Introductory Essay

1. Background and purpose

One of the main drivers for increasing global temperatures is human activity that causes greenhouse gas emissions (Hegerl et al., 2007). In Sweden, the real estate sector accounts for about 20 percent of the total greenhouse gas emissions and 28 percent of total energy usage (if heating is included) (Toller *et al.* 2009). It is often argued that there is an energy efficiency gap in the Swedish real estate sector, as market actors are not undertaking all *apparent* profitable energy investments. Economic literature has identified a number of barriers that hinder a more efficient energy usage. These barriers can be divided into *market failures* and *market barriers*. Market failures focus more on "mispriced" commodities, ill-formed incentives etc. which causes a non-optimal resource allocation. Put differently, the market fails to price the commodity in a proper way. In this case, a government intervention can be justified, if the benefits exceed the costs. Market barriers have a stronger emphasis on market behavior, from a decision-maker's point of view. However, market barriers are not necessarily signs of market inefficiency. In the following passage a number of market failures and market barriers are explained more thoroughly.

1.1 Market failures

Asymmetric Information: This phenomenon is common in many business relations. For instance, a producer will have an information advantage compared to an end-user. Therefore, a rational producer will foremost stress a commodity's positive qualities and tone down the negative qualities. Related to energy efficiency in a real estate context, real estate developers/owners will not emphasis a buildings energy performance if it is not performing well. In addition, knowledge about energy efficiency measures is often limited within an organization, which reduces the implementation of energy efficiency measures.

Externalities: Energy production is linked to negative externalities, where the magnitude and type of these depends on the energy source. The externalities (e.g. greenhouse gas emissions) are seldom priced correctly on the market and therefore the energy market price is too low in comparison to the social cost. This could result in a higher energy production/usage than what is optimal from the society's point of view.

Split incentives: This scenario occurs when two (or more) actors have diverse incentives, due to agreements, organizational framing and/or asymmetric information. The standard example is the "landlord-tenant-dilemma"; if the tenant pays the energy bill, the landlord will not have any incentive to carry out any energy efficiency investments in the building. Alternatively, if the landlord pays the energy bill, the tenant will not have any incentive to reduce his energy usage.

1.2 Market barriers

Transaction costs: This includes all the additional costs that are required for a transaction to take place (e.g. effort, time, money). Are these cost to a larger extent born by the buyer, it would result in a higher total cost than the actual transaction price. This could, depending on the price sensitivity, result in an overall lower demand (e.g. for energy efficiency measures).

Uncertainty: All estimations of future benefits are more or less uncertain. Energy efficiency investments include uncertainty factors such as: *Future price development of energy, technical risk* (will the technical system work as predicted?) and *technical development* (will the technical development enable a better investment opportunity in the future?). In all, these factors have an impact on the profitability of conducting energy efficiency investments and can result in postponed energy efficiency investments.

Capital Constraints: Firms access to capital is often limited, especially for small and medium-sized firms. This limitation forces the company to prioritize among different investment options and investments in line with the company's core business and/or with shorter pay-off periods are usually preferred. As energy efficiency investments may not necessarily be in line with the core business strategy and/or usually have longer pay-off periods, these investments may be neglected (SOU 2008:110, 2008; Swedish National Board of Housing, Building and Planning, 2005; van Soest and Bulte, 2001; Schleich, 2009; IEA, 2007).

1.3 Is there an energy efficiency gap?

Levine et al. (2007) argue that there is a big, profitable, energy saving potential within the real estate sector. However, as argued by Jaffe and Stavins (1994), the size of this potential gap mainly depends on the viewpoint, *technical* or *economic*. The authors suggest two separate starting points, *economic* and *social*. From an economic standpoint, increased energy efficiency could be achieved by eliminating market failures and market barriers, as shown in figure 1 below. From a social perspective, a slight increase in energy efficiency investments can be achieved by eliminating the market failures that passes the cost-benefit criterion. If environmental issues were taken into account, a higher level of energy efficiency would be justified.

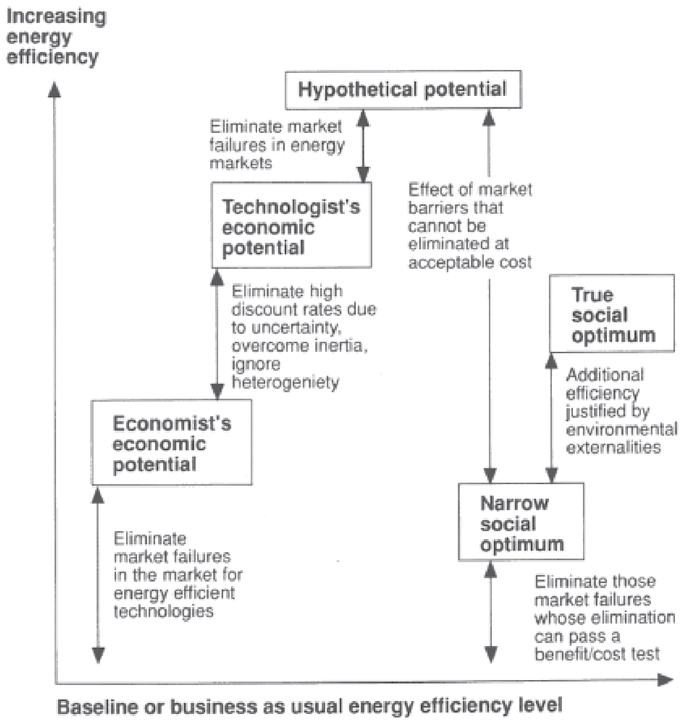

Figure 1: Illustration of Energy efficiency gaps (Jaffe and Stavins, 1994)

As illustrated by figure 1, the "Hypothetical potential"-level can only be reached by removing *all* market failures/barriers. The authors argue that this level of energy efficiency is impossible to achieve and even not desirable due to the large cost that would be required to implement the necessary government regulations.

As shown, estimating and defining an energy efficiency gap is a hard task. Profu (2008) have tried to estimate the energy saving potential in the built environment in Sweden. In the baseline case, the "technical" potential gap 2016 would be around 34 TWh, 22 percent of the average annual base year (2001-2005) usage. Spontaneous efficiency measures (e.g. replacing malfunction equipment) are assessed to result in an increased energy efficiency of 8 TWh, which leaves a gap of 26 TWh, about 17 percent of the average annual base year (2001-2005) usage. About 10 TWh of the remaining gap was assessed to be due to transaction costs, split incentives and investors myopia. The remaining part, 16 TWh, is mainly due to remaining hinders which was deemed too difficult to quantify.

