

CHALMERS



Aiming for sustainability in real estate through using LEED in construction projects

*Master of Science Thesis in the Master's Programme Design and Construction Project
Management*

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Division of Environmental Systems Analysis
CHALMERS UNIVERSITY OF TECHNOLOGY
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ABSTRACT

The construction and real estate industry stands for a lot of the world's total energy consumption. It is both from the existing building stock and from the newly constructed building stock. There are a lot more work that has to be done on the existing building stock but it is important to set the standard for this in new construction.

Therefore, the the main purpose of this study was to investigate the use of the environmental classification system LEED-New construction and LEED for Core & shell development as environmental policy instruments to obtain a building that performs energy efficient on Swedish ground. In order to achieve the main purpose of this study seventeen semi-structured interviews with sixteen different end-users, property developers, contractors and experts were conducted. I tried to talk to people that had experience of LEED from projects.

In my interviews I tried to ask questions relating to energy efficiency. What came out of it was that LEED is not suitable for Sweden at the moment and that LEED has a small effect on the energy efficiency of buildings at the moment. This depends on that few things have to be changed in a building when choosing to certify with LEED. But there is a lot of potential as a communication, goodwill and documentation tool in LEED.

Keywords: LEED, Green building, Performance, Applicability

Siktet inställt på hållbarhet genom bruket av LEED i byggprojekt

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SAMMANFATTNING

Bygg- och fastighetsbranschen står för en stor del av världens totala energiförbrukning. Det är både från befintliga byggnader och från det nybyggda byggnadsbeståndet. Det är mycket mer arbete som måste göras på befintliga byggnader men det är viktigt att sätta standarden för detta i nybyggen.

Därför var det huvudsakliga syftet med denna studie att undersöka användandet av miljöklassningssystemet LEED-New Construction och LEED för Core & Shell development som styrmedel för att få en byggnad som är energieffektiv i Sverige. För att uppnå det huvudsakliga syftet med denna studie utfördes sjutton semi-strukturerade intervjuer med sexton olika slutanvändare, byggherrar, entreprenörer och experter. Jag försökte prata med folk som hade fått kunskap om LEED genom att arbeta med LEED-projekt.

Resultaten visar att LEED inte är lämpligt för Sverige just nu och att LEED har en liten effekt energieffektiviteten i byggnader för tillfället i Sverige. Detta beror på att det är få saker som måste ändras när man väljer att bygga efter LEED i Sverige. Men det finns en stor potential i LEED som kommunikationsmedel, goodwill och dokumentationsverktyg.

Nyckelord: LEED, Green Building, prestanda, användbarhet

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Preface

This Master's thesis is the final phase in the Design and Construction Project Management Programme.

In October of 2010, I considered what would be an interesting topic for me to look at and at the same time explore the opportunity to write about something that I wanted to work with in the future.

I would like to thank Maria Alm and Therese Malm at WSP in Gothenburg for the opportunity to have an office at WSP under the period January 2011 to May 2011 that helped my discipline a lot. I would also like to thank my supervisor at the division of Environmental Systems Analysis at Chalmers Mathias Lindkvist for his always so valuable advice and patience during my process, extremely valuable. Additional to that I would like to thank docent Henrikke Baumann also from the division of Environmental Systems Analysis for her valuable time as an examiner.

I also want to give special thanks to all interviewees that took their time and contributed to the material for this study and to Dr. Conny Wollbrandt for help with STATA.

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Jonas Pettersson

Abbreviations and Notations

ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BBR	Boverkets building regulation
Boverket	The Swedish national board of housing, building and planning
BREEAM	Building Research Establishment Environmental Assessment Method. Internationally known environmental classification system for green buildings, established in UK
Energimyndigheten	Is a government agency that works for safe, environmentally sound and efficient energy systems.
EPBD2	The Energy Performance Buildings Directive ² is a recast of the European Union Directive 2002/91/EC, on energy efficiency of buildings
EU GreenBuilding	A certificate that buildings can get if they use 25 % less energy than BBR:s demands.
GBCI	Green Building Certification Institute
Green building	Refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle.
HVAC	Heating, Ventilating and Air Conditioning
LEED	Leadership in Energy and Environmental Design

Miljöbyggnad	Swedish environmental labelling
SGBC	Sweden Green Building Council
USGBC	U.S Green Building Council

1 Introduction

Today there is an increasing societal awareness of environmental issues. A company's actions for the environment and environmental footprint get a lot of media attention. In the company world today it is so important to think and act green that it has become one of the new trends in order to keep a competitive edge in business. A new way to get goodwill and to make a profit has become evident to different companies in a variety of industries. One way for a company to show that they care about the environmental field is to brand their product with some kind of environmental label and this is increasing in all fields. (Fuerst & McAllister, 2011a) Labeling can be seen in many fields: from food, clothing to buildings. This development indicates that there has almost become a custom in trying to create products and construct services that are considered sustainable, environmentally efficient and that should result in some environmental benefit.

The construction and real estate sector is no different in this aspect mention above and the industry can make large savings on energy in buildings. Today the construction and real estate sector in the U.S. stands for approximately 48 percent of the total U.S. energy consumption. EU's construction and real estate sectors' consumption is about 40 percent of the EU total, and Sweden falls below this, with 30 percent of the Sweden's total energy usage coming from the construction and real estate sector. (Byggindustrin, 2011) This high consumption of energy has led to demands from both local and international directions. On the 1st of January this year, the Swedish government announced that the total energy usage 2020 of new buildings was to be lowered by 20 percent from the usage level of the year 1990 and by 2050 the usage should be 50 percent of the 1990 level. These are connected to the international demands from EU with the latest one being the relatively new Energy Performance of Buildings Directive 2 (EPDB2) commission that demands that all new public buildings by 2018 should be close to zero-energy buildings. Furthermore, all new buildings should by 2020 fulfil the demands on close to zero-energy buildings. (Ekohus, 2011) The demand "close to zero-energy" can be rather misleading due to the fact that it doesn't really have to mean close to zero. Instead it refers to that the building should be a high-performing and an energy efficient building. The term "close to zero-energy building" is defined from country to country and in Sweden it was "Energimyndigheten" that was assigned to investigate the demands and make some recommendations. Also, the market forces pressure the construction and real estate industry towards less energy usage and less environmental impact. This means that the construction and real estate sector has both pressures to consider and benefits to gain when constructing new buildings or renovating existing buildings. Today, when constructing a new building a lot of companies and customers have the ambition to use some sort of environmental classification system for new or existing buildings. This is one way on the road to try to gain from benefits and handle demands concerning environmental questions brought up to questions when constructing buildings. (Fuerst & McAllister, 2011b)

There are a lot of different classification systems that companies can choose between today and in many of these classification systems there are different levels a company can aim for. The most common ones used and best suited for the Swedish construction and real estate

sector at the moment are either of international or national origin: LEED, EU GreenBuilding, BREEAM and Miljöbyggnad. (SGBC, 2011) This study is about LEED because I got the feeling the LEED was the certification that was going to be the biggest one in Sweden and globally. Therefore I thought it was most interesting.

1.1 Purpose

The main purpose of this study is to investigate the use of the environmental classification system LEED® New Construction and LEED for Core & Shell development as environmental policy instruments to obtain a building that performs energy efficient on Swedish ground. In order to achieve the main purpose of this study I conducted seventeen semi-structured interviews with sixteen different end-users, property developers, contractors and experts. All people that were participating in the study had one thing in common: they all had first contact with LEED-NC or LEED-CS in different situations. The interviews were the source for the primary data to answer the studies main purpose. The study will also contain a brief background to the up come of sustainability and a description on how LEED works.

To help this purpose, six questions that are relevant for an environmental policy instrument that aims at improving energy efficiency in a building, were formulated. The first question relate to how well the organisation can apply and work with LEED. The second one relates to how suitable LEED is for Swedish conditions. The third one and the fourth one illustrate the benefits and opportunities and the weaknesses and threats, respectively, of using LEED in Sweden. The fifth one shows if LEED has any role in Sweden when it comes to energy efficient buildings. The last questions show how the follow up is looked upon in LEED since buildings often will be used during a long period of time. The questions are listed below:

1. How deep and how widely spread are the skills in using and knowledge about LEED in the organisations that use it in Sweden?
2. How relevant and how practically applicable is LEED from an energy perspective in Sweden?
3. Which are the benefits of using LEED as an instrument for sustainable energy efficiency in Sweden?
4. Which are the negative effects of using LEED as an instrument for sustainable energy efficiency in Sweden?
5. Which role does LEED have in Sweden in relation to energy efficiency?
6. How are follow-ups looked upon in LEED certifications in Sweden?

1.2 Delimitations

This study aims at taking a closer look at the biggest current certification systems for buildings –LEED – with the delimitation of only trying to look at the components that affects the energy part of the certification.

LEED consists of different rating systems for different kinds of projects, but this study aims at looking at LEED-New Construction and LEED for Core & Shell development because they are some of the biggest certification programs for new buildings in the world. But also because when choosing to work with LEED in new constructions LEED-NC and LEED-CS are the two most common ones used in Sweden. Also, there are indications that the higher levels of a LEED certification, such as gold and platinum, are going to be the some of the most popular certifications in Sweden, which is partly due to LEED's broad environmental approach and its international recognition.

The study will not cover the entire LEED certification, but focus on energy related questions about a LEED certification. Also, the energy questions are relevant both for potential money savings and regarding other environmental aspects.

Most of the empirical studies made on LEED are performed on other markets than the Swedish due to the fact that LEED-classification is fairly new in Sweden. Therefore, only a small part of the literature used in this study is going to be from Sweden.

The studies ambition is to look at the LEED certification for New Construction and Core & Shell development focusing on non-domestic dwellings, mostly office spaces, because it is here so far that the Swedish construction and real estate industry mostly has begun to implement LEED. There are a lot more work that has to be done on the existing building stock but it is important to set the standard for this in new construction.

