy found in the Chicago case study seem to support Gifford's notion that

LEED-certified buildings actually use more energy than conventional buildings. However, NBI 2008 points out that this variation in results is likely to come from a number of sources, including differences in operational practices and schedules, equipment, construction changes, and other issues not anticipated in the modeling process. A more in-depth analysis of some of the best and worst performers could identify ways to eliminate the poorer outcomes and communicate lessons from the best results (NBI 2008, 4).

Exhibit 4.4: Measured versus Proposed Savings Percentages in LEED Buildings (NBI 2008, 4)



Realistic Costs of Green Buildings

<u>Davis Langdon Study</u>

One of the main reasons that it has taken so long for LEED to become a commonplace in the building industry is that there is a continuance by project teams that conceive of sustainable design as a separate feature. This leads to the notion that green design is something that gets added to a project, and so there is added cost. This tendency is especially true for less experienced teams that are confronting higher levels of LEED certification (Langdon 2007, 3). In a 2007 study, Davis Langdon analyzed a total of 221 buildings, 83 of which were "LEED-seeking", or had the goal of LEED certification in their project. The other 138 projects were buildings of similar program types, which did not have a goal of LEED certification. Langdon analyzed the cost differences in the initial and final budgets between the 83 LEED buildings, which used LEED Version 2.2, and the 138 non-LEED buildings. His conclusion was that there is no significant difference in cost between LEED projects and non-LEED projects, and that many projects can achieve sustainable design within their initial budget, or with very little supplemental funding. It is also worth noting that from 2004 to 2006, construction costs increased 25-30% in many parts of the country, putting tremendous pressure on contractors (Langdon 2007, 3). Still many projects have been able to achieve sustainable goals within their budgets, with the most successful establishing clear goals from the start.

Costs of Building Green

A 2009 study conducted by the USGBC New York Chapter Urban Green Council set out to find actual costs of building green using the LEED rating system. Data was gathered on 107 recent projects, of which 63 were either pursuing or had achieved LEED certification with LEED for New Construction or Commercial Interiors. Construction costs for two building subsets were analyzed statistically: high-rise residences (38 projects) and commercial interiors (25 projects) (LEED #11, 7). For cost data, the study surveyed the 107 buildings and gathered data on construction costs, design fees, LEED design fees, LEED additional fees, and commissioning fees (LEED #11, 10). To begin analyzing the financial costs associated with green building, the study team first examined the construction costs per square foot for all surveyed projects, including acquisition fees, soft costs, site work, and parking structure costs (LEED #11, 12). The majority of all new construction high-rise residential projects fell within the range of $300 to $600 per sq/ft, with the LEED projects falling within the same range, while the costs for the majority of commercial interiors fell within the range of $100 to $200 per sq/ft, with the LEED projects again falling within the same range (LEED #11, 12).

Exhibit 4.5: Costs per sq/ft for High-Rise Residential Buildings and Commercial Interior Projects (LEED #11, 7).

HIGH-RISE RESIDENTIAL BUILDINGS
Cost Normalized to Construction Year

	LEED	NON-LEED
AVERAGE	$440/sf	$436/sf
MEDIAN	$439/sf	$407/sf

COMMERCIAL INTERIORS PROJECTS
Cost Normalized to Construction Year

	LEED	NON-LEED
AVERAGE	$191/sf	$204/sf
MEDIAN	$158/sf	$163/sf

Their analysis concluded that there was no statistically significant difference in construction costs between LEED and non-LEED buildings, shown in Exhibit 4.6 (LEED #11, 13).

The Urban Green Council 2009 study points out again that additional costs are incurred because LEED buildings often require the use of higher cost materials, systems, and construction processes. They also incur soft costs for LEED design fees, documentation fees, and commissioning fees (LEED #11, 14). However, they find three reasons why there are no significant construction cost differences between LEED and non-LEED buildings. First, LEED project teams make different choices about how to spend the money available to them, relocating funds within the project budget to accommodate green measures.

Exhibit 4.6: Construction Costs for LEED and non-LEED buildings in NYC (LEED #11, 14).

CONSTRUCTION COSTS: HIGH-RISE RESIDENTIAL ($/SF)

	ALL	LEED	NON-LEED	CERT	SILVER	GOLD	PLAT
AVERAGE	438	440	436	315	467	433	463
MEDIAN	431	439	407	315	439	440	463

Table 4:
CONSTRUCTION COSTS: COMMERCIAL INTERIORS ($/SF)

	ALL	LEED	NON-LEED	CERT	SILVER	GOLD	PLAT
AVERAGE	197	191	204	N/A	156	330	100
MEDIAN	160	158	163	N/A	158	244	100

Second, as the building market is maturing with respect to sustainability, many of the additional costs currently associated with LEED are decreasing as LEED-compliant materials, systems, and processes are becoming more common. Third, project teams are learning to take a more disciplined and integrated approach to design, which also reduces costs (LEED #11, 13).

Green Premiums

In order to justify Langdon's findings, cost data must include both green building and conventional building design costs for the same buildings. Kats (2003) set out to find accurate cost comparisons of green and conventional building designs for the same buildings for 33 green buildings across the United States. It was found that the average premium for these green buildings is slightly less than 2%, or $3-$5/ft2, substantially lower than is commonly perceived, shown Exhibit 4.7 (Kats Oct. 2003, 15). The majority of this cost is due to increased architectural and engineering design time, modeling costs and time necessary to integrate sustainable building practices into projects. Generally, the earlier building features are incorporated into the design process, the lower the cost (Kats 2003, 3).

Exhibit 4.7: Level of Green Standard and Average Green Cost Premium (Kats Oct. 2003, 15).

Level of Green Standard and Average Green Cost Premium

Level of Green Standard	Average Green Cost Premium
Level 1 – Certified	0.66%
Level 2 – Silver	2.11%
Level 3 – Gold	1.82%
Level 4 – Platinum	6.50%
Average of 33 Buildings	1.84%

Source: USGBC, Capital E Analysis

In 2008, Norm Miller et al released a similar report on their findings from data received by USGBC of green building cost premiums. They found that on average, green buildings meeting the minimum LEED Certified incur cost premiums of only about 3%. With LEED Silver being at 2.5%, plus the 3%, the premium is still only at 5.5% (Miller et al 2008, 8). Like Kats, Miller et al points out that these extra costs are incurred early in the building process from increased design time and modeling costs. They importantly note that it is very likely that the building market value enhancement exceeds the direct extra costs for LEED certification, and that considering many benefits are not energy or environmentally related savings but rather occupancy benefits, going green becomes more compelling with cost savings seen in other areas (Miller et al 2008, 8).

Upgrading from Gold to Platinum Case Study: Cooper Union

The Cooper Union case study from Urban Green Council 2009 offers a good example of the cost differences of going from one LEED certification level to the next. As the design process of Cooper Union's New Academic Building progressed, the project team realized that LEED Platinum certification was within reach (LEED #11, 25). In order to analyze the increased costs associated with progressing from LEED Gold to Platinum certification, the study focused on which sustainable features were added after the project team's decision to pursue the higher level of sustainability. These features included a greywater system, provision of low-emitting vehicles for users of the building, photovoltaics, purchase of green power, and the implementation of a measurement and verification commissioning plan to evaluate the building's performance over time (LEED #11, 25). Additional costs, such as design, LEED, and commissioning fees were associated with the shift from Gold to Platinum. The additional sustainable design features together added only 0.83% to the project's cost, or $4.96 per sq/ft (LEED #11, 25).