This thesis focuses on the economic aspects of environmental and energy efficiency issues in the Swedish commercial real estate sector. The purpose is to add knowledge about how different actors in the real estate sector respond to building's environmental/energy performance, mainly focusing on barriers, actions and economic outcome/impact.

2. "Green" buildings and environmental assessment systems

The term "sustainable development" can be derived to the Brundtland Commission, which lay forth the following definition: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). Further definitions of “sustainability” is: “Sustainability is the principal of seeking to avoid, minimize, and/or mitigate adverse current and future social, environmental and economic impacts (externalities)” (Runde and Thoyre, 2010). However, as sustainable development is difficult to evaluate, a “triple bottom line” framework has been elaborated in order to assess sustainable development. This framework focuses on *economic, social* and *environmental* performance (Slaper and Hall, 2011). Kohler (1999) argues that this approach can be applied within the built environment, where economic sustainability refers to investment and maintenance costs, environmental sustainability refers to the protection of the ecosystem and usage of resources, and social sustainability refers to human wellbeing/health issues, as illustrated in Figure 2.

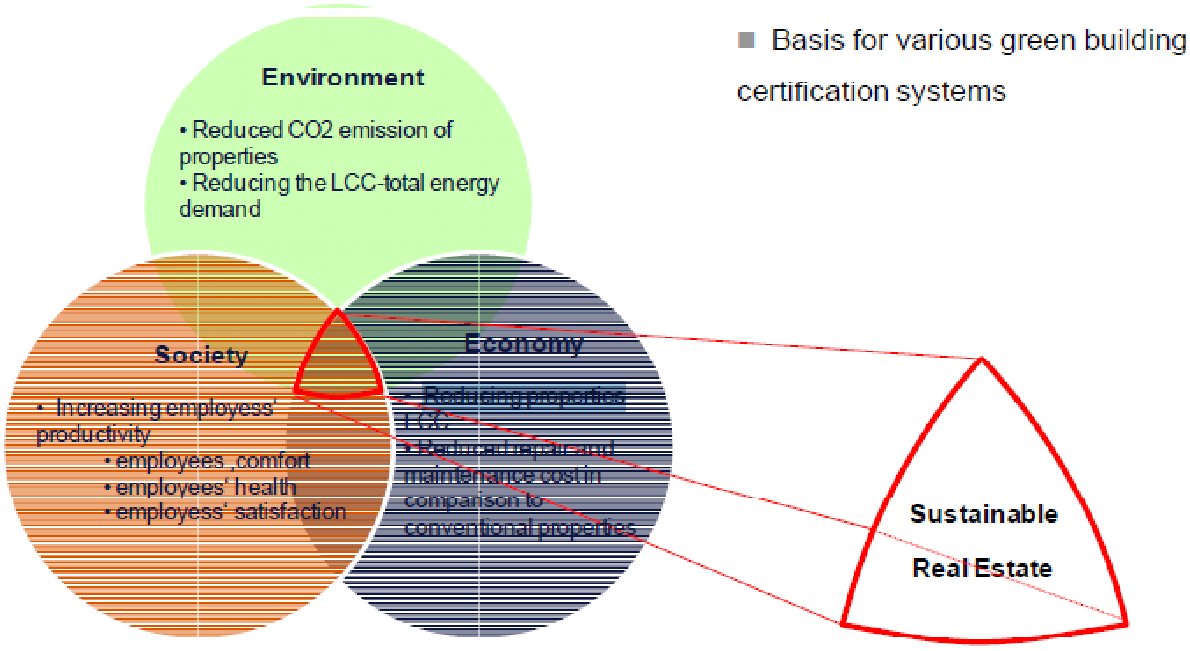

Figure 2: Illustration of “Sustainable Real Estate” (Bienert et al., n.d.)

As of today, there is no standard definition of what constitutes ”green” building. The U.S. Environmental Protection Agency (EPA) uses the following definition: “Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable or high performance building.” Kibert (2008) defines green building as: “healthy facilities designed and built in a resource-efficient manner, using ecologically based principles”. Further definition of sustainable (green) building is given by Royal Institution of Chartered Surveyors (RICS): “Sustainable buildings should optimise utility for their owners and occupiers and the wider public, whilst minimising the use of natural resources and presenting low environmental impact, including their impact on biodiversity” (RICS, 2009). In order to evaluate a buildings environmental performance with a more straightforward approach, multiple environmental assessment systems have been developed.

2.1 Environmental assessment systems

The main focus of an environmental assessment system is to evaluate a buildings environmental performance in an easy manner. This improves the transparency on the market, as well as creates a common standard of how to measure environmental performance. Internationally, the American assessment system Leadership in Energy and Environmental Design (LEED) and the British scheme Building Research Establishment Environmental Assessment Method (BREEAM) are the most recognized. In Australia, the environmental assessment system Green Star have been in use for a about a decade and since a couple of years ago Sweden and Germany have also developed national assessment schemes of their own (Miljöbyggnad and DGNB, respectively). Additionally, other countries have developed national systems, for instance France (HQE), Norway (Økoprofil) and Finland (PromisE). The environmental assessment systems are not static tools, but instead are revised over time, as new versions are introduced. In Sweden, BREEAM, LEED and Miljöbyggnad are most commonly used for evaluating environmental qualities in the built environment. These systems are explained more thoroughly below.

BREEAM

The first BREEAM scheme was introduced in the beginning of the 1990s in Great Britain. The founding organization was the Building Research Establishment (BRE) who, in corporation with U.K. Green Building Council (UKBGC), still administrates and develops the BREEAM schemes (Saunders, n.d.; Guy, 2008)

The BREEAM system assesses the following building attributes:

- *Management*
- *Waste*
- *Health and Wellbeing*
- *Pollution*
- *Energy*
- *Land Use and Ecology*
- *Transport*
- *Materials*
- *Water*
- *Innovation*

Within the BREEAM system, different schemes have been developed in order to properly assess new construction (e.g. offices, retail) as well as existing buildings. By using a "Bespoke" scheme, buildings that do not fit the standard schemes can be assessed. This scheme, as well as the international schemes, can be used to assess buildings not located in the United Kingdom. In addition, countries are able to develop their own versions of the BREEAM system, in co-operation with BRE Global.

The BREEAM schemes have five different grades of certification: *Pass, Good, Very Good, Excellent* and *Outstanding*. The following procedure is followed when a building's rating is calculated; first each individual aspect points' are summarized (as a percentage of the aspects total score). In the second step, these scores are weighted in accordance to the aspects predetermine significance. Third, the weighted scores are summarized and eventual innovation points are added. Before the building is rewarded with a certificate, the building has to comply with the schemes minimum requirements, which gets tougher for the higher certificates. This procedure is also illustrated in figure 3 below (BRE, 2010).