2 Background

This section's aim is to give the reader a more thorough background and understanding to green building and sustainability. In this section, a brief description of how the energy performance of buildings has become so important in the construction real estate sector is given. This intends to show how the need of the environmental classification system LEED has evolved.

2.1 Green Building

One of the most well known definitions of sustainable development is the definition from the Brundtland Report (Brundtland Report, 1987):

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” (Brundtland report page 54)

The Brundtland commission's definition of sustainability is pretty wide so under this definition of sustainability subsets have been developed, such as green building and sustainable construction. These concepts offer a possibility to look at a building and that buildings life span. (Haselbach, 2010)

Today when talking about a sustainable approach in the construction and real estate sector, a popular concept is the concept known as 'green building'. Briefly the green building concept can be seen as part of a movement that wants to put more emphasis on sustainability in the construction of buildings. (Haselbach, 2010)

Green buildings are buildings where an attempt is made to minimize the energy consumption and to protect and conserve water resources. There is also a lot of focus on optimizing the maintenance and operational practices in the building. Along with this is the attempt to reduce the environmental impact the materials used in a building causes from a life-cycle perspective. All of this should lead to a green building that which is environmentally sound and where the impacts on the human health are minimized. (Yudelson, 2008)

The concepts of sustainable development and green building are, however, not new. Looking at our building and construction history, this can be traced back several of thousand years, by for example looking at how the Indians selected to place their dwellings so that they could draw benefits from the sun or how the Romans aligned their dwellings along a certain direction to trap the sun in the winter. That buildings should work with the nature instead of against it and thereby have a sustainable energy performance is nothing new in this world. It has for a long time been important to people on our planet in the endeavour towards maintaining a sustainable society. (Yellamraju, 2011)

Around 1920-30 more modern constructions of buildings started to take place and people wanted an effective heating and cooling system in these buildings. This was the start of the

use for HVAC systems in United States. This was a good solution to heating and cooling in buildings because of the cheap price of fossil fuel during that period. These buildings that used HVAC systems demanded a lot of energy. From 1920-60 lots of buildings were constructed with HVAC systems without anyone thinking about the energy effect of it to the extent that it became a trend in United States. (Building Design & Construction, 2003)

It wasn't until more modern time, starting around 1970, that the question about a more sustainable energy usage got more actualised in the mainstream society and these systems that used a lot of fossil fuel got questioned. This climaxed with the manifestation of the First Earth Day. In April 1970, the first Earth Day was held, and this was the first time that people at the grass roots level were involved at a larger scale for the benefit of the environment. Around 20 million people participated on this day. This was a clear indication of people getting more socially involved and that a green mindset began to take shape. In the 1970s there were two events that kick-started the sustainability mindset in the construction industry. These events were the OPEC oil embargo of 1973 that got the attention of a lot of people and governments. Similar events that got people's attention towards our societies energy consumption was the shortage of oil in 1979 due to the Iranian revolution. A similar event in the 1990s was the Gulf war that led to increased oil prices. These events had so large impacts that they were considered as world energy crises. These events occurring over 20 years challenged people to change their current mindset towards a more sustainable way of thinking and acting. (Building Design & Construction, 2003)

Environmentally sounds buildings is still not mainstream in society for several reasons, but today when buildings stands for 48 percent of the United States' and 30 percent of the Swedish energy consumption the construction industry has begun to notice green buildings. As already mentioned, the concept of green building has today become popular. McGraw-Hill made a report on the U.S. green building market, focusing on how much the use of green building has increased and is expected to increase. From 2008 to 2010 the value of green building construction went from \$42 billion to \$52-71 billion. Moreover, McGraw-Hill estimates that the green building construction in 2015 will be valued to \$135 billion. (prnewswire, 2011)

When competing and acting in the construction and real estate sector it is important to have a wider understanding and a range of tools to improve the performance of a building. The construction and real estate sector are nowadays so conscious about appearance and social responsibility that it has to consider more aspects than financial. This can be achieved with the Triple Bottom Line Approach. The phrase was used for the first time in 1994 by the author John Elkington and is today used more than ever. The concept of the triple bottom line addresses not only the economic values, but looks at financial, social as well as environmental values that are added or not to the product considered. The triple bottom line can also be translated to or referred to as profit, people and planet. (Henriques & Richardson, 2004)

One approach to green construction is the supporting of the Triple Bottom Line Approach. Today, the Triple Bottom Line often used in the same sense as Corporate Social Responsibility. (Norman & MacDonald, 2004)

Green in construction addresses CSR on several issues, such as minimising the energy usage and by treating the stakeholders of the company more fairly. (Meade & Presley, 2010)

In practice, however, companies often approach green construction by certifying their buildings with LEED to get tax incentives (mostly applicable in the US), and to receive goodwill by building green. (Maines & Sprinkle, 2010)

But the largest factors that have change the construction and real estate sectors view on green construction is the creation of ways to rate green buildings, such as the rather recently developed environmental classification system LEED. The term green building is today closely associated to non-domestic constructions that hold a LEED-certification of some kind. (Yellamraju, 2011)

2.2 Environmental classification systems

In 1990, in the United Kingdom, the first comprehensive environmental classification system was introduced: Building Research Establishment Environmental Assessment Method (in short BREEAM). This classification system was an initiative from the construction industry in the U.K.

Today there are about 100 different energy and environmental assessment systems. (Fischlein & Smith, 2010) Some countries have developed their own classification systems, such as Japan with CASBEE, Australia with Green star and Sweden that tries to implement Miljöbyggnad. An environmental classification is primarily a certification and guarantee that the building constructed should be green. The large number of energy and environmental assessment systems indicate that the awareness in today's construction and real estate market has increased. There are also indications that a certification is a growing popular tool to include in an environmental policy and for trying to influence the market. (Matus, 2009) The overall use of environmental systems is to offer an overview of a range of ways to enhance buildings' environmental performance, for example increased energy efficiency and improved indoor environment. In some cases classifications can result in a label that shows that it is an enhancement to the building's design and user friendliness. An environmental classification can be seen as a guide to a systematic approach to different environmental problems and to solving them or it can function as a management tool in the work process. (SP Technical Research Institute of Sweden, 2011)

2.3 Environmental policy instruments for energy efficiency

There are different types of instruments for working with energy efficiency in Sweden that are used for obtaining energy efficient buildings. From the beginning Sweden has a history of using economic instruments in the forms of taxes for reducing the energy usage but is at the moment going more towards market driven instruments (Energimyndigheten, 2011).

Currently used instruments can be divided into three different categories. Administrative instruments, economic instruments and informative instruments. (Boverket, 2010) These instruments can be voluntary or they can be mandatory. An Administrative instrument that is mandatory when constructing new buildings today in Sweden is “Boverkets building regulation (BBR) and it has been so since the 1960s. In these standards there are figures for how much energy a building is allowed to use depending on which climate zone in Sweden it is being built in. In Sweden there are three different climate zones. A mandatory informative instrument that is used in Sweden is the Energy declaration. The Energy declaration requires that all newly constructed buildings must explain how the building handles its energy use and how this usage shall be improved. The energy declaration must not be older than 10 years. The reason why the energy declaration is informative is because it is not mandatory to carry out what is reported. Instead its aim is to inform about what can be done and that the real estate owners hopefully act according to it. Other voluntary instruments are for example environmental classification schemes such as BREEAM and LEED. According to (Lee & Yik, 2004) the best way to achieve energy efficiency buildings is to use both voluntary and mandatory instruments in a combination of each other.

3 LEED

In this chapter a manicure description of LEED is given, with emphasis on LEED for New Construction. This chapter is to inform the reader about how a LEED certification is designed and carried out.

3.1 Introduction to LEED

In 1993 people involved in the building craft, such as architects, engineers, and contractors, officially formed the United States Green Building Council (USGBC), which is a non-profit organisation with the agenda to promote construction and sustainability in the United States. After the start the growth of USGBC has been rapid; (USGBC, 2011a) in 1998 the organisation of USGBC had about 150 member companies. In 2006 it was more than 7000 members and today it is over 16000 member companies and organisations from the building industry. From the beginning USGBC worked with American Society of Testing and Materials (ASTM) to find some kind of rating system to measure sustainability or greenness in a building. This collaboration did not work out and in 1995 USGBC decided to create a system of their own that benchmarks green buildings. The work to develop their own system took USGBC three years to do and what came out of this collaboration was a benchmark system named Leadership in Energy and Environmental Design (in short LEED). LEED is a voluntary certification programme that organisations can choose to use. If the organisation chooses to certify it is a third party that approves the LEED certification in the end. The meaning with using a LEED certification is to diminish the buildings ecological footprint and to lower the operating costs of the building. (Polonsky, 2011) The first pilot of the system LEED version 1.0 was launched in 1998 and this was only LEED for New Construction. Due to a lot of mistakes and shortcomings in the system discovered in the pilot program of LEED version 1.0, LEED version 2.0 was launch to the public short thereafter in March 2000. Today LEED-New construction is version 2009. (Building Design & Construction, 2003)

The next versions of LEED to come are under construction and are LEED 2012 and LEED International. There are different countries that help the USGBC with the development of LEED International. In Sweden it is the Swedish Green Building Council (SGBC) that helps USGBC with the development of LEED International.

LEED is today one of the biggest and most widespread classification systems with almost 35000 projects participating in the certification spanning over 91 countries (USGBC, 2011a). However, BREEAM is still the certification with the most buildings certified.