With its new systems, the Cooper Union's New Academic Building yielded substantial savings in both energy and water costs for the operation of the building, with anticipated water use savings of 51% compared to baseline estimates (LEED #11, 25). Yearly estimated energy savings for the building come to 42.3%, a saving of $379,135 a year (LEED #11, 26). These systems are expected to pay for themselves almost immediately, demonstrating that upgrades between levels of LEED certification can help benefit the building and do not have to be costly.

Education Costs

Once a green building is constructed, education costs become an issue because considerable amounts of time and money must be put into getting around the learning curve associated with approaching a project differently. Additional expenses are associated with the time it takes a company to become conversant with the LEED program, the time to determine which materials and technologies to use, the time to educate tenant-rep brokers and potential tenants about the nature of a project, and the time to draft and negotiate leases that call for special specifications different from those typically present (Melaver and Mueller 2009, 158).

Blackburne (2009) points out that it took his company three years to manage this learning curve to the point where it could develop green building with the same efficiency of time and money as a conventional building project. A company will need time to get a grasp on a green building program. Even if a company hires consultants to expedite matters, there will still be members of a company’s development team that have to understand and implement what the consultant is talking about. This leads companies to invest in resources so that their staff becomes well versed in the green building program. These resources include providing workshops for staff members, covering the costs of accreditation exams, paying bonuses to all who pass, and the lost opportunity for time spent at the workshops and/or taking the exam, all done so that company members can become accredited green professionals. Having accredited professionals allows a building with energy efficient features to be operated accordingly and allows savings to be realized.

Blackburne found that the investment for educational costs was approximately $49,000, which includes the cost of investing employees in the LEED program, about $1,400 per person, plus the lost opportunity cost the company could have made if it had not gone through with the education, valuing it at around $15,000. While opportunity costs vary depending on the number of workers, Blackburne points out that these costs are usually outweighed by the cost savings of building green (Melaver and Mueller 2009, 130).

Business Case Benefits of Building Green

Worker Productivity

Labor costs are by far the largest expense for most companies, accounting for 92% of life-cycle costs, more than 72 times the cost of energy (Melaver and Mueller 2009, 207). Small increases in worker productivity can result in tremendous improvements in company revenue and/or reduction in expenses from fewer employee absences, fewer health claims, and increased productivity. Measures that can increase productivity by 1% could over time have a fiscal impact roughly equal to reducing property costs by 10% (Kats Oct. 2003, 54).

With the growing recognition that large health and productivity costs are imposed by poor indoor environmental quality, green buildings have been shown to increase worker productivity and health by enhancing indoor air quality (Kats Oct. 2003, 55). With other examples abounding, William Pape, the cofounder of VeriFone, reported that eighteen months after VeriFone employees began working in a building retrofitted to cut indoor pollutants and improve air quality, worker absenteeism rates were down 40% and productivity was up more than 5% (Kats Oct. 2003, 56).

Adding daylight to a building has also been shown to be a simple and effective way to boost productivity. Students end-of-year test scores from Colorado, Washington, and California in classrooms with the largest amount of daylight were found to be about 7 to 18% higher than those with the least (Melaver and Mueller 2009, 208).

In a 1999 study *What Office Tenants Want,* study respondents attributed the highest importance to tenant comfort features being comfortable air temperature (95%) and indoor air quality (94%) and that the number one reason tenants move out is because of HVAC heating and cooling problems (Kats Oct. 2003, 57).

A company that experiences a 1% increase in productivity is equal to $600 to $700 per employee per year, or $3 per sq/ft, while a 1.5% increase is equal to about $1000 per year, or $4 to $5 per sq/ft per year. Over a 20 year period at a 5% discount rate, the present value of the productivity benefits for LEED Certified and Silver level buildings is about $35 per sq/ft, and $55 per sq/ft for Gold and Platinum (Kats 2003, 7). These values become hugely important when considering that employee costs outweigh any other cost a company incurs, further promoting the desirability to build green.

<u>Real Estate Benefits</u>

Green building benefits can be seen in the real estate market for a number of reasons, including lower operational and utility costs, property value enhancement over time, and increased name branding that draws new consumers. Benefits in the real estate market can be separated into direct cost savings and indirect cost savings. Direct cost savings, including energy savings, water savings, lower common area costs, and lower configuration costs, are tangible benefits that companies can see directly (Melaver and Mueller 2009, 204). Indirect cost savings, including reduced absenteeism, reduced health claims, and reduced employee turnover are benefits that are less tangible and are often the least attended cost centers of American business, but should be calculated in overall cost savings nonetheless (Melaver and Mueller 2009, 206).

In his examination of real estate benefits of green building, Blackburne lays out the basic tenant lease structure, in which a tenant pays to the landlord a base rent plus its share of taxes, insurance, and operating expenses above the base year of its occupancy (Melaver and Mueller 2009, 117). By lowering operational costs with green investments, landlords are able to recapture some of the value of their investment, and tenants see a much larger benefit in the decreased cost of annual rent. Putting all direct and indirect costs into a projected cash flow over a ten-year period, Blackburne estimates that a tenant occupying a green building can expect to save 36.57% on annual utility bills compared to a baseline projection (Melaver and Mueller 2009, 212).

CO_2 emissions

One of the main goals of building green is to reduce a building's carbon footprint. Putting a price on CO2 emissions is a very important aspect when assessing total cost of the building as well as its impacts to society (Kats Oct. 2003, 37). Given the large range of prices assigned to CO2 by emissions trading markets, policy makers, analysts and others, there is no exactly right price per ton of CO2 (Kats Oct. 2003, 38). There is nevertheless a social cost taken on by CO2 emissions that green building attempts to account for. The Riverhouse building, a LEED Gold building in New York, is one such example that created a carbon model to compare Riverhouse as built to a hypothetical Riverhouse built conventionally. Based on various elements of its construction and LEED certification, such as the use of fly ash in its concrete, the incorporation of a high efficiency HVAC system, and its availability by public transportation, the Riverhouse reduced its operational CO_2 emissions by 17% compared to its baseline model (LEED #11, 23). Modeled over a 50-year period, it was concluded that the measures undertaken by the Riverhouse design to reduce its carbon footprint should prevent roughly 62,800 tons of CO_2 in the atmosphere. Based on Kats 2003's suggested price for CO_2 emissions of $5 per ton, this would come to a present value saving of $314,000 for just one building, a cost that would not have to be taken on by society, but would still be considered when performing a cost-benefit analysis.

<u>Altruism</u>

While realized benefits from real estate, worker productivity, and decreased CO_2 emissions may contribute to a company's financial success, the main financial benefit that a company may see from creating a green culture by building green is the sense of purpose and meaning that it brings to a company. This warm glow effect gives a sense that people are truly making a difference and being stewards of the environment (Melaver and Mueller 2009, 134). It is a sense of altruism that Blackburne points out became a sharing of core beliefs within his company, a deep feeling that what the company was doing made sense, something extra that each individual could identify with. Whether it is pride, a sense of accomplishment, or a meaning in the work being done, Blackburne calls it the "X" factor that allows everybody to work harder, go the extra mile, and automatically pick up the slack because everybody knows the ultimate goal (Melaver and Mueller 2009, 134). Blackburne sees this sense of altruism, this "X" factor, as the main driver behind improved productivity in his company and the desire to continue into the future with sustainable goals. In the end, altruism and its feel good effect on a company helps create the potential that companies will experience realized gains from green building (Melaver and Mueller 2009, 134).