BREEAM Section	Credits Achieved	Credits Available	% of Credits Achieved	Section Weighting	Section score
Management	7	10	70%	0.12	8.40%
Health & Wellbeing	11	14	79%	0.15	11.79 %
Energy	10	21	48%	0.19	9.05%
Transport	5	10	50%	0.08	4.00%
Water	4	6	67%	0.06	4.00%
Materials	6	12	50%	0.125	6.25%
Waste	3	7	43%	0.075	3.21%
Land Use & Ecology	4	10	40%	0.10	4.00%
Pollution	5	12	42%	0.10	4.17%
Innovation	1	10	10%	0.10	1%
Final BREEAM score				55.87%	
BREEAM Rating				VERY GOOD	

Minimum Standards for BREEAM 'Very Good' rating	Achieved?
Man 1 - Commissioning	✓
Hea 4 - High frequency lighting	✓
Hea 12 - Microbial contamination	✓
Ene 2 Sub-metering of substantial energy uses	✓
Wat 1 - Water consumption	✓
Wat 2 - Water meter	✓
LE 4 - Mitigating ecological impact	✓

Figure 3: Example of BREEAM score and rating calculation (BRE, 2010)

LEED

The U.S. Green Building Council (USGBC) launched the first LEED scheme in 1998. LEED assesses the following building characteristics when evaluating the environmental performance:

- *Sustainable sites*
- *Water efficiency*
- *Energy and atmosphere*
- *Materials and resources*
- *Indoor environmental quality*
- *Innovation and design*
- *Regional priority*

The LEED system consists of different schemes that are designed for assessing commercial, residential and institutional buildings. In addition, the schemes have been developed in order to assess the different stages of a building's lifespan, as illustrated by Figure 4 below.

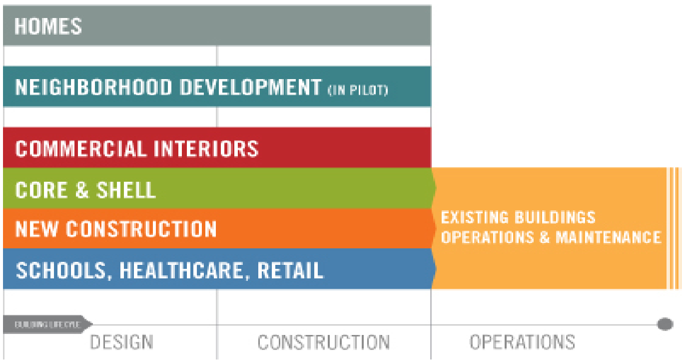

Figure 4: An overview of the different LEED schemes. (Source: www.usgbcga.org, Accessed: 2012-10-04)

There are four different levels of LEED certificates: *Certified, Silver, Gold* and *Platinum*. Each individual category, with the exception of "Innovation and design" and "Regional Priority", has a minimum of one prerequisite that needs to be fulfilled in order to obtain a LEED certificate. The LEED system does not use any individual category weights, as the BREEAM system does. Instead the points are allocated over the different categories in accordance to their potential environmental impact and human benefits. For the final evaluation of the building, all points are summarized into a final score which determines the certification level (USGBC, 2012).

Miljöbyggnad

The Swedish environmental assessment system "Miljöbyggnad" was developed within the "ByggaBo-Dialogen" framework, an association between the Swedish industry and governmental institutions. The scheme was introduced in 2009 and since 2011 the Sweden Green Building Council (SGBC) has governed it.

"Miljöbyggnad" can be used to assess new constructions, existing buildings and major renovations. The system was initially developed for assessing existing office, multi-tenant and school buildings, but has now been adapted to assess retail, hotel etc. The system assesses the following environmental parameters:

- *Energy*
- *Indoor environmental quality*
- *Building material and chemical substances*

The system has the following structure: Each environmental *parameter* consists of a number of *aspects*, which in turn are divided into different *indicators*. These indicators are made up by specific classification criteria's. Each criterion is graded in accordance to the following scale: *Gold, Silver, Bronze* (Built in accordance with present building standards) and *Assessed* (fail to fulfill present building standards).

Assessment of the building follows this three-step process:

1. *Indicator to Aspect*
   The lowest graded indicator will decide the Aspects overall grade.

Aspect	**Indicator**	**Grade**	**Air quality grade**
Air quality	*Amount of Radon*	Silver	**Bronze**
	Ventilation	Gold	
	Amount of nitric oxide in indoor air	Bronze	

2. *Aspect to Environmental Parameter*
   In this phase, it is the majority of the underlying Aspects individual grades that determine the Environmental Parameters overall grade. However, none of the included Aspects' grades can be more than one-step lower. If so, the Environmental Parameter grade is lowered.

Environmental Parameter	Aspect	Grade	Indoor environmental quality grade
Indoor environmental quality	*Air quality*	Bronze	**Silver**
	Thermal climate	Gold	
	Day light	Silver	
	Dampness	Gold	
	Legionella	Gold	

3. *Overall assessment of the building*
   In this final step the lowest Environmental Parameter determines the overall building grade.

Environmental Parameter	Grade	Overall building grade
Energy	Gold	**Silver**
Indoor environmental quality	Silver	
Building material and chemical substances	Gold	

The building assessment is thereafter valid for a maximum of ten years (SGBC, 2012a).

Overview of the different schemes

The environmental assessment systems have been developed in order to capture the essence of "green" or sustainability. As this is a very abstract term, the above-mentioned systems have their differences. In addition, the systems are largely affected by the regional environmental issues and building codes. This makes a comparison between the systems difficult. However, the different schemes show some similarities. The LEED and BREEAM systems have similar, broader, framing while "Miljöbyggnad" have a narrower framing. In addition, LEED/BREEAM also assesses indirect environmental effects (e.g. bicycle and changing rooms that *could* encourage more bike riding), while "Miljöbyggnad" mainly focus on direct measurable environmental impact. The systems also differ in how the overall grad for the whole building is set.

A critique against the environmental assessment schemes is that they are too simplified, which results in that they not necessarily are properly founded in environmental science. As the systems consider a range of issues, ranging from daily building operating routines to long-term technical solutions, there is also a risk of sub-optimizations (Lilliehorn, 2012).

2.2 Energy assessment systems

In addition to the above-mentioned environmental assessment systems, a number of schemes that only assesses the building energy performance exist. In Sweden, the EU Energy Performance Certificates (EPC) and EU GreenBuilding (GreenBuilding) are the two most commonly used schemes. The EPCs was introduced via the European Union (EU) directive on the Energy Performance of Buildings and is mandatory to undertake as it has been implemented into Swedish legislation. The GreenBuilding scheme is however a voluntary scheme, launched by the EU.