In LEED-NC and LEED-CS there is a 100-point scale with additional 10 bonus points to earn. The points are only positive, which means that points only are added when doing something good and that there is no possibility to get negative points for doing something that is bad. The points are divided into the five major categories and the two bonus categories shown below. Each category has one part that is mandatory to be certified in that specific category. These prerequisites are there to guide the customers and to enhance the credibility

of the LEED certification. The prerequisites do not give any extra points; it is as it say just mandatory. Thereafter are there subcategories that can be chosen to work towards to get more points.

There are 4 different levels of LEED to strive for depending on how many points the project can earn. The first one, the base-level is called Certified. This is the baseline for LEED and to achieve this level 40-49 points are necessary. This if follow by Silver (50-59), Gold (60-79), and finally Platinum (80+). (USGBC, 2011b)

3.1.1 Areas where LEED apply

From the origin of LEED it was a rating system that was oriented toward new construction and major renovations of non-domestic and civic development. Later on in the development of LEED, domestic developments that rose above three stories were included in this. From 2000 and forward there has been a development of LEED to go beyond new construction and it now includes 10 different rating systems. The 10 different rating systems are not entirely free-standing, but they can overlap to some extent:

- LEED for New Construction and Major Renovations, LEED-NC. Current version LEED 2009
- LEED for Existing Building: Operations and Maintenance, LEED-EBOM Current Version 3.0
- LEED for Commercial Interiors, LEED-CI. Current version 3.0
- LEED for Core and Shell Development, LEED-CS. Current version 3.0
- LEED for Homes, LEED-H. Current version 2008 (Limited to USA)
- LEED for Neighbourhood Development, LEED-ND. Current version LEED 2009
- LEED for Schools or of Existing Schools. Current version 3.0
- LEED for Retail or Retail Interiors
- LEED for Healthcare facilities
- LEED for Labs

In Sweden, based on the projects that are registered and visible on USGBS's homepage, the most common rating system in LEED are LEED-New Construction, LEED-Core and Shell and LEED for Existing Building: Operations and Maintenance

3.2 LEED for New Construction and Major Renovations

The points in LEED-NC and LEED-CS are divided over seven different categories. However there are some differences how the points are divided over the categories in LEED-NC and LEED-CS, but it is a small difference. I deliberately describe LEED-NC because it is the original LEED certification. In the Energy and Atmosphere category the points are awarded from an energy simulation that shows how much the building saves in money compared to a baseline building. For energy the baseline building is modelled to pass the ASHRAE 90.1-2007 Standard. The baseline building is used in some of LEED:s other categories to. ASHRAE is a benchmark for commercial real estate and is in some countries, particularly in

the USA, used as a standard in construction projects. The USA as a country does not have any mandatory building code, but each state has made its own decisions on this issue. The next version of ASHRAE 90.1-2010 has much tougher requirements than its predecessor. (Yellamraju, 2011) The categories are shortly described in the following:

- Sustainable Sites (SS), 26 points; this category accentuate the project's sustainability with the development of existing infrastructure but also aims to diminish the impact on the local ecosystem and the natural resources.
- Water efficiency (WE), 10 points; covers a buildings water usage.
- Energy and Atmosphere (EA), 35 points; this category covers the use of energy and how the origin of the energy. This is done by encouraging different kinds of energy strategies such as the use of renewable energy.
- Materials and Resources (MR), 14 points; is a category that promotes the choice of sustainable materials and how to handle waste.
- Indoor Environmental Quality (IEQ), 15 points; concerning questions like daylight and clean air.
- Innovation and Design (ID), 6 points; promotes the use of different innovations and designs that goes beyond what is covered in the categories above.
- Regional Priority (RP), 4 points; addresses the geographical placement of the building. This category is at the moment a template for international projects.

3.3 Certification Process

Because of LEED being a third part certification program the application must go through another organisation for the applicants' organisation to get the application approved. From the beginning the certification process went through the USGBC, but in 2008 the Green Building Certificate Institute (GBCI) was formed to assist USGBC in their work with the certification process. In 2009 USGBC handed over the verification of the certification to the GBCI except for LEED for Homes. The GBCI also handles the accreditation of LEED Appointed Professionals, LEED AP.

LEED AP is an exam for an individual to show that they have certain knowledge of LEED. Having a LEED AP on-board in a project also gives an extra point.

There are some exceptions with the certification process and that is if the country has its own national version of LEED. Then the certification does not have to go through GBCI and

therefore the projects do not have to use the U.S. standard. Countries that have developed their own national versions of LEED are India, Canada, Italy and Cuba.

To achieve a LEED certification, 6 steps need to be accomplished. The first step is to decide that a LEED-certification will be used in the specific project. Then follows five steps related to the GBCI.

- **Project Registration:** First the project must be registered to show that the intent is to certify the project with LEED. When registering, the project gets access to all the necessary tools and resources provided by the GBCI as assistance towards finally achieving the certification. Initially there is a small registration fee to be paid. When the registration fee is paid the project group can begin the documentation and gain access to LEED online. LEED online is a tool that is developed with the intent to ease the certification and is shaped as a joint-space to help the workgroup with the documentation.
- **Prepare Application:** This part is more difficult to carry out. In theory it is possible to attain 110 points with a LEED-NC but in reality no building has to my knowledge achieved this amount. Therefore, when preparing the application the project team assigns persons to document and in some cases calculate how the points they have chosen to strive for and the prerequisites will actually be obtained. After that is fulfilled the project sends its calculated numbers to LEED online and the start of the review process begins.
- **Submit Application:** This can only be done by the LEED project administrator. The application can be handed in as a split review or a combined review. The split review means that design and construction is evaluated separately and combined review means that the design and construction are judged together.
- **Application Review:** If the application is handed in as split review this part consists of four phases: Preliminary Design Review, Final Design Review, Preliminary Construction Review and Final Construction Review. If a combined review is performed, there are two phases: preliminary review and final review. The preliminary review can be accepted as final and then makes the final review optional.
- **Certification:** When the review is approved and the applicant is satisfied with the result, the GBCI recognizes the project as successful and hands out plaques to put on the building's wall.

3.4 Cost of LEED

Costs in LEED can be divided into hard costs and soft costs. The hard costs are the investments needed to fulfil the requirements in LEED's five first categories. The soft costs are registration fees, documentation and commissioning. (Enermodal Engineering, Inc., 2006)

Depending on which of the levels in LEED that an organisation wants, the cost differs. The cost for achieving these different levels has been discussed and there are differences between different statistics in this area. What can be said is that to build a LEED building costs from 0% to 8 % more than the original budget. (Fröberg & Reuterskiöld, 2010)

3.5 Experiences of working with LEED-New Construction in non-Swedish markets

There has been some questions and critique raised when working with LEED for New Construction. One of the problems with LEED-New Construction is that it does not account for the building's real energy performance when looking at the energy consumption. Instead the classification builds on how much energy is predicted to be used in the building. This would not be a problem if there were more facts and investigations that really proved that LEED certified buildings were saving more energy than buildings without certification. However (Birt, Mancini, & Newsham, 2009) shows that on average the earlier LEED buildings, buildings certified with LEED-New Construction 2.x until 2006, save energy. However, 28-35 percent of the LEED buildings do not save energy, but use more of it. (Scofield, 2009) has shown that even if most buildings save energy individually, the net effect of all LEED-New Construction buildings is an increase in energy use because of some larger buildings that do not perform well. (Birt, Mancini, & Newsham, 2009) also states that there is no correlation between the certification level achieved and its energy savings or the number of energy points the building gets. There is also little consideration to the user behaviour when the building has been occupied and little knowledge on how to run the building energy efficient during occupancy. A LEED-NC has no expiry date or de-certification; after achieving a certification for a new construction it follows the building regardless of its performance during the use phase, by contrast to LEED for Existing Buildings that needs to be re-certified every 1-5 years. With this in mind it can be difficult to motivate an initial cost for the investors of an additional 0 - 8 percent, depending on the certification grade, for an environmental certification system.

Quoting from USGBC latest strategic plan that leaps from 2009-2013 shows awareness of some problems and question in LEED:

- *“Lack of capacity in the building trades to meet the demand for green building*
- *Lack of data on green building performance*
- *Lack of education about how to manage, operate, and inhabit green buildings*
- *Increasing interest in and need for green building expertise internationally.”*

Rob Watson, who is considered to be the father of LEED, said the following during the State green business forum, concerning the question about bridging the performance and design gap in a building:

“We spent years, literally years, arguing about that line between design and operation, and one of the reasons why LEED succeeded, in my opinion, is that we only graded people on things they'd have control over.

There are numerous fault lines in the control and delivery process of buildings ... initially our job (in developing LEED) was to make friends, not to be cops. Now that we've got people's attention, we can start moving the industry a little more. What I hope to see going forward is more integration of the design and operation issues.” (Greenbiz, 2011)

A problem with these problems is that this certification can lose its merits and credibility, resulting in a stagnation of the current greenmarket evolution.

4 Methodology

This chapter presents the methods that I have chosen to use for realising the purpose of this study. First, the choice of between a quantitative and a qualitative approach for data collection will be explained. This will be followed by a motivation of the choice between the inductive approach and the deductive approach. Then it will be explained how the data consisting of secondary and primary data has been retrieved, followed by an a priori discussion about the reliability and validity of the study. There will also be a description of the method for the interviews conducted and how the analysis of the data was conducted.

4.1 Choice of method for data collection

It is important that the choice of theory and method for the study gives the best answers to the problem that the study is focusing on. (Eliasson, 2006) It is important to build a deeper knowledge base about the subject so it becomes easier to find the right data and choose the right method for the study. (Eriksson & Wiedersheim, 2006). In this study this has been done through an extensive literature research both on the internet and in libraries. This has been complemented with discussions with people that have knowledge of LEED to see that I have grasped the essentials of the contents of LEED but also to broaden my own knowledgebase.

According to (Bryman, 2008) it is important to formulate clear research questions to get the research focused and to have a guide through the whole study. Therefore six research questions were formulated early in the research process. This study builds mostly on qualitative primary data gathered through interviews with semi-structured in-depth interviews.