Relating LEED Points to Building Performance

New Buildings Institute focuses a part of its 2008 study to explore the relationship between LEED credit achievement patterns and actual energy use. In order to do this, the study focuses much of its attention on LEED's Energy and Atmosphere (EA) Credits, which are a prioritization for LEED 3.0. EA credit 1, Optimize Energy Performance, contains 1-19 possible points for LEED-NC and LEED-Schools and 3-21 possible points for LEED-CS. By increasing a building's energy performance, a project team can achieve more EA credit 1 points. Exhibit 4.8 shows a consolidated table of points awarded based on the percent of energy saved.

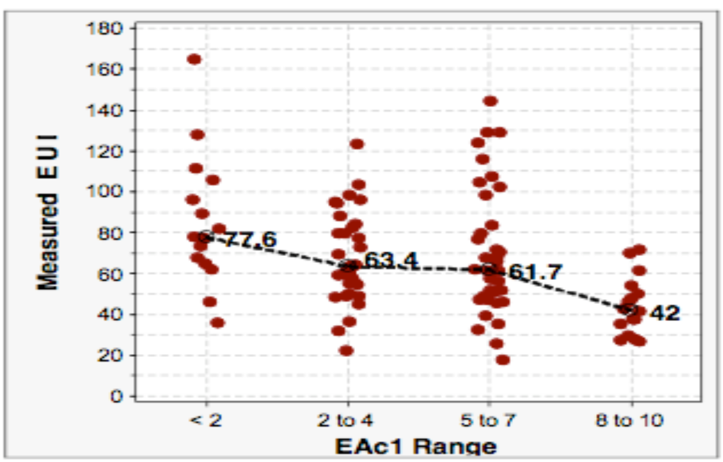
Exhibit 4.8: Points Awarded for NC, Schools, and CS Based on Percent of Energy Saved for EA Credit 1, LEED 3.0 (LEED #3, 257)

New Buildings	Existing Building Renovations	Points (NC and Schools)	Points (CS)
12%	8%	1	3
16%	12%	3	5
20%	16%	5	7
24%	20%	7	9
28%	24%	9	11
32%	28%	11	13
36%	32%	13	15
40%	36%	15	17
44%	40%	17	19
48%	44%	19	21

In keeping with the concept of integrated design, EA credit 1 points out that achieving a high level of points for this credit will also allow a project to achieve points in other credit areas (LEED #3, 260). This same pattern can be seen in EA Credit 2, On-site Renewable Energy, where buildings can achieve up to 7 points for the amount of on-site renewable energy they use during construction, adding to their overall energy reduction. Projects that use 1% renewable energy receive the baseline 1 point, whereas projects that use 13% or higher receive the maximum 7 points (LEED #3, 289).

NBI 2008 found in its study that projects that achieve higher point levels for EA credit 1 also show a generally declining (improving) EUI level, meaning they use less energy as they achieve more points (NBI 2008, 17). Exhibit 4.9 shows how building EUI's decline from the range of less than 2 to 10 achieved EA credit 1 points.

Exhibit 4.9: Measured EUIs (kBtu/sf) by EA credit 1 Point Range (NBI 2008, 17).



NBI 2008 also analyzed EA credit 3, Additional Commissioning, and credit 5, Measurement and Verification, which is meant to provide post project and occupancy energy levels, and found that there was little conclusive impact on energy performance associated with achievement of these credits. However, NBI does point out that, given the nature of the points, the lack of clear performance impact from achieving EA credit 3 says nothing about the value of the basic post-construction commissioning process, but does criticize credit 5 for its lack of effectiveness at providing actual performance documentation in a cost-effective manner (NBI 2008, 30).

Some projects can achieve additional points simply by the nature of the environment in which they are built. For example, a project could achieve an easy 5 points for Sustainable Sites (SS) credit 2, Development Density and Community Connectivity, by developing a building in an area with the following characteristics (LEED #3, 23):

- Built in a previously developed site in a community with a minimum density of 60,000 sq/ft per acre net,
- Is within ½ mile of a residential area with an average density of 10 units per acre net,
- Is within ½ mile of at least 10 basic services,
- And has pedestrian access between buildings and services.

While this may seem like a lot of requirements, consider that almost any building in an urban setting will likely meet most, if not all, of these criteria. While a project would have to put more money into its building design to achieve 5 additional points for EA credit 1, a project could easily achieve the 5 SS credit 2 points by its location while avoiding extra costs.

The SS credit 2 example brings up the notion that there are many LEED points that could be considered "easy points" that a project can achieve without incurring additional costs. Miller (2008) finds that, with proper building design planning, it is neither that difficult nor costly to achieve a significant amount of points out of the possible total that can be achieved. The study points out many points that are easy to achieve, such as SS credit 4.4, which creates no new parking for a building, or SS credit 4.3, designating minimal parking for low emission vehicles (LEED #3, 61, 71). The study points out that a building, from its virtue of design, can achieve the minimum point total for Certification for LEED 2.2 by implementing easy points, shown in Exhibit 4.10.

Exhibit 4.10: Easy point totals by credit category for LEED 2.2 (Miller et al 2008, 10).

	Points Possible	Easy Points
Sustainable Sites:	14	6-7
Water Efficiency:	5	4-5
Energy & Atmosphere:	17	0-1
Materials & Resources:	13	6-8
Indoor Environmental Quality:	15	5-7
Innovation and Design:	5	1-2
Total:	69	**22-30**

The ease at which projects can achieve certain LEED points can also depend on where they are located geographically - whether they are in urban or non-urban areas. New York City projects, for example, are better able to achieve certain LEED points compared to the rest of the country, and are also less likely to achieve other points. NYC buildings for NC had 92% achievement for SS credit 2, compared to only 21% achievement compared to the rest of the country (LEED #11, 17). Similar patterns are seen for SS credits 3, Brownfield Redevelopment, 4.1, Public Transportation Access, and 7.1, Non-Roof Heat Island Effect, which all combined could reward a project 13 points without incurring large additional costs.

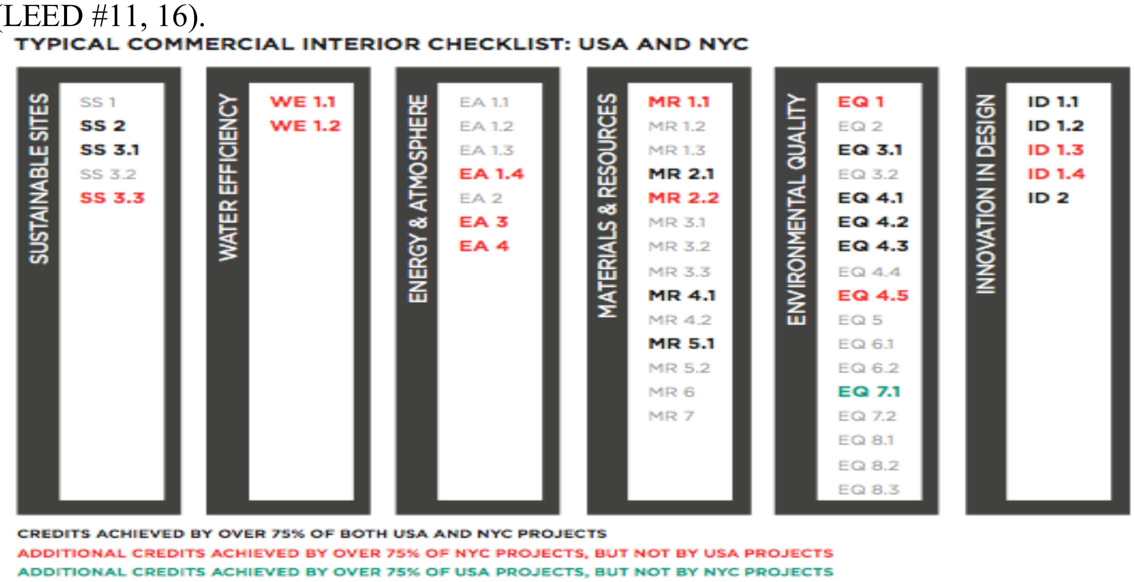
Other points in the LEED credit structure are less easily attainable by NYC buildings compared the rest of the country, such as Materials and Resources (MR) credits 4.2, Recycled Content, and 5.2, Regional Materials, shown in Exhibit 4.11.