EU Energy Performance Certificates

The main purpose with the EPC scheme is to assess a building's energy performance and forward the result to the different stakeholders in a straightforward manner. The process has to be undertaken by an accredited, third-party assessor. In Sweden, the result of the EPC is presented as the exact annual energy usage per square meter (weather corrected), which is also presented on a grading scale from "low" to "high". In addition, the EPC also present comparison values for similar existing buildings (location, age and design-wise) as well as current building standards. Moreover, the EPC suggests improvements that should be cost efficient. The suggested improvements are divided into three different sub-categories; *Construction, Technical installations, Operation and control measures*. When finalized, an EPC is valid for ten years (Swedish National Board of Housing, Building and Planning, 2008; Swedish National Board of Housing, Building and Planning, 2009).

All commercial buildings (with exceptions of special purpose buildings such as defense premises) should have been certified as of 2009. Nevertheless, by February 2012 just about 50 percent of the commercial building stock had undergone an EPC (Swedish National Board of Housing, Building and Planning, 2012a). This delay is due to a number of reasons: First, the directive was not implemented into Swedish legislation until 2006. In addition, the process of accrediting energy assessor was bureaucratic. Altogether, this resulted in a shortage of accredited energy assessors. Second, as many market participants did not request the EPC, the willingness to fulfill the directive could be questioned. Third, the supervision of the directive has not been ideal (Swedish National Audit Office, 2009; Swedish National Board of Housing, Building and Planning, 2009; Swedish National Board of Housing, Building and Planning, 2012b).

EU GreenBuilding

The GreenBuilding is a certificate that indicates energy efficiency improvements. The initiative was launched by the European Union in 2004, as a mean to speed up the implementation of energy efficiency measures in the commercial built environment. As of June 1st 2010, the system is administrated by SGBC.

The main condition for *existing* buildings to become GreenBuilding certified is to lower the current energy usage by at least 25 percent. For *new construction*, the requirement is a 25 percent energy usage reduction in comparison to current building regulation. In order to keep the certificate, an annual report (deadline 31 of January) concerning the energy management of the building/buildings has to be submitted to SGBC (SGBC, 2012b; SGBC, 2012c; SGBC, 2011).

3. Economic impacts

Capital Cost

The most common question regarding green buildings and environmental retrofits is: "How much does it cost?". This is obviously a very relevant question, as construction/retrofitting costs have a great impact on a project's revenue. Kats (2003) assessed the additional cost for a LEED certified building to be about two percent of the conventional building cost. For the highest certificate level an additional capital cost of 6.5 percent was needed. The additional cost is mainly due to increased architectural and engineering design time. Kats (2003) also emphasize that the earlier the green features are integrated into the process, the lower the additional cost will be. A study in the U.K. showed similar results; the lower BREEAM ratings required just about a two percent capital cost increase while an additional cost increase of about seven percent was needed to meet the requirements for the higher certificate levels (EMEA, 2009).

Rents/Sales prices/Market values

"Green" features, such as improved energy efficiency, improve indoor environment etc. should generate direct economic benefits (e.g. increased sales prices, higher rents, higher occupancy rates). Studies have indicated rent as well as sales premiums for energy/environmental-assessed premises. Eichholtz *et al.* (2010) was one of the first empiric articles that found a significant relationship between certified (Energy Star[1] or LEED) office buildings and increased rent levels/ higher sales prices (about three percent and 16 – 19 percent, respectively), in comparison to similar non-certified buildings. Then again, when looking at the green labels separately, no significant relationship was found between LEED-certified office buildings and greater sale prices/increased rents. This could either be due to a low number of observations or the fact that tenants/investors only are prepared to pay for increased energy performance, while disregarding other "green" features. Fuerst and McAllister (2011a) found similar results, with the exception that they also observed a rent premium (around five percent) as well as a sales price premium (about 25 percent) for LEED-certified buildings, in comparison to similar, non-certified, buildings. Moreover, Fuerst and McAllister (2011b) found that buildings labeled with both Energy Star and LEED certificates obtained even larger rent and sales premiums, 9 and 28 percent respectively. In addition, Eichholtz *et al.*, (2010b) found that the rental drop after the economic crises in 2009 was lower in the "green" (LEED or Energy Star) building stock, in comparison to the similar, non-certified, building stock.

In the Netherlands, Kok and Jennen (2012) studied the relationship between energy efficiency (using EPCs) and rents. The study showed that "non-green" buildings (labeled D – G) had lower rents than "green" buildings (labeled A – C). A study in the U.K. found that BRREAM certificates had a positive impact on rent levels (about 23 – 30 percent) as well as sales prices (around 27 – 43 percent)(Chegut *et al.*, 2011). However, when Fuerst and McAllister (2011c) investigated the relationship between EPC:s and market values and market rents in the U.K., they could not observe any significant relationship between superior EPC ratings and greater market rents/market values.

[1] American Energy rating tool

Tenants

Are there certain tenants that prefer green premises? Eichholtz *et al.* (2010c) studied the American real estate sector and found that companies within the mining and construction sector, public administration and organizations employing higher levels of human capital are more likely to lease a green office. Reasons for this could be; to comply with the company's CSR policy, it is "the right thing to do" or to reap the benefits of a superior indoor climate (which could have a positive impact on the employment productivity and wellbeing). Increased wellness among a company's employees is essential as salary costs constitute the overall largest share of a company's total costs (Woods, 1989 cited in Armitage et al., 2011). However, studies have shown ambiguous results regarding employment wellness/productivity in green buildings. For instance, Armitage *et al.* (2011) show that employees do not believe that the "green" office indoor environment has a significant impact on their health and productivity. In addition, a South African study showed that workers in a green building did not perceive the indoor environment in a green building significantly better than the indoor environment in a conventional building (Thatcher and Milner, 2012). On the other hand, an Australian case study indicated improved perceived indoor environment, which for instance resulted in reduced average sick leave (Sustainability Victoria, n.d.). These somewhat ambiguous results could be explained by the fact that one's work environment is very subjective and is affected by many different factors, not necessarily linked to the physical work environment.