4.1.1 Qualitative and quantitative research

When conducting a more thorough study of some kind it can be important to notice the difference between qualitative and quantitative research. The main difference between quantitative research and qualitative research is that quantitative research focus more on numbers and things that are measurable in diagrams and qualitative research focus on what is said with words.

Qualitative research has four main topics that the researcher can use. These are: observation, textual analysis, interviews and recording and transcribing. (Bryman, 2008) This study chose to focus on two of them and these are: textual analysis and interviews. A textual analysis was done to understand the context of how LEED fitted in the construction and real estate industry and to be able to write a relevant background. The textual analysis also helped to formulate relevant interview questions to the thesis. The interviews were conducted with the intent to collect empirical facts for this study. These approaches can be used one at the time but are often used in combination of each other. (Silverman, 1993)

This study is a qualitative study due to the reason that LEED-certification is fairly new in Sweden, so it is more of a phenomenon that is suitable to be investigated with words. The choice qualitative also came as a natural choice depending on that LEED is so recent that it is not possible to obtain quantitative figures on its performance. In addition, this is also suitable since qualitative research is more flexible and can be combined with other methods and since if using qualitative research the researcher can decide which level of thoroughness he/she wants to work on. (Eliasson, 2006) Another major reason for choosing a qualitative approach, and which will be explained further in the next section, is that the quantitative research is more compatible with using a deductive approach while qualitative research is more compatible with an inductive approach. (Bryman, 2008)

The use of a qualitative approach in this study is clearly seen from that this study tries to map the actors that work with a LEED point of view and their experiences of working with LEED.

4.1.2 Deductive and inductive

It is of great importance to choose a suitable approach when beginning a study. Do I want to come up with a theory or does he/she want to prove a theory. Regarding theory, there are two common ways of relating to it. The first one is the deductive approach and the second one is the inductive approach. The deductive approach is that you start with an existing theory and from this you form a hypothesis. Then the data collection begins and from the hypotheses is either confirmed or rejected. With the inductive approach it is the other way around. This means that from the data collection and findings a theory is formed. (Bryman, 2008)

In this study an inductive approach was chosen due to the reason that an inductive approach is useful for answering the open aim of this study. (Bryman, 2008) This choice leads to an extensive research using interviews and documents before formulating any explanations, which has turned out to be the suitable way of summing the results from this study rather than formulating a formal theory.

However, according to (Bryman, 2008), an inductive approach does use of a small input by the deductive approach when the analysis iterates between data and explanations. This also applies to this study.

4.1.3 Primary- and secondary data

There are two kinds of data to collect, the first being primary data and the second one being suitable secondary data. Primary data is data that the researcher by himself collects and analyses. (Eliasson, 2006) The researcher has full control over where the data comes from. This study has gathered the primary data from in-depth semi-structured interviews to get a more Sweden oriented view since this is the focus of the issue that motivates this study. This is necessary because of the fairly few studies done in Sweden to draw secondary data from.

Secondary data is data that is collected from another person; this person probably did not have the same purpose with his/her study so it is important to look thoroughly on the data to select relevant data for this study. The use of secondary data can be beneficial to use due to the fact it can cost a lot of time and money to collect and analyse the same amount of data. (Bryman, 2008) Most of the data comes from articles found on the internet and accessed through the Chalmers library. Scientific journals such as Applied energy, Energy, and Building Research & Information and literature consisting of books and papers on green and environmental classification has also been used. The data is found through searches with keywords such as: LEED-certified, energy efficient, energy performance, green building, and LEED-New Construction. The literature selected has been chosen partly with the constrain of up-to-date data due to the circumstance that energy efficiency and green building is a concept that is influenced by a lot of new facts and figures this makes it beneficial to use up-to-date data

4.2 Interview as a research method

There are two major approaches when conducting a qualitative interview. (Bryman, 2008) This study has chosen in-depth semi-structured interviews to collect its primary facts due to that it is a flexible approach and a guidance towards openness. The openness lies partly in the use of open-questions instead of closed-questions. The interviewees chosen have been in first person contact with LEED from different perspectives. I have divided these persons in to four categories: property developers, contractors and end-users and a segment that I chose to call experts due to their acknowledged knowledge of the field of LEED.

With closed questions there are fixed answer alternatives and with open questions there is room to answer freely. (Bryman, 2008) There are some benefits with using open questions. It is useful when exploring new areas, and it is a good way to tap the interviewee on their knowledge and the answers that maybe would not have been an alternative in a survey. (Bryman, 2008). Since this study examines a fairly new area in Sweden the open questions are suitable.

When doing an interview it can be beneficial to conduct a trial interview with someone that maybe should have been in the study. This is useful to investigate if the questions are useful. (Bryman, 2008). In this case a trial has been done to the interview questions twice. This to have the opportunity to sharpen the interview questions to answer the purpose of the thesis.

4.2.1 Interview design

The interviews lasted between 30 and 60 minutes and were taped with the permission from the interviewee. The interview template consisted of 3 different templates with 17 - 22 questions in them depending on if the interviewees' role. Some of the questions were asked to all different roles and these questions were designed to get an overview of LEED and to get the conversations started. After these questions were asked, more specific questions were asked about that role's knowledge and experience, with an orientation towards energy

oriented questions in LEED-New Construction. The questions were formulated to address LEED-New Construction and in the cases where questions indicated something else, such as LEED-EBOM or the overall LEED, this was clearly stated in the questions.

4.2.2 Sample

There are not so many LEED projects in Sweden; there are 32 projects registered as LEED projects in Sweden that are visible on the USGBC's homepage. When including all projects, even the ones that have chosen to be secret in Sweden, there are about 55 projects all together that are registered. Until recently (May 2011) only 5 of these projects are certified. So there were some difficulties with finding the right persons to talk to. The interviewees were selected in collaboration with my supervisor Therese Malm on WSP due to her knowledge of people in the construction and real estate industry. The intention with my sample choice was to talk to people that had recognized knowledge about LEED in the industry and preferable had been involved in the LEED-certification process in some way.

The interviewees were also chosen to best describe the Swedish construction and real estate industry. In one case I had to go outside the chosen interview field of the study and interview an actor in another European country and then generalise the findings from that interview to the Swedish market.

All and all seventeen interviews were conducted. Out of these, sixteen was then used.

4.2.3 Routines for initiating and performing the interviews

When contacting the interviewees I first constructed an e-mail template that was used for the initial contact. If the interviewee did not answer I decided to follow up the e-mail with phone calls after one to two weeks. The intention was to conduct eighteen interviews in total, and seventeen interviews were actually carried out. I could not by any means arrange an interview with the last interviewee. Of these seventeen interviews, sixteen were used in the analysis because the last interview was not compatible with the other sixteen. This depended on that one interviewee was not connected to any company.

The optimal situation of conducting interviews is to conduct them face to face and most of the interviews in this thesis have been done face to face. However, a few of the interviewees were located far away, and they were interviewed by video call and in three cases, due to lack of proper equipment, by phone.

4.2.4 Analysis

After I had transcribed the data obtained from the interviews a study of the interview material began with the intention to get more familiar with the material. Following this phase an Excel spreadsheets was created with the intent to use to decode the material. I decoded the material with certain code words that could summarise the answer given to the specific question as

well as possible. In the spreadsheet, for each code word, an answer was translated to 1 if the interviewee had answered the specific question within in, to 0 if they had not and to a dot if the interviewee had not understood the question. The interviewees were given specific id-numbers that followed them under the analysis and which were used to uphold the anonymity. The id-numbers were distributed between 1 and 16. To make it more obvious which of the four roles that the interviewees were considered to have, they also got a number depending on this; '1' stands for an expert, who is someone that has a recognised expert knowledge of the specific subject. '2' stands for an end-user, who belongs to the organisation that in the end inhabits the building. '3' stands for a property developer; this is the one who order the building or builds it for their own use. '4' stands for a contractor; this is the one that builds the building.

The decoding was done in EXCEL so it would be compatible to use with the statistical program STATA. After the material was imported into STATA it was used to show and to evaluate the decoded findings. After first trying to work with the program and doing linear regression analysis on the data, STATA was instead used as a complement for the analysis because of its interpretation qualities and visualisation qualities. The analyses continued with a SWOT analysis in an attempt to see the strengths, weaknesses, opportunities and threats with LEED-New Construction as an instrument for energy efficiency. The SWOT-analysis is a clear way to illustrate the strengths, weaknesses, opportunities and threats for an organisation or an organisation's product. The SWOT-analysis is shown in findings and elaborated on in the discussion part.

4.3 Reliability and validity

To achieve a higher credibility of a study, two criteria should be looked upon: reliability and validity. In short, reliability is about if the investigated material gives stable and reliable answers. This means that if someone else should conduct the same study they should get the same results. In a study, the reliability of the results depends on how thorough it is and, in this case, how the interviews are conducted (Eliasson, 2006) to enhance the results in my study all interviews were conducted by me, they were taped, and some notes were taken at the same time. Close after the interviews they were transcribed to have the interviews fresh in mind. After the interviews were conducted only three participants said they wanted to see the printed interview transcription from the interview.

Validity is about that what was meant to be investigated actually was investigated. It is important to look at two different aspects: internal validity and external validity. (Eriksson & Wiedersheim, 2006). External validity is about if the study can be generalised beyond the interview sample. (Eriksson & Wiedersheim, 2006) Due to the fact that LEED-certification is fairly new in Sweden, I decided to choose a sample of people that had different experiences of LEED because they had gotten in contact with LEED through different roles. Because of my limited knowledge of people in this industry, I got help to find the interviewees by a person that has a very broad knowledge base about the industry.