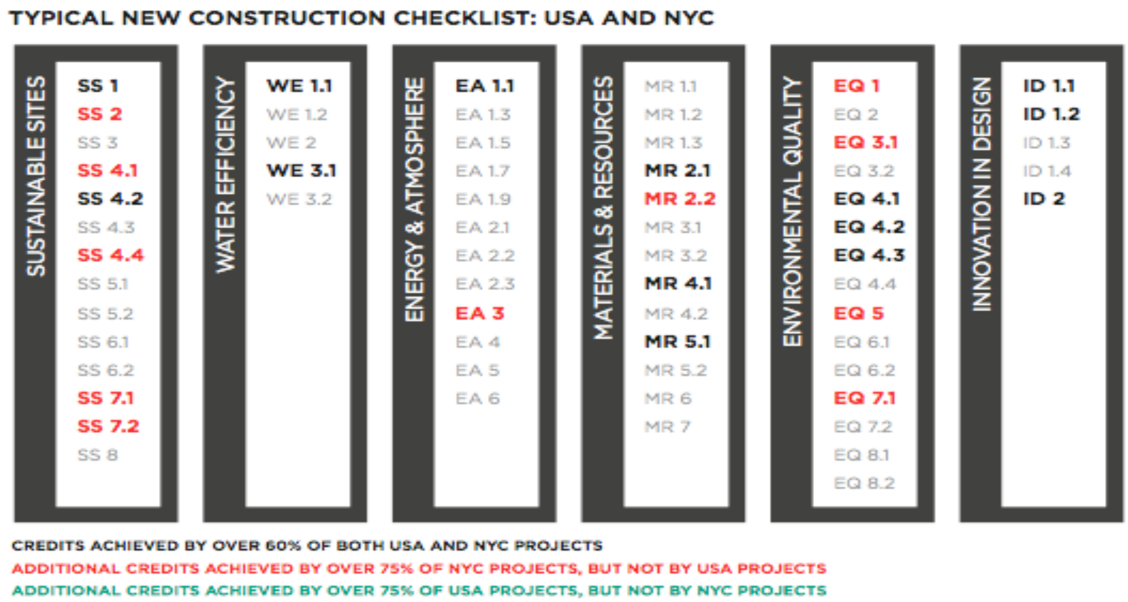
Exhibit 4.11: Percent of Buildings Achieving MR credits 4.2 and 5.2 for LEED NC in New York City and Across the United States (LEED #11, 17)

	Achievement for LEED NC in NYC	Achievement for LEED NC in US
MR credit 4.2- Recycled Content	49%	71%
MR credit 5.2- Regional Materials	36%	71%

Exhibit 4.12 shows typical credit achievements for projects in NYC compared to projects around the US. Overall, by virtue of where a project is undertaken, it can achieve some points easier than others. The Urban Green Council 2009 study found that remaining LEED-NC points are achieved at similar percentages for both NYC and countrywide projects. However, the study also points out that achievement percentages in San Francisco were similar to those in NYC, implying that dense urban areas with strong public transportation infrastructure share patterns of LEED credit achievement (LEED #11, 17).

Exhibit 4.12: Typical LEED Point Checklists for CI and NC Project in NYC and the US (LEED #11, 16).





The LEED credit structure seems to consist of a relatively balanced mix of credits that are designed to be both environmentally friendly and economically efficient. EA credits are mostly designed to lower utility costs over the life of the building. But some credits, such as MR credit 1.1, Building Reuse- Maintain Existing Walls, Floors, and Roof, which offers 1 base point for a project that reuses 55% of a building, 2 points for 75%, and a maximum 3 points for 95% of a building for LEED-NC, can lower initial construction costs and thus lower the magnitude of the initial investment into a green building project (LEED #3, 347). This cost saving could certainly be quantified and be factored into a life-cycle cost-benefit analysis. Most importantly, in keeping with the notion of integrated design, just about all of the LEED credits are designed to work with and promote other credits, both within the same credit category and other categories as well.

Credit implementation is largely influenced by urban landscape, public policy, climate location, project budget, and expected performance. It is for this reason that it takes a knowledgeable design team that takes all these factors into account when deciding which credits to implement and the extent of certification they want to achieve (Ercoli, LEED AP). Full documentation of all LEED 3.0 credits, including benefits, related credits, implementation, timeline and team, documentation guidance, and examples can all be found in the LEED Reference Guide for Green Building Design and Construction, 2009 Edition.

Cost-Benefit Analysis

Life-Cycle Analysis

With an understanding of the costs and benefits associated with building green, it is now possible to accurately create a cost-benefit analysis incorporating all of these factors. Dennis Blackburne, CFO of Melaver, Inc. created a realistic model of a cost-benefit analysis of a made up company, Green, Inc., a smaller version of Melaver, Inc., whose revenues and profitability understate the performance of their own company while using their actual cost structure. The analysis incorporates many factors that go into becoming a green company, and these factors help create realistic values of revenue and expenses to produce the net present value (NPV), which reflects the stream of current and future benefits and costs, and results in a value in today's dollars that represents the present value of an investment's future financial benefits minus any initial investment (Kats Oct. 2003, 9).

Blackburne assembles this data into a ten-year amalgamated cash flow statement to get an overall picture of whether their investment in becoming a green company has paid off. His analysis includes various aspects of Green, Inc., including early investment in shaping company values, shaping a company's culture, developing an environmental audit, and education in becoming green (Melaver and Mueller 2009, 130). With total revenues and expenses, the total cash flow is produced, and at the appropriate discount rate, a positive NPV of $2.3 million is found for all investments. The analysis (Exhibit 4.13) also produces an internal rate of return (IRR) of 28%, much higher than the company's minimum threshold of 15%. Overall, this example by Blackburne gives an accurate assessment of how to value a green company. Considering present value, realized benefits are shown to outweigh costs.

Exhibit 4.13: Amalgamated Cash Flow Analysis for Green Inc (Melaver and Mueller 2009, 130).