4. Integrating "green" in property valuation

The value of green can be defined as: "the net additional value obtainable by a green building in the market compared to conventional or non-green properties" (Bienert et al., n.d.). Lorenz and Lützkendorf (2008) argue that that this value is due to financial benefits (direct and indirect) or reduced property (investment) risk. The authors argue for the following link between reduced risk and "green" characteristics:

Characteristics and attributes of sustainable buildings	Examples of reductions in/avoidance of property specific risks
Flexibility and adaptability	Reduction of risks through changes in market participants' preferences (obsolescence) and through restricted usability by third parties
Energy efficiency and savings in water usage	Reduction of risks through changes in energy and water prices; reduced business interruption risks (e.g. caused by power outages) through facilities that derive energy from on-site resources and/or have energy efficiency features
Use of environmentally friendly and healthy building products and materials	Reduction of litigation risks and of being held liable for paying compensations to construction workers and building occupants
High functionality in connection with comfort and health of user and occupants	Reduction of vacancy risks or of losing tenant(s)
Construction quality, systematic maintenance and market acceptance	Lower risks of changes in property values
Compliance with/over-compliance with legal requirements in the areas of environmental and health protection	Reduction of risks from increasingly stringent legislation (e.g. expensive retrofiting or losses in property values)

Table 1: Examples of links between "green" characteristics and reduced risk (Lorenz and Lützkendorf, 2008)

Runde and Thoyre (2010) argue for a three-step model when integrating "green" criteria's into real estate valuations:

1. *Assess Market Uptake of Sustainability*
   In this initial step relevant local market stakeholders are identified and assessed. These can be divided into three different categories; policy makers (government and non-government organizations), property owners and end-users (tenants and "owner-users"). The main idea is to classify the market as a so-called "Sustainability-Oriented" or "Not Sustainability-Oriented". The following characteristics' is, amongst others, assessed in order to classify the local property market:

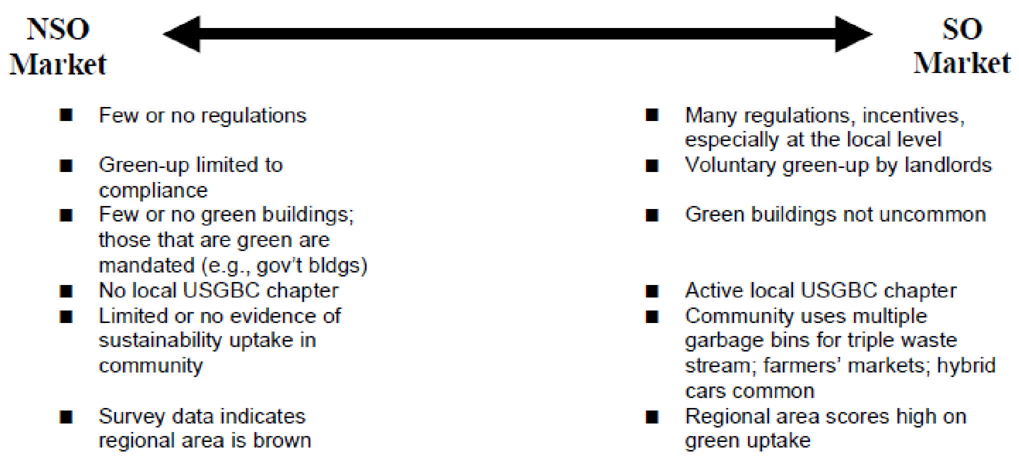

Table 2: Characteristics of Not Sustainability-Oriented (NSO) and Sustainability-Oriented (SO) markets (Runde and Thoyre, 2010)

2. *Categorize the Subject*
   The focus is to assess the valuation object and the comparable buildings characteristics'. The main idea is to categorize the building as a green or conventional (brown) building. As this procedure is completed, a 2*2 matrix is formed, as the green/brown building could be located in a Sustainable/Not Sustainable-oriented market (see figure 5 below).

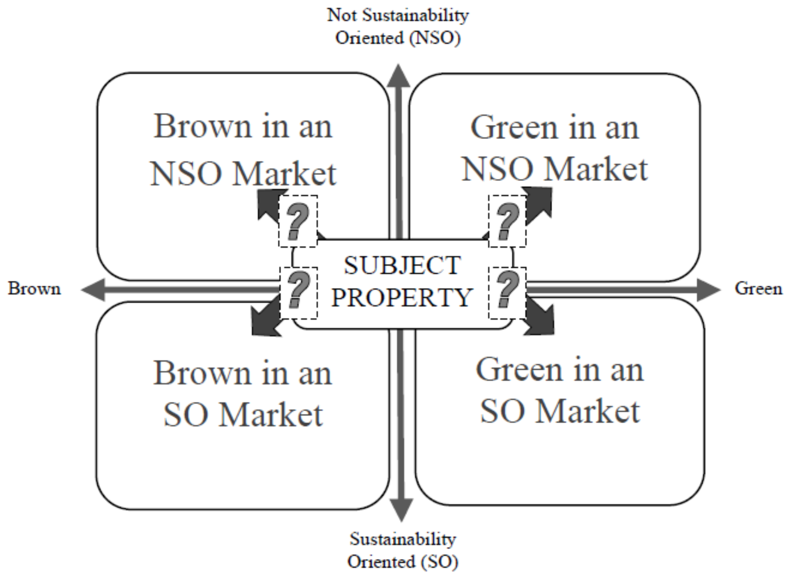

Figure 5: Valuation matrix (Runde and Thoyre, 2010).

As the real property been analyzed and placed in a right square, adjustments of the "comparables" can be undertaken in accordance to the following scheme below:

SUBJECT	MARKET	Adjustments to Comps (Sale and Rent)		Potential Impacts on Subject in the:	
		Brown Comps	Green Comps	Income Approach	Cost Approach
BROWN	NSO		Analyze any specific green features of comps & adjust as needed		
GREEN	NSO	Adjust ↑ for green features that brown market values	Compare green features of comp to subject	Analyze green features for + or (-) economic impact	Market may not recognize all extra costs on $ for $ basis – assess green feature costs individually
BROWN	SO		Adjust ↓ for any superior green features of comp	↓ rent and/or growth rate? ↑vacancy? ↑absorption? ↑energy and/or water cost? ↑ Cap Ex reserves ↑OAR ↑Discount rate? Cap Ex to green up	Replacement cost will likely reflect green construction so depreciation should reflect brownness of subject
GREEN	SO	Adjust ↑ for green feature deficiency	Compare specific green features of comp to subject	Assess if subject meets/exceeds the "greenness" of the market	

Table 3: Sustainability valuation impact grid (Runde and Thoyre, 2010)

3. *Monitor over Time*
   Runde and Thoyre (2010) also stress the importance of "getting the big picture". The main focus is to monitor trends regarding sustainability, for instance changes in national environmental targets or improved standards/regulations for company's sustainability reporting (e.g. the Global Reporting Initiative's Construction and Real Estate Sector supplement (GRI-CRESS)).

However, it has to be stressed that appraisers do not "make the market". As financial benefits and/or tenant productivity gains are difficult to quantify, a local green market premium may not be observable. The main issue for real estate appraisers is the lack of market transactions of green buildings. Furthermore, the additional cost for "greening" a building may not necessarily result in a higher building value. This is because the willingness to pay for these improvements may differ in different property markets. As such, the appraiser cannot simply add a "green" premium when valuing the premises. However, it is argued that information from EPCs and LCCA (Life Cycle Cost Analysis) could be used to improve the quality of real estate appraisals (Bienert et al., n.d.).