Internal validity is about if the findings really reflect what they claim to reflect, and if the facts investigated are accurate. (Eriksson & Wiedersheim, 2006) By interviewing different interviewees in the same field I strived to make the results correlate to the reality in an accurate way and to give a broader view of the same field, but also to achieve some kind of source triangular effect with thoughts from actors in the same field but from different positions in the construction and real estate industry. (Malterud, 1998)

4.4 Criticism of literature

When I was studying the extensive literature on green building, LEED, energy performance and topics associated with saving energy in the building industry, I got the feeling that a big part of the literature was not objective to the extent that could be expected. The author came to the conclusion that LEED, in this case, had to be shown in a very beneficial perspective to be successful. This was taken into consideration when the literature was looked upon.

5 Findings

In this section the analysed findings will be presented. The findings will begin with an overview of LEED to picture why LEED is being used and after that go towards more specific questions concerning energy and feasibility. Throughout the interviews I got the impression that the knowledge and the focus of a LEED certification were very varied. In the findings when LEED is mentioned it is as LEED-New Construction and LEED-Core & Shell; otherwise it is specified.

5.1 Where did the initiative to use LEED transpire from in Sweden?

When evaluating this question I decided to divide the answers into three different categories too see if the choice was customer oriented, situation based or a higher decision from a company. This was done with the intention to see who or what drive the initiative to use LEED in Sweden. What can be seen in Figure 1 is that there for experts (1) is a slight indication of situation based followed by customer decision in Sweden. For the end-users (2) the main initiative is also situation based. For property developer (3) it shows strong indication for customer based and for contractors (4) there is a tie between situation bases and company decisions. When summarised over the four categories 8 interviewee gave an answer that was situation based.

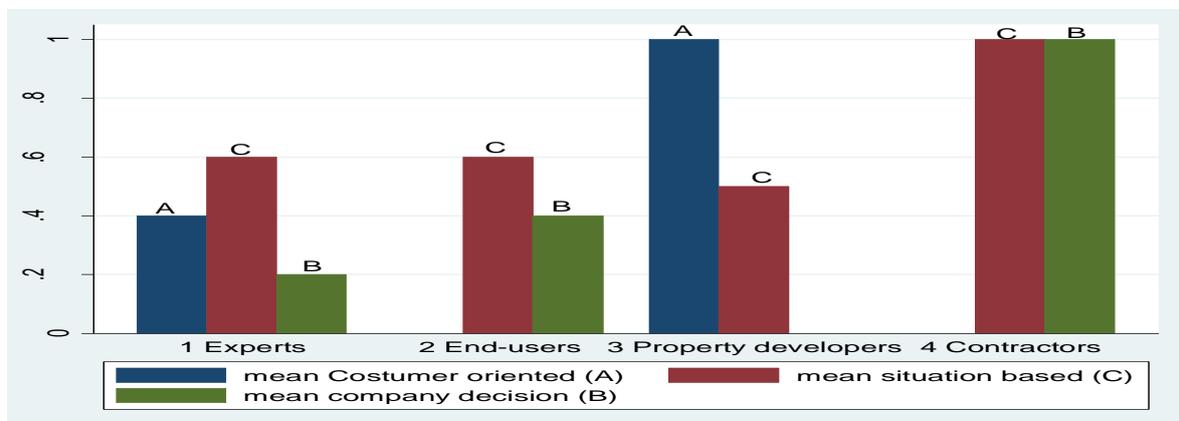


Figure 1. The initiatives for LEED in Sweden

5.2 Reason for working with LEED in Sweden

The first thing the interviews looked at was the main intention that got the interviewees' organisations to start working with LEED. This was done with the intention to see where the focus was. There were a lot of different answers given to this question and the spread of them was very wide. Figure 2 is mostly used to give a more illustrative picture of what kind of answers that were given. What can be seen in the figure below is that the experts (1) saw a growing demand from the market and therefore acted on that. For the end-users (2) the main reason was that LEED was beneficial and best suited to use for their own environmental focus. The property developer (3) acted mostly on the demand they saw on the market. For

the contractors (4) any specific answer did not stand out. However the answers given from the contractor to the question could be divided between social reasons and reasons concerning the building. The ones concerning the building were that it's a comprehensive system and it gives a seal of quality. Then there is a social value that shows itself with the communication value and the focus on LEED for their company's environmental focus.

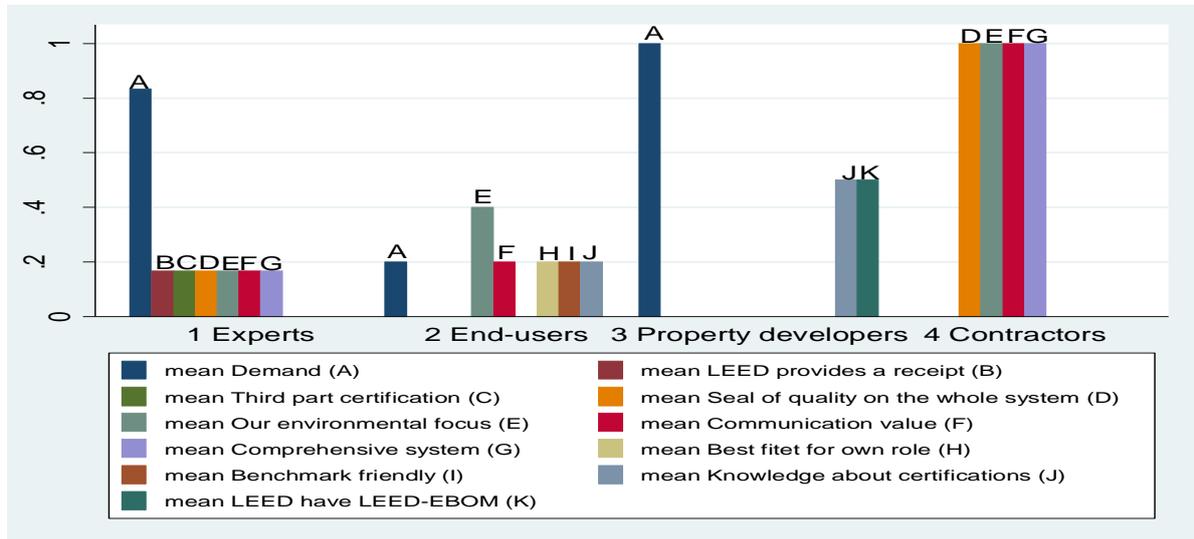


Figure 2. Why the organisations started working with LEED in Sweden

5.2.1 Values of a LEED-certified building

What kind of values do the interviewees think that a building certified with LEED obtains? What Figure 3 shows is that the main three values that the Experts (1) mentioned: LEED-New Construction will give lower operating costs, the real estate keeps its value, and that it is difficult to know due to the lack of facts from the Swedish market. The answer that stood out among the end-users (2) was that they thought that buildings that had a LEED certification were going to give a higher real estate value. The property developers (3) and contractors (4) answer didn't have any answer that was more significant than the others.

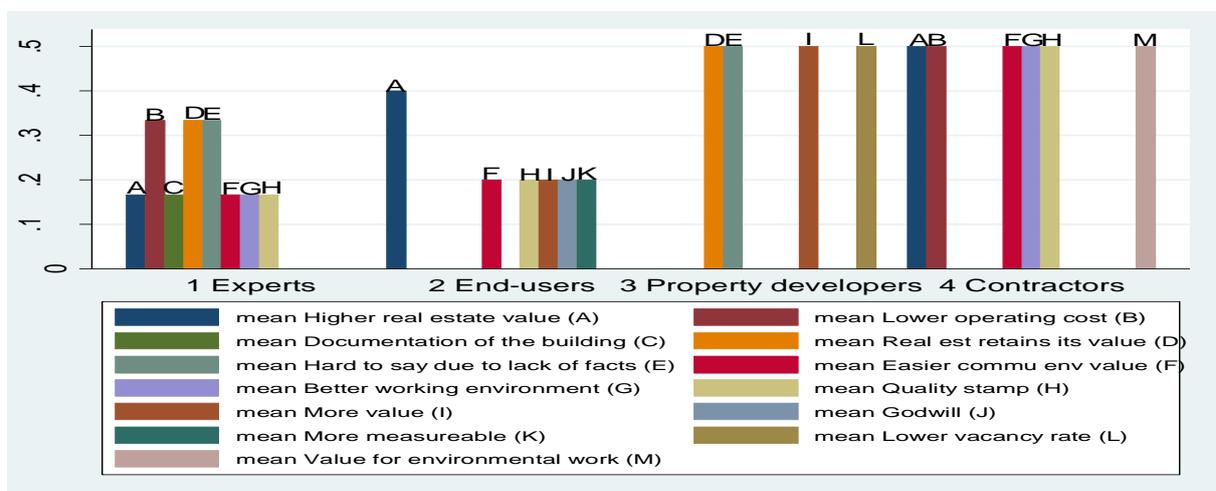


Figure 3. The values a LEED-certified building obtains or does not obtain in Sweden

5.3 Knowledge

The interviewees were also asked about how established the knowledge of LEED is in their organisations today. A variable named knowledge was formed through an estimate of the answer in a range of 1-4, where 4 stands for very good knowledge and 1 stands for very little knowledge. This variable was created to give a more illustrative picture of the knowledge of LEED in the organisations in the construction and real estate industry that applies LEED and to obtain a mean value, and the results are shown in Figure 4. The mean value is 2.75. This value indicates that there is a relatively low knowledge of LEED in the organisations that apply LEED in Sweden.

