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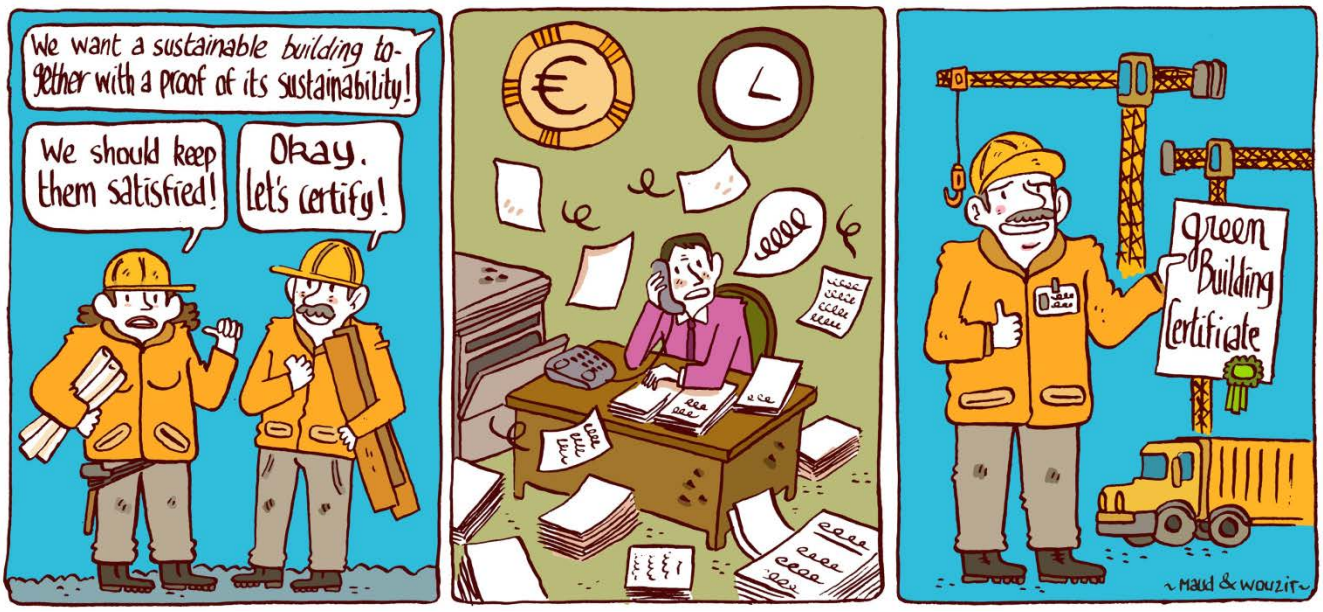

The use of LEED Green Building Rating System™ in Sweden

A case study of Gröna Skrapan in Gothenburg

Master's thesis within the Master's Programme Industrial Ecology

MAUD LANAU

Department of Energy and Environment
Division of Environmental System Analysis
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2014
Report no. 2014:19

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Cover: "There's a battle outside and it's ragin'." Drawing by Wouzit on a scenario of Maud Lanau, 2014. The whole comic strip can be found on the last page of this report © Maud Lanau & Pierre Tissot, 2014

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ABSTRACT

The construction industry's extensive use of materials increases the pressure on the Earth resources. It is of capital importance to address such environmental impacts and to design and construct green buildings: buildings that are more respectful of the environment. Many companies wishing to develop such green building use environmental certifications. LEED (Leadership in Energy and Environmental Design) Green Building Rating System is one of the most famous of these environmental certification schemes. Although developed in and for the United States, LEED is being used in Sweden. The goal of this study is to analyse the usefulness and pertinence of using this US-based certification system when it comes to the development of green buildings in Sweden. The whole study has been based on the case of the high rise office building Gröna Skrapan in Gothenburg, constructed by Skanska and certified at the highest level of LEED. Firstly, Gröna Skrapan and its LEED certification process were studied and analysed. It was found that the prestige of being highly LEED-certified can make design team obsessively concerned with getting credits instead of focusing on these credits environmental value. Skanska seems to use LEED as a powerful tool of communication, but getting LEED certified in Sweden is not as much of a hassle as it is in the US for example. The main reason for certifying a building is the marketing value associated with a certificate, which influence the ability to sell a building or not. Which certification system is used does not matter however. The choice of LEED as a certification was questioned by comparing it to its biggest opponent in Europe, Building Research Establishment Environmental Assessment Method (BREEAM). The study shows that BREEAM is a more accurate scheme to use in Sweden. A focus on the operational phase and use of the building – through an online survey addressed to Gröna Skrapan's users – showed that several use-related issues exist. The Swedish construction industry needs to switch its focus back on actual efficient sustainable work: environmental certification schemes should be a tool, not a goal.