5. Method in included studies

In this thesis, both a qualitative and a quantitative approach have been used. The first paper ("Difficulties in changing existing leases – one explanation of the "energy paradox"?") uses an action research approach, which often is used to study one organization, or smaller parts of multiple organizations, in depth. This qualitative approach has two objectives; to study and at the same time improve the studied object ("client") (Kock, 2011). As such, the researcher is *not* a neutral observer.

This could of course be a potential problem, as the mindset of the researcher may be to find and overcome obstacles. However, it also gives the researcher a chance to test his theories in practice, to be in "the front line", instead of having a more passive role in a research project.

When conducting an action research project, the most common method for gathering data is the participant observation method, which comprises a scheme of synchronized analysis of agreements, interviews and direct participation/observation (Denzin, 1989 cited in Flick, 2009). As in all qualitative research, the researcher will have an effect on the studied subject, for example, when being present at meetings or conducting interviews. Even so, I still believe that the researcher can give a fair picture of the studied "client", especially if he or she has is working in a larger research group. I believe that the great advantage with this research approach is the close link to the studied object. The main disadvantage with the qualitative method approach is that it is more difficult to generalize the results (McEnery and Wilson, n.d.).

The second paper ("Is Energy Performance Capitalised in Office Building Appraisals? ") used an econometric approach to investigate if energy performance had an impact on office buildings' appraised market value. Preferably, it would have been more interesting to investigate sales prices, as these could reveal the true willingness to pay for greater energy performance. However, this information was not available. The main issue with using appraisals is the impact of smoothing over time. This is mainly due to the fact that appraiser use past estimations of market values when doing present appraisals. This is of course a drawback, but I still find it interesting to study how appraisers regard energy efficiency. The data used for this study was anonymized, and therefore some information had to be rounded off, normalized or omitted. The main effect of this is that some variables were omitted from the model, which would have been interesting to include. However, I believe that the marginal effect of these omitted, normalized or rounded off variables is limited for this study. As in all quantitative research, the possibility of errors in the measurement of the different variables is present, as well as errors depending on "the human factor" in the handling of the data (Lind, 2012). The main advantage with a quantitative research method is that the results can be generalized to a larger population. However, for this to be true the sample has to randomly selected from the larger population (McEnery and Wilson, n.d.). As this study is dependent on economic data from IPD Nordic, this condition may be violated.

6. Articles included in the licentiate thesis – main results and general reflections

Paper 1: "Difficulties in changing existing leases – one explanation of the "energy paradox"?"

Magnus Bonde

Introduction

Economic theory tells us that rational market actors will undertake all investments that result in a positive net present value (NPV). However, it is often argued that *seemingly* profitable energy efficiency measures are not being undertaken in the real estate sector and therefore it is argued that an "energy efficiency gap" exists. From an economic perspective, this gap is due to "market failures/barriers", for instance asymmetric information, split incentives (often referred to as the "landlord-tenant-dilemma") and transaction costs. In theory, collaboration between a tenant and landlord should result in a more efficient energy usage in the built environment.

Purpose

The main purpose with this project was to identify obstacles to a more efficient energy usage in the commercial office-building sector in Sweden. In addition, the project had a goal of implementing a "green" lease in order to overcome these, or at least some of these, barriers.

Method

This project had a "two-case" study design, in which two commercial office buildings in Stockholm where chosen. The project had the characteristics of an action research project, as the main objectives were to gather new knowledge and to improve the studied object. The main source of information was gathered through participatory observation, which includes a simultaneous analysis of documents (leases, maintenance agreements), conducting interviews with the different parties and direct participation at meetings.

The main reason for choosing a "two-case" study design was that, even though the cases had similarities (e.g. single-tenant occupation and technical standard), the leases set-up and the management of the building maintenance differed. By including both cases it was possible to observe how this effected the outlining of the" green" lease.

The project was divided into four different phases: First, a pre-study/literature review. Second, outlining of an additional agreement ("green" lease) that could create better incentives to reduce the buildings energy usage. Third, implantation of these agreements (and routines) and lastly, evaluating the effect of the new agreements and routines.

Key Findings

The principal result in this project was that no new agreements/routines were implemented. The study showed that complex contracts involving different parties easily create so called "split incentives", which can be very hard to resolve by additional agreements. This could be one explanation to why some profitable energy efficiency investments are not being realized. Furthermore, the study showed that the building owners were quite risk averse, in the sense that they were reluctant to conduct energy efficiency investments with longer pay-back periods than the current lease term. As Swedish commercial leases have a short contract length, this myopic view hampers energy efficiency investments with longer pay-off periods. An additional result from the study was the emotional aspect, from the tenant's point of view, to invest in somebody else's property. In general, the tenant considered building improvements to be the landlord's responsibility. All in all, a conclusion that could be drawn is that the separation of building ownership and usage may have a negative impact on the leased commercial building stock's energy performance.

Paper 2: "Is Energy Performance Capitalised in Office Building Appraisals?"

Magnus Bonde & Han-Suck Song

Introduction

In the strong form of market efficiency, the price of a commodity will reflect all available information about the asset. Nevertheless, different market failures/barriers may hinder the efficiency on the market, making it more or less imperfect. Consequently, prices may not reflect the information at the market, which may result in an inefficient resource allocation. As energy costs account for rather large share of the overall building maintenance costs, a more energy efficient building should generate a greater market value, via a greater net operating income, ceteris paribus.

Purpose

As Sweden has implemented the EU directive on the Energy Performance of Buildings, all commercial buildings (with some exceptions) should have an Energy Performance Certification (EPC). The intention with the EPC is to demonstrate the building's overall energy performance in a straightforward manner. This makes it easier for market actors to estimate the buildings energy performance, which in the end should be reflected in the market value. The objective with this paper was to examine if the EPC rating had an impact on commercial office buildings' market values.

Method

This paper had an econometric approach, in which a model was elaborated in order to estimate the EPC impact on the buildings' market value. The dataset consisted of a panel dataset, in which economic data from IPD Nordic had been matched with EPC data from the Swedish National Board of Housing, Building and Planning.

Key Findings

The overall result was that the EPC rating had *no* impact on the commercial office buildings' market values. The study indicated that rents, "time of valuation", changes in vacancy rates, location and "low building age" had the greatest impact on assessed market values. This result could be due to that the correlation between energy usage and maintenance costs is low. Further explanation could be that the specified model suffers from multicollinearity, as the effect of improved energy efficiency cannot be separated from the building age or rent

7. Future research

As this thesis show, energy efficiency measures seem difficult to integrate and evaluate to the full extent within the real estate sector. Therefore, future research will focus on how "green" features could be integrated in the real estate valuations procedure, in order to evaluate these features in a more correct way. First, the initial focus will be on how market actors, such as real estate appraisers, lenders, etc. perceive this phenomena. Second, it will be studied how information regarding building environmental performance could be integrated in the valuation procedure. Further, it will be studied if concepts such as "market worth" could be an interesting complement to the market value concept.