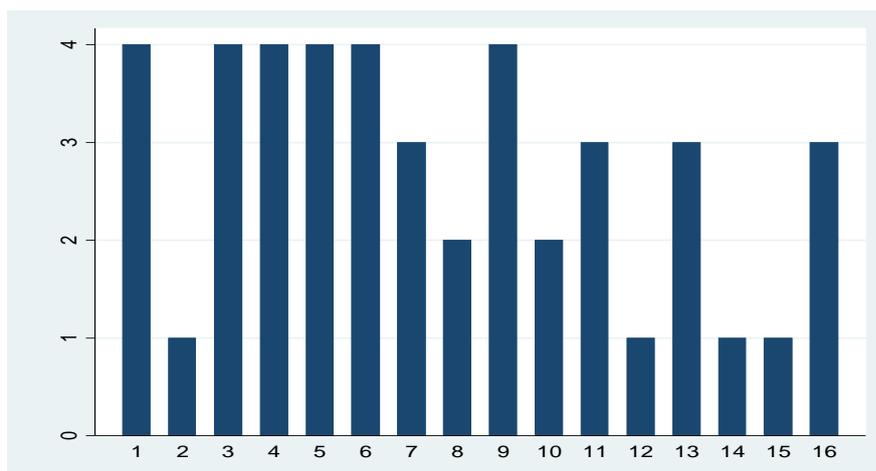


Figure 4. How established the knowledge of LEED is in the interviewees' organisations today

It is worth to mention that the only end-user that thought that they had very good knowledge of LEED is the only end-user that inhabits a LEED-EBOM building. This can depend on that this end-user has a triple-net lease which means the tenant is responsible for all costs concerning maintenance and therefore has clear incitements to lower their own energy usage. Additional to that, this specific end-user is as far as my knowledge stretches, the only end-user that is a chairman of a Nordic Green Building Council and by that participating in the evolution of sustainability initiatives and discussions in the industry.

5.4 LEED's applicability and feasibility

During the interviews, it has come to my attention that when constructing a new building with LEED in Sweden, there is not much that has to be changed to the building to reach the Gold standard in LEED. In addition to this, it was said that in many cases the LEED certification was not in the plans from the beginning. Instead it came in later in the building process in many of the projects, but still the building was able to get a high score in the certification. One interviewee thought that this depended on that Sweden has a culture of building good energy efficient houses from the beginning. Another interviewee thought that the reason why Sweden got high scores was due to that LEED is from the USA, is inspired by the European model to build, and therefore Swedish projects from the beginning are similar

to the inspiration source of LEED while the U.S. projects need to change when choosing to certify according to a LEED-New Construction

5.4.1 How to improve LEED?

This question was only given to the expert category and aimed to investigate how LEED could be enhanced. There were two answers that stood out. The first one was that the user has to be shown how much energy he in reality is using. The second one was that there should be more meters in the building so that more figures can be obtained to see if the building really performs as it is designed to do. Other answers given were: it needs to be more stringent, LEED-EBOMs need to be performed, more use of advanced energy modeling is needed, and the Swedish “Husguide” (building guide) could be used to make anyone understand how to run a building.

5.4.2 Working with ASHRAE

In this section, the positive and negative aspects of the ASHRAE standard from a Swedish energy perspective, is evaluated. Three answers were most common concerning the negative aspects. The first one was that the standard is too low in some parts of ASHRAE. The second one was that it is complicated to use another standard, in this case a U.S. standard that is tailored for the U.S. market. The third answer given was that there were some difficulties to interpret ASHRAE correctly. One interviewee actually said when we talked about how it was to work with ASHRAE, that:

"We do not know if those who were certified earlier just ticked a box in a form as the only proof of that they followed ASHRAE and then believed that they followed ASHRAE, ..."

The positive answers given to this question outnumbered the negative ones given. The positive answers differed: it is good that energy modeling is used, it is good for an educational purpose, it is beneficial that ASHRAE looks at the whole energy picture, and it is good to use because it makes benchmarking possible to carry out.

5.4.3 Have LEED had any effect on the work process?

From this question, twelve different answers were obtained. What was significant for this question was that eight of the interviewee gave the same answer. They all thought that there was a lot more documentation that had taken place when using LEED.

Other answers that stood out were that it resulted in more of a focus on a system, and that more reflection was made concerning environmental questions. One answer that stood out as indifferent was that there was no difference from the earlier practice of not building according to LEED.

5.4.4 LEEDs role in energy effective building in Sweden

The answers that were given on this issue were both positive and negative. The negative aspects that were brought up during the interviews were: that the standard of LEED is so low

that there is no incitement to build better, and that LEED does not lead to more energy efficient buildings. The negative answers are both related directly to the building.

However, also in this section the positive answers outnumbered the negative ones. The positive answers concerned both the building and the social effects. The social effect mentioned was that LEED created a debate about energy. The ones concerning the building were: clarification of which buildings that are good from an energy perspective, more advanced use of energy modeling, that the certification requires a certain amount of renewable energy, and that LEED helps to document aspects of the construction that before using LEED were not documented to the same stringency and magnitude.

5.4.5 Most important parts in the development of LEED international

Two answers stood out here. The first one was that more focus has to be put on the primary energy use. The second one was that it has to be more difficult to fulfil the criteria in order to obtain the certification. Other answers given were: use of an alternative compliance path known as ACP (ACP is an alternative way to fulfil LEEDs criteria), that the new performance part has to be developed, that there is a need to look at the building's carbon footprint, and that it should be more measurable.

5.4.6 Education of the user

The question about the importance of educating the user was asked to experts, property developers and contractors. All together there were ten interviewees that answered this question. One answer stood out in this category, and that was the importance of visual meters so the end-user could see how much they used in reality. One interviewee talked about that if the end-user sees how much they use the usage goes down a certain percent, but if the neighbours see the usage level it goes down more. Other answers given were: the importance to take the time to explain to the end-user how everything works, the importance with tenant-cover, educate the end-users by lectures, the importance to get the end-user involved early in the project, incitements to involve end-users, and that the interviewee had not looked at it yet.

5.5 Long term and short term expectations on a building certified with LEED

What kind of expectations does the end-user have on their real estate that has a LEED certification? No answer stood out. Instead, the end-users had different expectations relating either to the internal or external expectations. The answers given were: lower energy cost, generally higher expectations from this kind of building, a guarantee for a low climate impact from the building, that the expectations were low because better and new energy related initiatives were expected to be developed, support of their own internal environmental goals with energy goals, business benefits when dealing with environmental conscious business partners, and better values for international buyers.

5.6 How the end-user looks at the energy consumption in the real estate

To the question about how the end-user looked upon the energy use in the real estate, a lot of different answers were given. None of the answers were similar. The answers given to this question were: that it is the real estate owners responsibility, own sub-meters should be used, some kind of statistics should be produced to monitor the energy usage, LEED-EBOM should be used, the energy use should be connected to central saving goals, it should be included in the management system and one interviewee said that it was difficult to answer the question because he didn't feel he was informed about the energy consumption,

5.7 Future of the energy savings market

When the experts were asked about the future of the energy market, many relevant ideas were presented. The answers given were: more effective instruments, green leases, more consideration when it comes to the installations in the building, to make it more obvious for everybody how much energy they are using, more holistic thinking when constructing a building, a strive for more close to zero both concerning primary energy and carbon emissions, more use of energy modeling tools, warranty for energy consumption after hand over, look at the life cycle performance and look at the whole picture that a building is part of.

5.8 SWOT analysis

To summarise the findings about LEED-New Construction as an instrument for energy efficient buildings in Sweden, the relevant findings from the interviews are evaluated with a SWOT analysis table. The answers were divided into strengths, weaknesses, opportunities and threats. The information presented in the SWOT analysis are extracted from the above part of the findings chapter and complemented with answers from the interviews that are not shown in the findings. The SWOT analysis is based solely on the interview material and is not complemented with additional external findings. The SWOT analysis was done to get a better overview of the answers and to do a thorough evaluation. The SWOT analysis is more thoroughly investigated and discussed in the discussion section of the study. In Figure 5, the strengths, opportunities, weaknesses and threats in LEED are presented, and it should be noted that not each interviewee sees all of these problems and positive aspects.

Strengths	Weaknesses
<ul style="list-style-type: none"> • Market-driven • LEED provides a receipt • Third part certification • Seal of quality on the whole system • Comprehensive system • Big in the USA • Benchmark friendly • Energy modelling is used • Includes business electricity • Provides a documentation of the building • LEED includes LEED-EBOM • LEED requires increased use of renewable energy • Communication value • Energy savings and environmental objectives are related to money • Voluntarily to certify • Popular • Is being developed all the time 	<ul style="list-style-type: none"> • Complicated to use a US standard • Difficulties to interpret ASHRAE correctly as it is being used abroad • ASHRAE is not integrated in the layout-design of the building • Low level in certain parts of ASHRAE • Difficult to say due to a lack of proper knowledge • Low knowledge level in certain organisations on how to maintain a LEED certification • Large undertaking to certify • An additional cost • Lack of public knowledge about LEED • Little experience in Sweden, because of few approved projects • No requirement to prove that the building can be run in a good way • In LEED you compare costs and not kWhs, and in Sweden, the cost figures are confidential. • Costs are not equivalent to the energy use • LEED puts all responsibility on energy follow-up on the real estate owner • Uncertainty if the LEED certification is correctly done to be able to achieve the certification or the right level of the certification • Environmental impacts do not necessarily correspond to the money measured by LEED • Does not lead to more energy efficient buildings • No incentives to build better because of the low requirements
Opportunities	Threats
<ul style="list-style-type: none"> • Higher real estate value • Lower operating cost • The real estate keeps its value • Easier to communicate the environmental benefit • Better working environment • Quality stamp • Goodwill • Lower vacancy rate • Value for environmental work • More value for international buyers • To show what will be used in reality for users • More measurable • Make a LEED-EBOM • Beneficial for educational purpose • Creates debate • Clearer which houses that are good from the energy point of view • To support own environmental goals with energy objective • ASHRAE can bring in positive aspects with an different approach than otherwise used when constructing • People become proud by being involved in the use of an established system like LEED 	<ul style="list-style-type: none"> • Marketing advantage through marketing a certified building even though it is not certified • Translation problems regarding the language in certain parts of LEED, this can occur when people without English as a native language work with LEED. They misinterpret the language. • Difficult to get the correct understanding mediated to all actors involved concerning what work LEED requires • Too easy in Sweden to achieve high scores. • Miljöbyggnad and BREEAM takes too much of the market to make enough room for an additional certification system • Difficulties to do be good at doing energy modelling correctly

Figure 5. SWOT-analysis of LEED

6 Analysis

In this section the findings are discussed and elaborated on, by linking them to the six research questions of this study. When LEED is mentioned in the discussion it is as LEED-NC and LEED-CS otherwise it is written out.