Key words: Gröna Skrapan, LEED, Skanska, BREEAM, NCC, UX Survey, Green Building, Certification, Gothenburg, Office building

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Definitions of terms

ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
BRE	Building Research Establishment
BREEAM	BRE Environmental Assessment Method
EA	Energy & Atmosphere
GBCI	Green Building Certification Institute
IEQ	Indoor Environmental Quality
LEED	Leadership in Energy and Environmental Design
MR	Material & Resources
(M)SEK	(Millions of) Swedish Krona
SGBC	Swedish Green Building Council
USGBC	United-States Green Building Council
WE	Water Efficiency

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Introduction

> *"The 60 m tall Gårda building, with its distinctive architecture and black and glazed façades, has become a landmark building in central Gothenburg. The development was also Gothenburg's first environmentally certified building and helped meet the demand for green commercial space in the city."*
>
> *Skanska, 2011*

The construction industry is responsible for several environmental impacts (Eco Cycle Council, 2010). Its extensive use of materials increases the pressure on the Earth resources. Worldwide, the construction phase is associated with great amounts of waste, accounted for 15 to 30% of all waste in landfills. The water consumption in buildings is responsible of 16% of the world's fresh water consumption. The operational phase of buildings accounts for 70% of the sulphur oxides produced and half of carbon dioxide emissions. Hazardous substances in building material used during construction and operation are health hazards and have a major impact on public health and ecosystems. But the greatest environmental impact of this industry comes from the energy use associated with buildings: currently, buildings and residential sectors account for 40% of Sweden's energy consumption (Swedish Energy Agency, 2013). It is thus crucial to improve the energy performance of Europe's building stock to achieve the EU's 2020 target, and to meet longer term objective on slowing down climate change (Commission to the European Parliament and the Council, 2013).

It is thus of capital importance, nowadays, to address all these environmental impacts and to design and constructs buildings that are more respectful of the environment. Such buildings are commonly referred as green buildings, green constructions or sustainable buildings. Y. Ji and S. Plainiotis (2006) define a green building as a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle, i.e. from the design stage to demolition. At the same time, green buildings should address the concerns of classical building designs: economy, utility, durability and comfort (US Environmental Protection Agency, 2009). To achieve such buildings, it is of capital importance that all teams involved in the building design and construction – design team, architects, engineers, clients etc. – closely cooperate at all project stages (Ji and Plainiotis, 2006).

Designing and constructing green buildings is thus a complex process, and many companies who wish to do so choose to use green building certifications. Such accreditation systems, that measure environmental performances of buildings, exist for more than 20 years. Many certifications exist and the differences between them are numerous. Some are focused on a checklist that need to be fulfilled, other are more flexible. Some are used globally, others only regionally, such as Miljöbyggnad in Sweden. Some offer different levels of certification, some result in a simple certification.

The goal of the present research is not to compare all these certification processes. Instead, this study focuses on the use of one particular certification scheme in Sweden, namely Leadership in Energy and Environmental Design (LEED), which has been developed in the United-States in 1998. Indeed, in the past ten years, green buildings have dramatically developed in Sweden (Lind et al., 2013). To certify these building, among other certification systems, LEED is used in Sweden. However, numerous critiques have arisen about LEED. The goal of this study is to analyse the usefulness and pertinence of this US-based certification process when it comes to the construction of green buildings in Sweden.