It is also important to assess the actual performance of green commercial properties, similar to what has been done in Zalejska-Jonsson (2011). One alternative is to have a quasi-experimental approach, in which “green” (certified in accordance to at least one of the general environmental assessment systems used in Sweden) buildings are “matched” with very comparable conventional buildings, similar to an experiment and control group. However, in reality there are no perfect matches and therefore a number of pairs are needed in order to cancel out other differences. Nevertheless, this approach could be an interesting complement to the more common quantitative research studies.

References

Armitage, L., Murugan, A. and Kato, H. (2011), "Green offices in Australia: a user perception survey," *Journal of Corporate Real Estate*, Vol. 13 No. 3, pp. 169–180. doi:10.1108/14630011111170454

Bienert, S., Schützenhofer, C., Leopoldsberger, G., Bobsin, K., Leutgöb, K., Hüttler, W., Popescu, D., et al. (n.d.). *Methodologies for Integration of Energy Performance and Life-Cycle Costing Indicators into Property Valuation Practice* (Working Paper No. D7.2). Retrieved from http://immovalue.e-sieben.at/pdf/immvalue_wp7_report_d7.2.pdf

BRE. (2010), *Scheme Document - BREEAM Offices 2008 SD 5055 Issue 4.0*, BRE Global Limited, Watford. Retrieved from:

http://www.breeam.org/filelibrary/Technical%20Manuals/SD5055_4_0_BREEAM_Offices_2008.pdf

Chegut, A., Eichholtz, P. and Kok, N. (2011), *The Value of Green Buildings: New Evidence from the United Kingdom*, Working Paper, Maastricht University Netherlands.

Eichholtz, P., Kok, N. and Quigley, J.M. (2010a), "Doing Well by Doing Good? Green Office Buildings," *American Economic Review*, Vol. 100 No. 5, pp. 2492–2509. doi:10.1257/aer.100.5.2492

Eichholtz, P., Kok, N. and Quigley, J.M. (2010b), *The economics of Green Building*, Working Paper, UC Berkeley: Berkeley. Retrieved from http://escholarship.org/uc/item/3k16p2rj

Eichholtz, P., Kok, N. and Quigley, J.M. (2010c), *Who Rents Green? Ecological Responsiveness and Corporate Real Estate.*, Working Paper, UC Berkeley: Berkeley. Retrieved from:

http://urbanpolicy.berkeley.edu/pdf/Who_Rents_Green_Journal_Version_NK071310.pdf

EMEA. (2009), *Who Pays for Green? The Economics of Sustainable Buildings*, CB Richard Ellis. Retrieved from:

http://portal.cbre.eu/portal/page/portal/research/publications/FPR_EMEA_ECONOMICS_OF_SUSTAINABLE_BUILDINGS_2009.pdf

Flick, U. (2009), *An Introduction to Qualitative Research*, Ashford Colour Press Ltd., Gosport, Hampshire, Great Britain, 4th ed.

Fuerst, F. and McAllister, P. (2011a), "Green Noise or Green Value? Measuring the Effects of Environmental Certification on Office Values," *Real Estate Economics*, Vol. 39 No. 1, pp. 46–69. doi:10.1111/j.1540-6229.2010.00286.x

Fuerst, F. and McAllister, P. (2011b), "Eco-labeling in commercial office markets: Do LEED and Energy Star offices obtain multiple premiums?," *Ecological Economics*, Vol. 70 No. 6, pp. 1220–1230. doi:dx.doi.org/10.1016/j.ecolecon.2011.01.026

Fuerst, F. and McAllister, P. (2011c), "The Impact of Energy Performance Certificates on the Rental and Capital Values of Commercial Property Assets," *Energy Policy*, Vol. 39 No. 10, pp. 6608–6614. doi:10.1016/j.enpol.2011.08.005

Guy, S. (2008), "BRE Global and UK-GBC to partner on BREEAM," *BRE Press Releases*. Retrieved July 18, 2012, from http://www.bre.co.uk/news/BRE-Global-and-UKGBC-to-partner-on-BREEAM-461.html

Hegerl, G.C., Zwiers, F.W., Braconnot, P., Gillett, N.P., Orsini, J.A.M., Nicholls, N., Penner, J.E., et al. (2007), "Understanding and Attributing Climate Change," in

Solomon,S.,Qin,D.,Manning,M.,Marquis,M.,Averyt,K.,Tignor,M.,Miller,H.L.,et al. (Eds.),*Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Retrieved from:

http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter9.pdf

IEA. (2007), *Mind the Gap - Quantifying Principal-Agent Problems in Energy Efficiency*, (May,C.,Ed.), Stedi Media, France.

Jaffe, A.B. and Stavins, R.N. (1994), "The energy-efficiency gap - What does it mean?," *Energy Policy*, Vol. 22 No. 10, pp. 804–810.

Kats, G.H. (2003), "Green Building Costs and Financial Benefits," The Massachusetts Technology Collaborative. Retrieved from:

http://www.bouldercolorado.gov/files/commercial_green_building_costs_and_benefits_-_kats_2003.pdf

Kibert, C.J. (2008), *Sustainable Construction: Green Building Design and Delivery*, John Wiley & Sons, Inc., Hoboken, New Jersey, Canada, 2nd ed.

Kock, N. (2011), "Action Research," in Soegaard,M. and Dam,R.F. (Eds.),*Encyclopedia of Human-Computer Interaction*, The Interaction Design Foundation, Aarhus, Denmark. Retrieved from http://www.interaction-design.org/encyclopedia/action_research.html

Kohler, N. (1999), "The relevance of Green Building Challenge: an observer's perspective," *Building Research & Information*, Vol. 27 No. 4-5, pp. 309–320. doi:10.1080/096132199369426

Kok, N. and Jennen, M. (2012), “The impact of energy labels and accessibility on office rents,” *Energy Policy*, Vol. 46, pp. 489–497. doi:http://dx.doi.org/10.1016/j.enpol.2012.04.015

Levine, M., Ürge-Vorsatz, D., Blok, K., Geng, L., Harvey, D., Lang, S., Levermore, G., et al. (2007), “Residential and commercial buildings,” in Metz,B.,Davidson,O.R.,Bosch,P.R.,Dave,R. and Meyer,L.A. (Eds.),*Climate Change 2007: Working Group III: Mitigation of Climate Change*, IPCC Fourth Assessment Report, United Kingdom and New York, NY, USA. Retrieved from:

http://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch6.html

Lilliehorn, P. (2012), *Miljöklassning i praktiken - Miljöbyggnad, BREEAM, LEED och GreenBuilding i offentliga byggnader*, Utvecklingen av fastighetsföretagande i offentlig sektor (UFOS), LTAB, Linköping.