How wide is the know-how in the construction chain of LEED in Sweden?

The knowledge of LEED in the organisation that applies it is essential for the cost of the project that uses LEED. (Kats, 2003) has in a study found that the more experience the organisation has of using LEED, the lower are the cost premium for achieving a LEED certification. As can be seen in the findings the mean value of the knowledge is relatively low in Sweden, and therefore the costs can be assumed to be relatively high for conducting a LEED certification. However, the more projects an organisation undertakes and finishes the more knowledge the organisation will get. This will in turn probably lead to lower the cost for conducting a LEED certification. This also includes some of the soft costs such as documentation, commissioning and energy analysis; when gathering more experienced in these fields the soft costs are likely to go down. During my interviews it was discovered that there were organisations that worked with getting LEED into their standard way of working and had lowered their costs for conducting a LEED certification. When organisations get more comfortable with LEED as a system the cost is also likely to go down. When an instrument is more cost effective it should more desirable for the market to use.

Which are the strengths and opportunities of using LEED as an instrument for sustainable energy efficiency in Sweden?

In the construction and real estate industry in Sweden, it is well acknowledged that there is a need for energy efficient buildings in Sweden. In today's society where the construction and real estate industry stands for such a large amount our society's energy usage the industry has reacted. The demand for more energy effective buildings increases and the customers are more aware today than ever.

During the interviews there was a clear indication that the analysis of energy question until recently in the construction industry has received little attention. I think that a combined effect of environmental classifications and energy certificates has helped to put more focus on the energy questions concerning a building.

As seen in Figure 5 LEED has some strengths. The strengths related to energy efficiency make up a big part of the strengths, and is divided into seven parts in the following analysis. First, LEED is voluntary, which means that the certification is optional to use. According to (Lee & Yik, 2004) the best way to achieve energy efficient building is by using a combination of mandatory and voluntary instruments. Sweden is small country and already has a mandatory building code, BBR that becomes more stringent for every version. Similarly, LEED is intended to be reviewed every second year, and with every new version there are more stringent demands. The combination of BBR and LEED gives an opportunity for the development of energy efficient buildings. LEED is market-driven and if the market demands more energy efficient buildings LEED will be pushed to follow the market demands. However, being a market-driven instrument has the possible disadvantage of being

pressured to relate energy savings and environmental goals to money. Second, LEED is a third part certification which means that a third part validates that the building was designed and built according to for example certain energy savings. Third, LEED is a very comprehensive system that covers a lot of different aspects, where Energy and Atmosphere is a big part with 35 points of the 100 points in the standard categories. This puts a lot of focus on the energy questions. Before LEED advanced energy modeling was not used to the same extent as now. In LEED, an energy model is mandatory. Fourth, the seal of quality of the whole building is a reminder to the tenants that they inhabit an energy efficient building, which may encourage them to act accordingly. Since LEED is mainly based on ASHRAE, business electricity is included. Business electricity is the electricity used by the users' organisation. BBR in Sweden does not account for business electricity, but sub-meters must be installed since BBR requires the separating of business electricity from the heating energy. Fifth, renewable energy makes up a small part of the points in LEED, and even if buildings constructed in Sweden seldom change much because of LEED, they often add more solar cells. Sixth, when doing a LEED-NC is it easier to do a LEED-EBOM and by doing that get a follow up on the energy usage. Seventh, and final, when doing a LEED-certification there is an extensive documentation required to make sure that everything is finalised. This is a strength since everyone can see what has been done to the building and re-evaluate it if there is something wrong.

Concerning the opportunities when applying LEED there are potentially many. Three of them relate to energy efficiency. The first one is lowered operating costs which are obtained when succeeding to construct and maintain an energy efficient building. Second, when working with an environmental classification such as LEED it gives value for the environmental work and it becomes easier to push for different solutions that otherwise could have been difficult to implement. Third, and final, when using LEED there are opportunities to draw from the use of ASHRAE such as energy modeling and benchmark benefits.

In addition, six other opportunities have been identified. First, when more buildings become LEED-certified it may be easier to sort out which buildings that are good from an energy perspective, on the condition that LEED actually leads to an improved energy performance. Second, if LEED-NC is complemented by the already existing system LEED-EBOM, the combination of a seal and a continuous renewal may provide the building with a strong marketing advantage. Third, there is an opportunity to show the user how much energy they use. It might be easier to implement a device that shows how much is being used when referring to LEED and to the challenge of maintaining the sustainability of a building. Fourth, people become strengthened when working with LEED; people think that they do something good and may act accordingly in other situations as well. Fifth, a company can support their own environmental goals with energy goals backed up by LEED. Sixth, and final, the use of LEED can start a debate about energy efficiency in buildings.

Which are the weaknesses and threats of using LEED as an instrument for sustainable energy efficiency in Sweden?

Some weaknesses of LEED were revealed during the interviews. To begin, LEED does not give more energy efficient buildings. There are proofs of both that LEED gives more energy

efficient buildings and that it does not. When looking at the Swedish market, it is difficult to tell how it would have turned out without the use of LEED. Under the interviews it was said that EU Green building is beginning to manifest itself as the standard tool when constructing new buildings. To obtain an EU GreenBuilding certificate the energy usage should be 25 percent lower than the current BBR standard. Another reason might be that LEED has too low requirements and thereby give no incitements to build better. This makes LEED more of a communication and goodwill tool in Sweden that organisations use to show that they think about the environment. One big weakness in LEED is that you do not have to prove that you can run your building in a good way, which is essential when almost 85 percent of the buildings' energy usage comes from the operation phase. This goes hand in hand with that there is little knowledge in some organizations about how to run a LEED building properly. Additional to that LEED does not give the tenant any incitement to lower the energy use because of lack of monitoring during the operation phase.

For some of the persons that work hands on with LEED there can be difficulties when working with another standard than they are used to. In addition to this, there can be problems because of the difficulties to interpret ASHRAE correctly. Also, in Sweden, it is secret how much big companies pay for energy. This is relevant since, in LEED, when calculating points, the price of the electricity is the most important factor. This leads to that in Sweden the company must use a made up figure to get points.

The threats in LEED that were mentioned during the interviews are to some extent limited. The threats that were mentioned were that it was too easy to reach high scores and that it was difficult to get a proper understanding to all actors involved for the certification to be implemented in a good manner.

How is the follow-up looked upon in a LEED certification in Sweden?

Throughout the interviews, the interviewees seemed to be very aware of how important the education of the end-user is: to show them how the building worked, educate them through tenant-cover, and so on. The interviewees also talked much about visual meters and incitements for the end-user to lower the usage. This, however, still seems to be on a planning stage. Solutions like showing the end-user how much energy they use combined with incitements to lower the usage seems to be a way forward, based on the interviews.

Regarding the education of end-user, all of the interviewees seemed to understand the importance, but no suitable standard exist to work according to.

The end-users seem to a large extent to be aware of that they ought to follow up the energy usage. This also concerns the end-users that really do not have any direct incitements to lower the energy usage. It would show awareness from the end-users to keep their buildings energy efficient.

How feasible is LEED from an energy perspective in Sweden?

If using LEED does not result in more energy efficient buildings in Sweden, if it is easy to achieve high LEED scores, and if LEED is yet another standard that it is difficult to work with, the applicability is low for the Swedish market. There is an ongoing work to make

LEED more suited for the international market, called LEED international. This is going to make LEED more applicable for Sweden and easier to work with. At the moment a lot of extra work is needed to use LEED in Sweden, and for the organisations that are not used to work with LEED the cost for the certification is high. The SGBC arranges courses in LEED and there is some education of LEED within the organisations that are using LEED, but as seen in the findings project work with LEED is the best way to increase the knowledge of LEED in the organisation.

Which role does LEED have in Sweden regarding energy efficiency?

At the moment (May 2011) LEED does not push the market. According to my interviews, the reason is that a LEED certification requires too little. It is therefore essential that the next LEED version becomes more demanding. As an example, one interviewee was involved in constructing a LEED building using LEED-NC 2009 and had an estimated energy usage of 69 kWh/year. This is good at the moment, but when comparing to the Swedish energy departments proposal for 2020 this house would not pass.

What LEED does in Sweden is to create a debate on buildings' energy efficiency. When a building is LEED certified people start to wonder what it means and how it concerns them. When certifying with LEED it gives an indication of which buildings that have the potential to be good from an energy perspective, for example by the additional use of clearly visible energy meters. It also shows that the specific real estate has a stringent documentation of what has been done in the building by each subcontractor. LEED also provides the Swedish industry with a usage of advance energy modeling that could be useful.