Years	0	1	2	3	4	5	6	7	8	9	10	TOTALS
REVENUES												
Shaping values, chapter 1		21,300	21,300	21,300	21,300	21,300	471,300	538,800	548,925	550,444	550,672	2,766,640
Creating a culture of green glue, chapter 2		79,000	79,000	79,000	79,000	79,000	79,000	79,000	79,000	79,000	79,000	790,000
Green from the inside out, chapter 3		3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	3,300	33,000
Developing expertise in LEED, chapter 4	0	0	0	0	0	0	2,116,500	1,176,475	1,222,971	1,261,446	1,303,442	7,080,834
Sale of Green, Inc.											0	0
Total Revenues		103,600	103,600	103,600	103,600	103,600	2,670,100	1,797,575	1,854,196	1,894,189	1,936,413	10,670,474
EXPENSES												
Shaping values, chapter 1	(166,000)	(114,500)	(91,875)	(97,286)	(103,490)	(110,605)	(118,765)	(128,125)	(138,866)	(151,190)	(165,335)	(1,386,037)
Creating a culture of green glue, chapter 2	0	(57,600)	(64,631)	(72,717)	(82,016)	(92,710)	(105,007)	(119,150)	(135,413)	(154,117)	(175,625)	(1,058,987)
Green from the inside out, chapter 3	0	(78,490)	(22,381)	(22,998)	(24,858)	(26,997)	(29,456)	(32,285)	(35,538)	(39,278)	(43,580)	(355,862)
Developing expertise in LEED, chapter 4	(49,000)	(150,000)	(417,000)	(890,000)	(57,000)	0	0	0	0	0	0	(1,563,000)
Total Expenses	(215,000)	(400,590)	(595,888)	(1,083,002)	(267,365)	(230,311)	(253,228)	(279,560)	(309,817)	(344,585)	(384,541)	(4,363,886)
Total Cashflow	(215,000)	(296,990)	(492,288)	(979,402)	(163,765)	(126,711)	2,416,872	1,518,015	1,544,380	1,549,604	1,551,873	
Discount Factor	1.000	0.909	0.826	0.751	0.683	0.621	0.564	0.513	0.467	0.424	0.386	0
PV Cashflow	(215,000)	(269,991)	(406,849)	(735,839)	(111,853)	(78,678)	1,364,261	778,982	720,464	657,183	598,314	0
NPV	2,300,994											
IRR	28.38%											

Putting the Numbers Together

A definitive, general answer to what the energy and cost savings of a green building using the LEED rating system compared to a conventionally constructed building is not easily attainable. As the various studies mentioned have shown, evaluating a building's energy and cost saving performance is best dealt with on a case-by-case basis. On a scale of the entire country, this evaluation becomes far more complex. Projects vary on multiple degrees, including urban landscape, public policy, climate location, and others. However, on a whole, the LEED system does require certain credit completion and proven levels of sustainability for any project to be certified. LEED 3.0 for NC requires a minimum of a 12% reduction in overall building energy use just in order to be certified. Yet this 12% reduction may result in more or less cost saving depending on the EUI of the building in question, which is again influenced by a myriad of factors, such as building operational hours or building use. Timing of the construction phase can also make a serious impact on overall energy and cost saving. The earlier a project approaches sustainable options, the more cost effective those options become (Ercoli, LEED AP). This is due primarily because these sustainable options are given ample time to be worked through and gives the building a better chance at the most efficient integrated design.

Due to the myriad of factors that can influence a project, an accurate and generalized cost-benefit analysis of green building may be impossible to come up with. By virtue of the LEED system and the variability of projects, no one LEED project may be the same as another, and this is likely true for a life-cycle analysis as well. It may be that the best approach is to focus on the studies that are specific to individual regions that will most likely examine buildings of the same consistency. For example, building necessities for a building in Arizona, such as the need to keep occupants cool on an annual basis, will vary drastically from a building in Massachusetts that needs to keep occupants warm on an annual basis. In doing so, it may be possible to predict the LEED system's energy and cost saving ability on a regional basis.

Kats' analysis of 60 LEED buildings in California compared to conventional buildings shows how a general cost-benefit analysis can be performed at the regional level. His report to California's Sustainable Building Task Force is one such regional evaluation and incorporates many of the costs and benefits that go into making an analysis for buildings in California, including energy savings, water savings, emissions savings, operational savings, and productivity and health benefits (Exhibit 4.14). He concluded that financial benefits of green design, as compared to baseline conventional buildings, are between $50 and $70 per sq/ft in a LEED building, over 10 times the additional cost associated with building green (Kats 2003, 8).

Exhibit 4.14: Financial Benefits of Green Buildings Summary of Findings (per sq/ft) (Kats 2003, 8)

Financial Benefits of Green Buildings
Summary of Findings (per ft^2)

Category	20-year Net Present Value
Energy Savings	$5.80
Emissions Savings	$1.20
Water Savings	$0.50
Operations and Maintenance Savings	$8.50
Productivity and Health Benefits	$36.90 to $55.30
Subtotal	$52.90 to $71.30
Average Extra Cost of Building Green	(-3.00 to -$5.00)
Total 20-year Net Benefit	$50 to $65

Source: Capital E Analysis

Paternalism: Public Policies

Policies Across the Country

While the LEED rating system may be an instrument that can be used in paternalistic decision-making, LEED by itself is not paternalistic. In no way does it force or restrict people's decision-making based on their best interest. Instead, LEED's goal is to compel people to look very closely at green building techniques, strongly encouraging public education and awareness. Green building's paternalism impact lies in the creation of numerous policy initiatives due to the growing concerns over GHG emissions and increased energy consumption in the US. Both the federal Energy Policy and

Conservation Act of 2005 (and its extension passed by Congress in 2006) contain increased incentives and tax credits for residential energy saving initiatives (Yudelson 2008, 57). Individual state governments have also passed green policy initiatives, such as New Mexico passing a major green-building tax credit in 2007, and Oregon passing a 35% tax credit for solar energy systems (Yudelson 2008, 27). The state government of Massachusetts in 2007 passed Executive Order 484 "Leading by Example- Clean Energy and Efficient Buildings," an order instructing all agencies involved in new construction and major renovation projects of over 20,000 square feet to meet the minimum LEED Certified, specifying increased energy performance as one of the order's main goals (LEED #10).

In January 2011, the state of California will adopt the first statewide mandatory green building standards in the nation, using LEED as its foundation. Known as CALGreen, the code sets a new framework for recognizing and codifying important public health and safety issues related to buildings while focusing on reduced energy, water, and material use and decreased GHG emissions (LEED #10).

Many city governments, such as Washington D.C., Boston, New York, and San Francisco have created policy requiring LEED-certification for all new public and most large private projects (LEED #10). In fact, city governments have been shown to be the most active users of LEED in their policy due to the recognition that their impact on the environment is enhanced due to the overall mass of buildings in their urban settings. These examples show the paternalistic nature of local and state governments that deem green building, and in particular, the LEED rating system, within the publics best interest.

A full comprehensive list of recent LEED initiatives undertaken by several states, including new additions, federal initiatives, state and local initiatives, and school initiatives (K-12 and Higher Education), can be found on the USGBC website (LEED #10). While there are multiple examples of LEED policy initiatives from every state in the US, Exhibit 4.15 (Appendix 1) shows examples of recent LEED policy initiatives implemented from 46 state, county, or city governments to demonstrate LEED's policy adoption. Montana, Nebraska, North Dakota, and Wyoming do not have LEED policy initiatives at this time (LEED #10).

Boston Case Study

After Washington DC became the first major city in the US to require that privately funded projects achieve LEED certification in December 2006, the City of Boston quickly followed suit and continued the trend with an amendment to its building code (Wendt 2007). The amendment, passed in January 2007, requires that all buildings larger than 50,000 ft^2, funded either by the City or by private developers, be able to meet LEED Certified standards. However, the amendment also gives project developers the option of pursuing LEED certification or presenting proof of the project's certifiability to City officials. This was done primarily because the City recognizes that the certification process can be a substantial endeavor for some project teams due to the fair amount of expense associated with it (Wendt 2007). The City also incorporates into its policy the use of Boston Green Building Credits.