Lind, H. (2012), *Qualitative vs. quantitative method: Critical reflections*, KTH Royal Institute of Technology.

Lorenz, D. and Lützkendorf, T. (2008), “Sustainability in property valuation: theory and practice,” *Journal of Property Investment & Finance*, Vol. 26 No. 6, pp. 482–521.

McEnery, T. and Wilson, A. (n.d.). “Part Three: Quantitative Data.,” *Corpus Linguistics*, Edinburgh University Press, Edinburgh. Retrieved from:

http://www.lancs.ac.uk/fss/courses/ling/corpus/Corpus3/3FRA1.HTM

Profu. (2008), “Energieffektivisering i bebyggelsen. Analyser utifrån samhällsekonomiska och beslutsfattarekonomiska metoder,” *Vägen till ett energieffektivare Sverige. Slutbetänkande från Energieffektiviseringsutredningen*, Edita Sverige AB, Stockholm, Sweden.

RICS. (2009), *Sustainability and commercial property valuation* (Valuation Information Paper No. 13), Columns Design Ltd, Reading, Great Britain.

Runde, T.P. and Thoyre, S. (2010), "Integrating Sustainability and Green Building into the Appraisal Process," *Journal of Sustainable Real Estate*, Vol. 2 No. 1, pp. 221 – 248.

Saunders, T. (n.d.). "A Discussion Document Comparing International Environmental Assessment Methods for Buildings," BRE Global. Retrieved from:

http://www.dgbc.nl/images/uploads/rapport_vergelijking.pdf

Schleich, J. (2009), "Barriers to energy efficiency: A comparison across the German commercial and services sector," *Ecological Economics*, Vol. 68 No. 7, pp. 2150–2159.

doi:10.1016/j.ecolecon.2009.02.008

SGBC. (2011), "Återrapportering Ny byggnad GB." Retrieved from:

http://www.sgbc.se/aterrapportering

SGBC. (2012a), "Metodik för nyproducerade och befintliga byggnader - Manual 2.1," Sweden Green Building Council.

SGBC. (2012b), "GreenBuilding - Certifikat i energibesparing och energieffektivisiering," *www.sgbc.se*. Retrieved October 31, 2012, from:

http://www.sgbc.se/certifieringssystem/greenbuilding

SGBC. (2012c), “Så funkar GreenBuilding,” *www.sgbc.se*. Retrieved October 31, 2012, from http://www.sgbc.se/om-eu-green-building

Slaper, T.F. and Hall, T.J. (2011), “The Triple Bottom Line: What Is It and How Does It Work?,” *The Indiana Business Review*, Vol. 86 No. 1, pp. 4–8.

van Soest, D.P. and Bulte, E.H. (2001), “Does the Energy-Efficiency Paradox Exist? Technological Progress and Uncertainty,” Vol. 18 No. 1, pp. 101–112. doi:10.1023/A:1011112406964

SOU 2008:110. (2008), *Vägen till ett energieffektivare Sverige*, Stockholm, Sweden: Edita Sverige AB.

Sustainability Victoria. (n.d.). *Employee Productivity in a Sustainable Building - Pre- and Post-Occupancy Studies in 500 Collins Street*. Retrieved from:

http://www.resourcesmart.vic.gov.au/documents/500_Collins_Productivity_Study.pdf

Swedish National Audit Office. (2009), *Energideklarationer – få råd för pengarna* (Government report), Riksdagstryckeriet, Stockholm, Sweden. Retrieved from:

http://www.riksrevisionen.se/PageFiles/1449/RiR_2009_6.pdf

Swedish National Board of Housing, Building and Planning. (2005), *Piska och Morot - Boverkets utredning on styrmedel för energieffektivisering i byggnader* (Government report No. 1), Karlskrona. Retrieved from:

http://www.boverket.se/global/webbokhandel/dokument/2005/piska_och_morot.pdf

Swedish National Board of Housing, Building and Planning. (2008), “Energy Performance Certification

– it's time," Swedish National Board of Housing, Building and Planning. Retrieved from:

http://www.boverket.se/Global/Webbokhandel/Dokument/2009/energy_performance_certification.pdf

Swedish National Board of Housing, Building and Planning. (2009), *Utvärdering av systemet med energideklarationer* (Government report No. 12). Retrieved from:

http://www.boverket.se/Global/Webbokhandel/Dokument/2010/utvardering_systemet_energideklarationer_2009.pdf

Swedish National Board of Housing, Building and Planning. (2012a), *Energideklarerade byggnader per kommun* (Government report). Retrieved from:

http://www.boverket.se/Global/Bygga_o_forvalta/Dokument/Energideklaration/statistik-2012/2012-09-01%20Energideklarerade%20byggnader.pdf

Swedish National Board of Housing, Building and Planning. (2012b), *Konsekvensutredning – Boverket föreskrifter om ändring av verkets föreskrifter och allmänna råd (2007:4) om energideklaration av byggnader, BED 5* (Government report). Retrieved from:

http://www.boverket.se/Global/Bygga_o_forvalta/Dokument/Energideklaration/Konsekvensutredning%20BED%205%20slutlig.pdf

Thatcher, A. and Milner, K. (2012), "The impact of a 'green' building on employees' physical and psychological wellbeing," *Work: A Journal of Prevention, Assessment and Rehabilitation*, Vol. 41 No. 1, pp. 3816–3823. doi:10.3233/WOR-2012-0683-3816

Toller, S., Wadeskog, A., Finnveden, G., Malmqvist, T. and Carlsson, A. (2009), *Bygg-och fastighetssektorns miljöpåverkan*. Retrieved from:

http://www.boverket.se/Global/Webbokhandel/Dokument/2009/Bygg_och_fastighetssektorns_miljopaverkan.pdf

USGBC. (2012), *LEED 2009 for New Construction and Major Renovations Rating System*, U.S. Green Building Council, Washington. Retrieved from:

http://www.usgbc.org/ShowFile.aspx?DocumentID=8868

WCED. (1987), “Towards Sustainable Development,” *Our Common Future*, Oxford University Press, Oxford, UK. Retrieved from http://www.un-documents.net/our-common-future.pdf

Zalejska-Jonsson, A. (2011), *Low-energy residential buildings - Evaluation from investor and tenant perspectives* (Licentiate Thesis), KTH Royal Institute of Technology, Stockholm, Sweden.