To do so, the whole study has been based on the case of the high rise office building Gröna Skrapan (literally Green Skyscraper in Swedish) in Gothenburg, constructed by Skanska and certified at the highest level of LEED, namely Platinum. This building has been the object of a lot of communication on the sustainable work done by Skanska: "Skanska sustainable case study", Wikipedia page, "Gröna Skrapan" video on vimeo.com, video on the Skanska website etc. In each and every communication related to the building, the key words are "first building pre-certified LEED platinum in Nordic countries".

Three complementary studies have been conducted using a comparative and embedded case research strategy. Firstly, Gröna Skrapan and its LEED certification process were studied and analysed. Secondly, the choice of LEED as a pertinent certification scheme was questioned, by comparing it to its biggest opponent in Europe, Building Research Establishment Environmental Assessment Method (BREEAM), launched in the United-Kingdom in 1988. Finally, a focus was brought on the operational phase and use of the building, through surveys to users of the Gröna Skrapan and to the staff in charge of its maintenance. This third part gave an insight on which technology or systems are actually used and work.

Section 1

Study Object & General Methodology

1. Study Object

The principal object of the study is the building Gröna Skrapan, built in 2010 by and sustainability flagship of Skanska. It is certified LEED Platinum, which is the maximum level of this US-based certification. By studying this building, this research aims at analysing the use of the LEED certification in Sweden, and consequently Skanska's point of view on sustainability work. Indeed, Skanska seems to always relate Gröna Skrapan's sustainability status to its LEED Platinum certification.

1.1. LEED Green Building Rating System™

Leadership in Energy and Environmental Design – LEED – is a voluntary environmental certification scheme aiming to develop high performance and sustainable buildings. It was developed in 1993 by the U.S. Green Building Council – USGBC.

> *"The USGBC makes its best effort at promulgating a standard that improves environmental and economic performance of commercial buildings using established or advanced industry principles, practices, materials, and standards. The LEED Green Building System™ is intended to be used by commercial building project stakeholders and project teams as a guide for green and sustainable design."*
>
> *(LEED Green Building Rating System™ Version 2.0, March 2000)*

1.1.1. **A brief history of LEED**

The USGBC is a non-profit organization co-founded in 1993 by David Gottfield, real-estate developer, and Mike Italiano, environmental lawyer and analyst. The Council was developed with the aim to contribute to a sustainable future by promoting energy-saving and cost-efficient buildings. In 1994, a committee was formed, uniting several professions: real estate agents, industry representatives, architects, a building owner and a lawyer. At the head of this committee was Rob Watson, a Natural Resources Defence Council senior scientist. After 3 years spent on working on principles of the soon-to-be first version of LEED, the committee received funding from the U.S. department of Energy's Federal Energy Management Program. In 1998, the first version of LEED was launched: LEED version 1.0. After the certification of a small number of projects, the ratings system got reconstructed, leading to LEED version 2.0 in March 2000, followed by LEED version 2.1 in 2002 and LEED version 2.2 in 2005. The LEED version 3.0 was launched in 2009 and the version 4.0 in 2013.

1.1.2. **LEED: scope of action**

Many types of projects are eligible to LEED. The certification system classifies different types of project in the following different rating systems (USGBC, 2012):

- New Construction & Major Renovation
- Core & Shell
- Schools
- Retail: New Construction & Major Renovations
- Retail: Commercial Interiors

- Healthcare
- Commercial Interiors
- Existing Buildings: Operations & Maintenance
- Homes
- Neighbourhood Development

A project can qualify to four levels of certification, decided according to the number of credits achieved. These levels are (from barely certified to the best): Certified, Silver, Gold and Platinum.

1.1.3. **The use of LEED in the world**

As of today, there are more than 58 000 commercial and institutional projects participating in LEED. Overall, these projects occupy 10.7 billion square feet (approximately 994 million square meters) of construction space, and are spread on all 50 U.S. states and more than 140 countries/territories (USGBC, 2014).