Any proposed project subject to the policy may obtain a maximum of four of the required points from the Boston Green Building Credits, which will be included in the calculation toward achieving a LEED certification (Boston Article 37). The Boston Green

Building Credit "Modern Mobility", for example, is awarded for any project that meets all of the Transportation Demand Management (TDM) prerequisites and at least three of the TDM optional credits. This credit focuses its attention on public transportation use and limited automobile usage, such as companies providing subway passes to occupants, or shuttle services to public transit stations (Boston Article 37). By incorporating their own credits into achieving LEED certification, the City not only promotes green building design, but also addresses the regional variability or area specific aspects of projects that LEED does not always take into account. The policy also makes the possibility of developers taking on more green projects much higher by offering the option of avoiding some of the certification costs that go into achieving LEED. However, regardless of whether a project achieves LEED certification or opts to avoid certification costs by submitting proof of credit implementation, the City recognizes LEED as the foundation of its green building design policy and compels project teams to achieve its standards (Wendt 2007).

Chapter V:
Conclusion

Interpretation of Findings

The evidence in chapter four indicates that the national stock of LEED-rated buildings are on average 25-30% more energy efficient compared to the national stock of conventionally built or renovated buildings. The evidence also suggests that LEED buildings are more likely to incorporate renewable resource technology, which allows them adapt to the future as the uncertainty in energy markets creates the demand for renewable energy. While it is true that LEED buildings promote greener technology, there are many inherent problems with finding overall realized energy savings from all LEED buildings. Studies are limited by regional differences, sample sizes, public policies, and, most importantly, energy performance measurements. For example, while EA credit 5, Measurement and Verification, focuses on monitoring post-project energy levels, LEED's lack of a stronger weighting to this credit limits data available for energy assessments of LEED buildings.

The evidence in chapter four also suggests that investments into a LEED project can be made at a premium of only 3%, with LEED Certified and Silver often costing even less. With the low cost at which a project team can achieve LEED Certified or Silver, it seems that choosing not to invest in a LEED project would make no economic sense. However, cost data was once again limited by regional differences and sample size. Certain projects will have harder times justifying investment into LEED due to their inherent complexity, be it building energy use, or location. Project teams must weigh all the options to come to the best conclusion, but as Blackburne (2009) points out, addressing sustainable goals early in the process creates the most efficient results.

The evidence from chapter four indicates that the external benefits created from a LEED project can significantly outweigh initial investment. On top of cost savings from reduced energy use, green buildings create more productive, healthier workers from enhanced indoor air quality or added daylight to the building, all of which can produce tangible added value to a company. Real estate benefits are realized by landlords who can lower operational costs and command higher tenant leasing rates. Green buildings also reduce the amount of GHG emissions they produce, which reduces external costs taken on by society.

Blackburne (2009) points out that incorporating education into the process is an essential aspect to the LEED system. A better understanding of the system can create more efficient results and reduce the chance of additional costs not initially taken into account. Costs will inherently differ depending on how much education is pursued, but some basic form of understanding of the LEED system has become essential for both industry professionals and building occupants. While initial education costs can add up, their lifetime influence becomes negligible and can lead to added value over time. Blackburne's cost-benefit analysis of Green Inc. incorporates the external and education benefits that can accrue over time and that undergoing the LEED project was net beneficial for his company. While Blackburne's assessment provides strong evidence for LEED's energy and cost saving and external benefit creation, it is unfortunately only one example that could be found.

The correlation between LEED points and building performance is a much more difficult task in evaluating LEED's merit. While there are hundreds of possible ways to accrue points to achieve LEED certification, there is no clear connection between the level of certification and the performance of the building. It is expected that a LEED Gold building will be more energy efficient than a LEED Silver, but there are multiple avenues of gaining points that do not make this an exact truth. For example, buildings that seek to achieve more Energy and Atmosphere points will expect to see higher energy efficiency. Yet the existence of "easy points" addresses the notion that two buildings can achieve similar amounts of points, or the same level of certification, but create buildings that use very different amounts of energy. However, looking at the overall certification level can be more effective because a system with multiple components may add value in other areas besides energy saving, such as reduced GHG emissions or water efficiency. The importance of these components will differ depending on certain factors such as regional differences and building energy use requirements. It may behoove USGBC to expand LEED to be more sensitive to regional building requirements.

Suggestions for Additional Research

Certain aspects of LEED create unanswered questions that most critics point to as fundamental flaws. Gifford points out that LEED buildings do not incorporate post-project energy monitoring as a focal point in their system, and so produce some buildings that can be energy inefficient. Indeed, LEED only allocates 2 points to EA credit 5, which is focused on post-project energy assessment. There are certainly enough Smart Grid and Smart Metering technologies to make a post-project monitoring system highly effective, not only in how it could quantify whole building energy use, but also in how it could quantify energy savings from individual building components. Post-project energy assessments would create useful information that could help convince both the industry and general public of LEED's benefits, as well as give LEED insights into which of its credit components add the most benefit to building performance.

The lack of concrete data on LEED's post-project energy use inhibits its ability to be completely accepted by the public, and allocating only 2 points to EA credit 5 offers little incentive to project teams to incorporate these systems into buildings. Allocating more points to this credit could help create far more support of LEED by helping prove its energy saving ability. This notion of allocating points should also be incorporated into the phenomenon of "easy points". While "easy points" might make project teams more willing to invest in features to achieve higher levels of certification, the amount of added benefit from these points may be less significant to overall building performance with respect to energy efficiency or external benefits. LEED should reexamine its point structure to allocate more points to those credits that create more benefit and improve the building more than others. However, this is once again contingent on how serious LEED becomes about post-project monitoring of its buildings.

The LEED system could also be held back because project teams are settling for LEED Certified or Silver levels that are relatively easy to reach, whereas LEED Platinum is conceived as requiring too much of an initial investment for the possible benefits it could accrue. Whether this is true or not, it should be the USGBC's goal to create more education on the matter. As pointed out, the industry has conducted a limited amount of cost-benefit analysis research. For future cost-benefit analysis, companies, project teams, investors, and USGBC alike should focus on performing more cost-benefit assessments to increase public knowledge of the net beneficial characteristics of the LEED rating system.

Another inhibitor to the LEED system could be that the current tenant leasing structure is outdated and provides little opportunity for landlords to experience the reduced operating leasing expenses enjoyed by tenants. To further promote green building, an innovative green lease structure is needed where the interests of the landlord and tenants are aligned. In the current scenario, the landlord is effectively penalized financially as green improvements in a property typically result in costs absorbed by the owner with benefits realized by the tenant. A green lease structure, where the landlord and tenant share the costs and benefits of energy improvements would be the most logical solution, as there are enough advantages to be shared. This complication may be no fault of LEED, but it is certainly something that could be worked out to further promote LEED and the public desire to invest in green building.

LEED's Accomplishments and Influence on Policy

Chapter four's evidence of LEED accomplishing its multiple objectives justifies LEED's place in public policy as a green building template that can educate both industry professionals and the general public on the net beneficial characteristics of green building. LEED has not only become the federal standard for green building systems, but has also been implemented into policy in almost every state in the US. The existence of hundreds of LEED policies city, state, and nationwide suggests that collaboration between LEED and policymakers is working productively and that there is an overall concurrence that traditional building techniques are outdated and do not take modern issues of future energy prices and conservation of resources into account.

With policy validating LEED's importance, LEED has also accomplished education within the building industry. Although green building still only makes up a small portion of the industry, it is without a doubt its fastest growing trend. With LEED quickly establishing itself as the new building standard, its impact has caused many developers to reconsider their building techniques and focus on greener methods. It is also likely that, as a result of the rating system, some developers are reaching farther in their projects to meet higher levels of certification. Whether these efforts actually produce better performing buildings is not as important as the fact that project teams are realizing the merit of LEED certification. LEED certification does not only mean a building will perform in a more efficient way compared to conventional buildings, but the "LEED-certified" branding also educates both the public and other contractors on the benefits of the system.