7 Discussion

It is difficult to present all the interesting answers given under the interviews. To strengthen this study it might have been beneficial to change the questions to a more quantitative art. Most of this study's workload was invested in summarising the material in a good way. The coding and sorting of this could have been performed quicker and maybe more accurately with more quantitative type of questions. Also, due to my limited knowledge of LEED in the beginning of the study, the questions were not as distinct as might have been required when the first interviews were conducted. This can also depend on my limited knowledge in the field of qualitative studies and that I did not work with the questions to the extent needed for the study. The most challenging aspect of this study has been to be objective and sort out the interviewee's thoughts from my own. This study has been about environmental questions, which most people that work with have a strong personal opinion about. To some extent has this influenced the study, but was also inspiring. If there had been a co-author for the study I think it would have been easier to keep a more objective perspective, because of the opportunity to discuss and be critical to the material collected.

This might have made the study's reliability lower than if I had had a broader knowledge of qualitative studies. If someone with a broader knowledge of qualitative studies would conduct the same study, it is therefore possible that a different way of approaching the answers given under the interviews had been used.

The external validity of the study can be assumed to be rather high because of the broad sample of persons that I interviewed and the spread over different roles in the construction chain in Sweden. Therefore, the study could be generalised to the entire construction and real estate industry in Sweden. However, it could have been higher if the participants were more equally distributed between the categories and if the sample was larger.

The internal validity of the study can also be assumed to be high because of the triangular effect that occurs after interviewing actors in the same field with experiences from different positions in the construction and real estate industry.

8 Conclusion

This study's main purpose was to investigate the use of the environmental classification system LEED-New Construction and LEED for Core & Shell development as environmental policy instruments to obtain a building that performs energy efficient on Swedish grounds. Based on this study, it seems that the opinion of the persons working with LEED is that it only has a small effect on energy efficient buildings at the moment. Also, the large responsibility that the real estate owners have in Sweden makes the incitements low for maintaining the sustainability of buildings.

At the moment LEED does not drive the energy questions forward in Sweden. This is the case because of the low requirements in the current version of LEED-New Construction. If it is possible to obtain LEED without changing much for a building, alternative paths should be looked upon, and preferably paths that more effectively require buildings to be changed. But also certifications that put more focus on the tenant in the building. Nevertheless, for most of the organisations that have constructed a LEED building, the benefits of goodwill and communication value for constructing a LEED building are large, and it has been shown that LEED also works as a documentation and discussion tool in the building process.

Reflections

In addition to the aspects mentioned above, LEED has other potentially positive influences on energy efficiency in Sweden. First, LEED is internationally recognised. Therefore, bigger companies such as IKEA, Starbucks and Coca-Cola are likely to be more willing to certify their buildings and in my interviews it was found out that, in Sweden, many projects receive publicity when they chose to build according to LEED. When bigger companies and spectacular buildings that stand out choose to certify according to an environmental certification, in this case LEED, smaller companies and municipalities are likely to follow. This could in the end benefit and pave the way for the Swedish Environmental classification Miljöbyggnad, which is a smaller system to implement than LEED. Many of the interviewees of this study thought that Miljöbyggnad would become the environmental certification with the biggest market share in Sweden.

Second, LEED relates environmental savings to money and that makes companies more willing to adapt LEED. Only focusing on money is on the other hand also a problem, which can be illustrated by the energy crises that in the first place occurred since fossil fuels were chosen because they were cheap and easy to access.

Currently, Sweden lacks an instrument that is anchored in the future energy saving goal of the nation, and the development of LEED does not point in that direction. Also, it may not be effective for the Swedish government to demand that an organisation should build according to LEED or some other environmental classification, particularly since the interviewees of this study focus on the need for better and more obvious incitement for implementing solutions that lead to energy efficiency. Demands are likely to only make the buildings being constructed according to the demand, but with incitements it creates the opportunity for the construction and real estate industry to gain advantages that are directly compatible with the market forces.

It is important to have in mind that LEED is not a solution to a sustainable building but merely offers an opportunity to have one in the future. I am also of the belief that an attempt must be made to warrant the end-user a certain energy consumption to reassure energy efficiency. Additional to that I think that much more hard facts and figures that support green buildings performance over time are needed.

9 REFERENCES

Published

- Birt, B., Mancini, S., & Newsham, G. (2009). Do LEED-certified buildings save energy? Yes, but... *Energy and Buildings* , 41 (8), 897-905.
- Bordass, B., Leaman, A., & Stevenson, F. (2010). Building evaluation: practice and principles. *Building Research & Information* , 38 (5) 564-577.
- Boverket. (2010). *Konsekvensutredning - Revidering av avsnitt 9 Energihushållning i Boverkets byggregler, BBR (BFS 1993:57)*. Karlskrona: Boverket.
- Brundtland Report. (1987). *Our Common Future, Report of the World Commission on Environment and Development*. Oslo: Brundtland Commission.
- Bryman, A. (2008). *Social research methods*. Oxford University Press: Oxford.
- Building Design & Construction. (2003, 03 11). White Paper on Sustainability. *Building Design & Construction* .
- Eliasson, A. (2006). *Kvantitativ metod från början*. Lund: Studentlitteratur.
- Enermodal Engineering, Inc. (2006). *The Costs and Benefits of LEED-NC in Colorado*. Denver: Enermodal Engineering, Inc.
- Eriksson, L., & Wiedersheim, P. (2006). *Att utreda, forska och rapportera*. Malmö: Liber.
- Fischlein, M., & Smith, T. (2010). Rival private governance networks: Competing to define the rules of sustainability performance. *Global Environmental Change* , 20 (3), 511–522.
- Fröberg, L., & Reuterskiöld, A. (2010). *Hur ser investerare på miljöcertifierade fastigheter?* Stockholm: KTH.
- Fuerst, F., & McAllister, P. (2011b). Eco labeling in commercial office markets: Do LEED and Energy Star offices obtain multiple premiums? *ECOLOGICAL ECONOMICS* , 70 (6), 1220-1230.
- Fuerst, F., & McAllister, P. (2011a). Green Noise or Green Value? Measuring the Effects of Environmental Certification on Office Values. *REAL ESTATE ECONOMICS* , 39 (1), 45–69.
- Haselbach, L. (2010). *The Engineering Guide to LEED—New Construction: Sustainable Construction for Engineers, second edition*. The McGraw-Hill Companies, Inc.
- Henriques, A., & Richardson, J. (2004). *The triple bottom line, does it all add up?: assessing the sustainability of business and CSR*. London: Earthscan.
- Kats, G. (2003). *Green Building Cost and Financial Benefits*. Massachusetts: Massachusetts Technology Collaborative.
- Lee, W., & Yik, F. (2004). Regulatory and voluntary approaches for enhancing building energy efficiency. *Progress in Energy and Combustion Science* , 30 (5), 477-499.
- Maines, L., & Sprinkle, G. (2010). The benefits and costs of corporate social responsibility. *Business Horizons* , 34 (4), 445—453.
- Malterud, K. (1998). *Att kombinera metoder. Kvalitativa metoder i medicinsk forskning*. Lund: Studentlitteratur.

Matus, K. (2009). *Standardization, Certification, and Labeling: A Background Paper for the Roundtable on Sustainability Workshop January 19-21, 2009*. Cambridge: Harvard University.

Meade, L., & Presley, A. (2010). Benchmarking for sustainability: an application to the sustainable construction industry. *Benchmarking: An International Journal* , 17 (3), 435-451.

Norman, W., & MacDonald, C. (2004). Getting to the Bottom of “Triple Bottom Line”. *Business Ethics Quarterly* , 17 (1), 243-262.

Polonsky, M. J. (2011). Transformative green marketing: Impediments and opportunities. *Journal of Business Research* , Article in Press.

Scofield, J. H. (2009). Do LEED-certified buildings save energy? Not really. . . *Energy and Buildings* , 1386–1390.

Silverman, D. (1993). *Interpreting Qualitative Data - Methods for Analysing Talk, Text and Interaction*. London: Sage.

Silverman, D. (1993). *Interpreting Qualitative Data - Methods for Analysing Talk, Text and Interaction*. London: Sage.

Yellamraju, V. (2011). *LEED–New Construction Project Management*. The McGraw-Hill Companies, Inc.

Yudelson, J. (2008). *The Green Building Revolution*. Washington: ICELAND PRESS.

Electronic

Byggindustrin. (2011). *Bygg- och fastighetssektorns är energianvändning överskattad*. Author: N. Köhler. Retrieved 04 17, 2011, from http://www.byggindustrin.com/energi--miljo/bygg--och-fastighetssektorns-energianvan__8289

Energimyndigheten. (2011). *Styrmedel*. Retrieved 03 03, 2011, from <http://www.energimyndigheten.se/sv/Om-oss/Energi--och-klimatpolitik/Styrmedel/> .

Ekohus. (2011). *Boverkets nya energikrav för slappa*. Retrieved 04 26, 2011, from <http://ekohus.nu/index.php/2011/01/boverkets-nya-energikrav-for-slappa/>

Greenbiz. (2011, 03 02)., *Smarter Buildings, Part 2: How to Close Gaps Between Design and Performance*. Author: L. Guevarra. Retrived 08 07, 2011, from <http://www.greenbiz.com/blog/2011/03/02/smarter-buildings-part-ii-how-close-gaps-between-design-and-performance?page=full>

Prnewswire. (2011). *Green Building Market Grows 50% in Two Years despite Recession, Says McGraw-Hill Construction Report*. Retrieved 04 02, 2011, from <http://www.prnewswire.com/news-releases/green-building-market-grows-50-in-two-years-despite-recession-says-mcgraw-hill-construction-report-107547978.html> .

SGBC. (2011). *Sweden Green Building Council*. Retrieved 03 25, 2011, from www.sgbc.se.

SP Technical Research Institute of Sweden. (2011). *Environmental classification of buildings*. Retrieved 02 28, 2011, from <http://www.sp.se/en/centres/zeb/miljoklassning/Sidor/default.aspx>.

USGBC. (2011a). *About USGBC*. Retrieved 03 15, 2011, from <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=124>.

USGBC. (2011b). *What LEED is*. Retrieved 03 17, 2011, from <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1988>.