One of LEED's most important accomplishments is how it addresses global ramifications involving energy consumption and the current uncertainty of energy markets. Especially as uncertainty in oil and energy prices exists, LEED's focus on energy conservation and innovation in renewable energy sources could create a more stable market where volatile energy prices have smaller effects on consumers. Competition between fossil fuel and renewable sources could result in a higher demand for renewables from raised consumer awareness. LEED and green building could play a very large role considering the amount of energy that buildings require.

While the LEED rating system has greatly advanced in the United States, both in terms of its building industry and public acceptance, LEED must stay focused on its initial goals of creating better performing buildings and bettering social welfare. Policymakers must continue to be in sync with LEED's changing template to provide the most relevant policies for building codes. They must also continue to be paternalistic and not assume that people will always choose the option that is best for them. This is especially true considering that there is still a lack of public education about LEED and what its real benefits are. As the green building industry grows and LEED incorporates future advancements, hard data for LEED buildings should also make overall economic assessments of LEED a much easier task. Devotion to fixing the shortcomings of its current system will help LEED reach new heights in the industry and help the public realize even greater benefits. As it stands, the multiple studies examined in chapter four indicate that LEED is more often than not a practical option, and the LEED rating system offers a good template for possible goals that a green-seeking building project could want to achieve.

Bibliography

American Institute of Architects (AIA). "About the American Institute of Architects". (2010). www.aia.org/about/index.htm.

Article 37: Green Building. City of Boston, Commonwealth of Massachusetts. (Jan 10, 2007).www.cityofboston.gov/Images_Documents/Article%2037%20Green%20Buildings%20LEED_tcm3-2760.pdf

Doan, Lurita. Letter to Hon. Christopher Bond, Chairman, Subcommittee on Transportation, Treasury, the Judiciary, HUD, and Related Agencies. 15 Sept 2006.

Ercoli, Christopher, LEED AP, Energy Consultant. WSP Flack & Kurtz, Boston MA, Interview, Jan. 10, 2011.

Gifford, Henry. "A Better Way to Rate Green Buildings". www.henrygifford.com. 2008.

Gould, Kira. "AIA/COTE: A History Within a Movement". 2008.

Higgins, Joseph, LEED AP, Sustainability Officer. Fidelity Investments, Boston MA, Interview, Nov. 4, 2010.

Holowka, Tayrn. "The Next Version of the LEED Green Building Program: LEED v3". *Environmental Design and Construction* 12(7) (July 2009): S10,S12-S14.

Kats, Gregory H. "Green Building Costs and Financial Benefits". Massachusetts Technology Collaborative. Westborough, MA, 2003.

Kats, Gregory H., Leon Alevantis, Adam Berman, Evan Mills, and Jeff Perlman. "The Costs and Financial Benefits of Green Buildings: A Report to California's Sustainable Building Task Force". Oct 2003.

Melaver, Martin and Phyllis Mueller. *The Green Building Bottom Line.* McGraw Hill, New York. 2009.

Meyer, John M. "Populism, paternalism and the state of environmentalism in the US". *Environmental Politics* 17(2), April 2008.

Miller, Norm, Jay Spivey, and Andrew Florance. "Does Green Pay Off?" Co-Star Executive Summary, July 2008.

New Buildings Institute (NBI). Prepared by Cathy Turner and Mark Frankel. "Energy Performance of LEED for New Construction Buildings, Final Report". Prepared for Brendan Owens, USGBC, Mar. 4, 2008.

Romm, Joseph J. *Cool Companies: How the Best Businesses Boost Profits and Productivity by Cutting Greenhouse Gas Emissions*. Island Press, Washington, D.C., 1999.

Silberman, A.P. "Green Building: Federal, State, and Local Governments LEED the Way", *The Procurement Laywer* 43(3), 2008.

Tietenberg, Thomas H. *Environmental and Natural Resource Economics*, 7th Edition. Pearson, 2006.

LEED Documents:

1. United States Green Building Council (USGBC) Chicago Chapter. "Regional Green Building Case Study Project: A post occupancy study of LEED projects in Illinois, Year 1 Final Report". 2009.

2. United States Green Building Council (USGBC). "Foundations of LEED". Approved by US Green Building Council Board of Directors. Jul. 17, 2009.

3. United States Green Building Council (USGBC). "LEED Reference Guide for Green Building Design and Construction". 2009.

4. United States Green Building Council (USGBC). "Green Building Facts". April 2009. www.usgbc.org/ShowFile.aspx?DocumentID=3340.

5. United States Green Building Council (USGBC). "GSA Says LEED Most Credible Green Building Rating System". Inside Green Business. USGBC In the News. Sept. 26, 2006. http://www.usgbc.org/News/USGBCInTheNewsDetails.aspx?ID=2628.

6. United States Green Building Council (USGBC). "Guiding Principles". (2010) http://communicate.usgbc.org/usgbc/2006/08.15.06_guiding_principles/guidingPrinciples/

7. United States Green Building Council (USGBC). "LEED 2009 for New Construction and Major Renovation". (July 2010)

8. United States Green Building Council (USGBC). "LEED Green Building Rating System Version 2.2". 2005. http://www.usgbc.org/DisplayPage.aspx?CMSPageID=220&#v2.2

9. United States Green Building Council (USGBC). "LEED Version 3.0" 2011 http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1970

10. United States Green Building Council (USGBC). "LEED Public Policies". 2010. www.usgbc.org/DisplayPage.aspx?CMSPageID=1852.

11. Urban Green Council- USGBC New York Chapter. “Cost of Green in NYC”. Oct. 1, 2009.

Wendt, Allyson. “Boston Requires Large Buildings to Go Green”. *Environmental Building News*. Feb 1, 2007.

Yudelson, Jerry. *The Green Building Revolution,* Island Press, Washington, DC. 2008.

Appendix 1

Exhibit 4.15: LEED Public Policy Initiatives Enacted by 46 State, County, and City Governments. Montana, Nebraska, North Dakota, and Wyoming do not have LEED policy initiatives at this time (LEED #10)

State Government	LEED Policy Initiative
Alaska	Anchorage 2008- Adopted Ordinance 2008-93, requiring all new municipal buildings, including new private construction for municipal leasing or renting, and major renovations of existing municipal building to be LEED Certified.
Arizona	Chandler 2008- Adopted Resolution #4199, requiring that all new municipal buildings over 5,000 sq ft earn LEED Silver certification and that all renovations of municipal buildings over 5,000 sq ft follow LEED guidelines.
Arkansas	Fayetteville 2007- Adopted Resolution #176-07, requiring all new city-owned facilities greater than 5,000 sq ft to achieve a minimum of LEED Silver certification.
California	Los Angeles 2009- Signed Ordinance 180636, the Green Building Retrofit Ordinance, requiring all municipal building larger than 7,500 sq ft or built before 1978 to be retrofitted with the goal of achieving LEED for Existing Buildings Silver certification.
Colorado	Denver 2007- Mayor Hickenlooper signed Executive Order 123 requiring new municipal building construction over 5,000 sq ft and major renovations (affecting at least 25% of existing building) that are funded after July 12, 2006 to earn LEED for New Construction Silver certification.
Connecticut	Greenwich 2009- Greenwich Board of Selectmen adopted a Green Building Resolution requiring all new and renovated Town buildings and buildings for which the Town provides the major source of operation and maintenance funds built or renovated after January 1, 2010 achieve LEED Silver certification.
Delaware	Dover- Municipal code (Article 3, Sec. 27.2) states that LEED certification may be used to satisfy the requirements for corridor overlay zones as it contributes to a superior urban development and higher quality of the built environment.
District of Columbia	Washington DC 2006- City Council passed Bill # B16-0515 requiring publicly-owned, non-residential, commercial projects to achieve either LEED for New Construction or LEED for Core and Shell Silver certification.
Florida	2007- Governor Crist issued Executive Order #07-126 adopting LEED-NC for any new building constructed for or by the State. New construction projects must strive for Platinum certification, the highest level possible.
Georgia	Atlanta 2003- City passed Ordinance #03-0-1693 in December 2003 requiring all city-funded projects over 5,000 square feet or costing

	$2 million to meet LEED Silver certified level.
Hawaii	Honolulu 2006- City and County of Honolulu passed Ordinance #06-06 requiring new city facilities over 5,000 square feet to achieve LEED Silver.
Idaho	Ada County 2003- County of Ada adopted Resolution 1180 requiring new construction and major retrofits of all County facilities over 10,000 sq. ft. to achieve a minimum of LEED certification.
Illinois	Chicago 2004- City of Chicago passed a resolution requiring all new city-funded construction and major renovation projects will earn LEED certification.
Indiana	2008- Governor Daniels signed Executive Order 08-14 requiring all new state buildings earn LEED Silver certification.
Iowa	2009- Iowa State Legislature adopted sustainable design standards codified in Chapter 310 of the State Code. Commercial buildings pursuing sustainable design standards in order to qualify for a tax credit or tax refund must achieve LEED Gold certification or better.
Kansas	Greensburg 2007- Greensburg City Council adopted a resolution to certify all new city-owned buildings greater than 4,000 square feet at LEED Platinum, making it the first city in the U.S. to pass such a resolution.
Kentucky	2009- Governor Beshear signed HB 2 requiring all new public facilities and renovations using 50% or more of state funding achieves LEED certification.
Louisiana	2008- Louisiana Recovery Authority approved a resolution founding the State and Local Facilities Construction Authority to support public schools in their pursuit of LEED for schools certification or energy efficiency measures.
Maine	Bangor 2007- Bangor City Council adopted a policy for all new city-owned or city-funded construction and major renovation projects to achieve LEED Certified.
Maryland	2008- Governor O'Malley signed the High Performance Building Act into law, requiring all new public construction and major renovation projects of 7,500 sq ft or greater, and intended for occupation, to earn LEED Silver certification.
Massachusetts	Boston 2004- Mayor Menino adopted the recommendations of his Green Building Task Force and now requires LEED Silver for all city-owned new construction and major renovation projects and LEED Certified for all city supported development projects.
Michigan	East Lansing 2009- East Lansing City Council adopted a resolution establishing a green building policy for the City. Included in the policy is a requirement that new municipal construction over 5,000 sq ft achieves at minimum LEED Silver certification.
Minnesota	Minneapolis 2006- passed Resolution 2006R-381 requiring all new construction or major renovations of municipal projects over 5,000 square feet should be built to the LEED Silver certification standard

	with an emphasis on achieving the Energy and Atmosphere credits in the LEED rating system unless otherwise directed by the City Council.
Missouri	Kansas City 2004- Kansas City City Council adopted Resolution 041222, requiring all new municipal buildings over 5,000 sq ft to earn LEED Silver certification.
Nevada	Las Vegas 2006- City of Las Vegas adopted Resolution 81-2006 adopting a green building program requiring the City to use its best efforts to build all new public buildings to LEED Silver standards.
New Hampshire	Derry 2008- Derry Town Council adopted a green building policy requiring all new construction or major renovations to town-owned or town-funded projects to achieve LEED Certified.
New Jersey	2008- Governor Corzine signed Senate Bill 843 into law, requiring all new state-owned buildings of 15,000 square feet or greater to earn LEED Silver certification or equivalent as determined by state authorities.
New Mexico	2006- Governor Bill Richardson signed Executive Order #06-001 requiring all public buildings over 15,000 ft2 to be LEED Silver certified.
New York	New York City 2005- Mayor Bloomberg signed Local Law 86 requiring all municipal construction over $2 million, including new buildings, additions to existing buildings, and major renovations to earn at minimum a LEED Silver certification.
North Carolina	Durham County 2008- Durham Board of County Commissioners adopted a High Performance Building Policy requiring all new County buildings over 10,000 sq ft to earn at minimum LEED Gold certification or a comparable standard.
Ohio	Cincinnati 2006- Cincinnati City Council approved a motion requiring that all new municipal buildings earn LEED Certified. The motion also requires that existing municipal buildings be renovated following LEED guidelines.
Oklahoma	2008- Governor Henry signed HB 3394 into law, requiring all state buildings over 10,000 sq ft to follow LEED guidelines.
Oregon	Portland 2009- City Council of Portland adopted a resolution requiring all new city construction must meet LEED Gold standards as well as achieve several other sustainability goals including construction waste recycling, water and energy savings exceeding the required baseline, and landscaping that uses no potable water for irrigation.
Pennsylvania	Philadelphia 2009- Philadelphia City Council adopted and Mayor Michael Nutter signed Bill No. 080025 requiring all new municipal buildings over 10,000 sq ft to achieve LEED Silver certification and use 20% less energy than basic, code-compliant structures.
Rhode Island	2009- Governor Carcieri signed Rhode Island Green Building into law requiring all major facility projects of public agencies entering the design phase after January 1, 2010 to achieve LEED Certified or

	equivalent.
South Carolina	Charleston 2008- Mayor Riley signed into law Resolution 2008-05 supporting a variety of sustainability policies, including requiring all new municipal buildings be LEED Certified, beginning in 2009.
South Dakota	2008- Governor Rounds signed into law SB 188 establishing leadership in public buildings by requiring all new construction and major renovations of state-owned buildings costing at least $500K or greater than 5,000 square feet to earn LEED Silver, two Green Globes or a comparable standard.
Tennessee	Nashville 2008- Nashville City Council approved Ordinance #BL2008-217 establishing a "Green Permit" for new residential and commercial buildings. In order to receive a green certificate of occupancy commercial buildings must earn LEED Certified.
Texas	Dallas 2007- Dallas Public Works and Transportation Department issued an updated "LEED Policy," requiring all city buildings larger than 10,000 square feet in the 2006 Bond Program and subsequent bond program to achieve LEED Gold certification.
Utah	2009- Utah State Building Board raised the High Performance Building Rating Systems standards to require all new state buildings to achieve LEED Silver certification.
Vermont	Burlington- The Burlington Zoning Code (Sec. 4.4.1) stipulates that developments built to a minimum of LEED Silver certification may be eligible for additional building height and corresponding floor area ratio.
Virginia	2009- Governor Kaine signed Executive Order 82, which requires all new executive branch buildings greater than 5,000 gross sq ft in size or renovations to existing executive branch buildings where costs exceeds 50% of the value of the building to conform to LEED Silver or two Green Globes.
Washington	2005- Governor Gregoire approved Chapter 39.35D of the Revised Code of Washington, "High-Performance Public Buildings," requiring all projects over 5,000 square feet receiving capital funds after July 1, 2006 to be certified to the LEED Silver standard.
West Virginia	Morgantown 2006- City of Morgantown passed a resolution adopting the LEED Certified level as minimum for new construction and major renovation projects of city-owned, managed, or operated facilities and buildings over 10,000 square feet.
Wisconsin	Madison 2008- Madison City Council adopted Resolution 08-00109, requiring all new municipal buildings over 5,000 sq ft to earn LEED Silver certification.