In the US, cities such as San Francisco, Portland or Austin require new municipal construction to be certified LEED Silver. Los Angeles City council voted, in 2003, that all new buildings should be certified LEED Gold (Inbuilt, 2010). Such requirements from US cities are big drivers of LEED development.

The USGBC recently created an info-graphic picturing the use of LEED in the world, divided in 8 regions (Table 1). They also did a ranking of the top 10 countries with registered and certified projects. (Table 2)

Each of these information give the number of projects registered and certified, together with the Gross Square Meter (GSM) – reported in million- which is the surface covered by the projects. (USGBC, 2014)

Table 1 Number of LEED projects registered or certified in top 8 regions by GSM (USGBC, 2014)

Rank	Region	Number of project registered or certified	GSM (in millions)
1	North America	44 998	658.1
2	East Asia	1 995	107.3
3	Europe	1 706	74.5
4	Latin America and Caribbean	1 704	39.5
5	Middle East and North Africa	1 297	69.2
6	South Asia	-	8.2
7	Africa	-	0.8
8	South Pacific		0.6

Table 2 Ranking of the top 10 countries by number of LEED-registered or -certified projects (USGBC, 2014)

Rank	Country	Number of projects (registered or certified)	GSM (in millions)
1	US	44 270	595.8
2	Canada	4 212	62.3
3	China	1 156	66.5
4	United Arabs Emirates	808	46.1
5	Brazil	638	18.1
6	India	405	6.9
7	Mexico	322	7.9
8	Germany	299	6.1
9	Turkey	194	8.9
10	Republic of Korea	188	15

1.2. Skanska

Skanska is one of the world's leading project development and construction groups. To offer competitive solutions, the group focuses on green construction, occupational health and safety and ethics. (Skanska, 2014)

1.2.1. **Presentation of the company**

A short history

Established in Sweden in 1887 under the name "Aktiebolaget Skånska Cementgjuteriet", the company was a concrete products manufacturer. It played an important role in Sweden, building infrastructure such as roads, power plants, offices or housing. In the mid-50s, the company moved into international markets and got, in 1971, into their nowadays largest market: the US. In 1984, the company changed its name to "Skanska". During the 1990s, Skanska doubled its sales. Nowadays, rather than growth, profitability is the main focus of Skanska. (Skanska, 2012)

Mission and vision

On their website, Skanska present their mission and vision as follows:

> *"Our mission is to develop, build and maintain the physical environment for living, travelling and working."*
> *"Our vision is to be a leader in our home markets, to be the customer's first choice in construction and project development."*
>
> *(Skanska in brief, 2014)*

Key figures

Table 3 presents some key data about Skanska for the year 2013. Skanska had sales of 136 billion SEK and 57 105 employees across Europe, Latin America, and USA. Their largest home market is the US, their second is Sweden. (Skanska, 2014)

Table 3 Key data on Skanska for the year 2013

SKANSKA in 2013	
Sales - Total/Nordic countries *(Billions SEK)*	136/56
Employees	57 105
Profit *(Million SEK)*	3474
Market share in Nordic Countries	6%

Operations and business units

Skanska group is divided into four business units, each of them taking care of specific operations. All divisions are present in Sweden, Norway, Finland, Poland and Czech Republic.

- **Construction** is their largest business stream. It includes residential and non-residential building construction.
  Additional areas of action: Slovakia, the UK, the U.S., Latin America.
- **Residential Development** is investing and developing homes to be sold directly to the consumer.
- **Commercial Property Development** focuses on commercial property projects (mainly office buildings, shopping malls and logistics properties with a green profile) that they initiate, develop, lease and divest.
  Additional areas of action: Hungary, Romania and the U.S.
- **Infrastructure Development** is investing in and developing public-private partnership projects and infrastructure solutions such as highways, hospitals, or power generation stations.
  Additional areas of action: Slovakia, the UK, the U.S and Chile.

(Skanska in brief, 2014)

1.2.2. **Sustainability work in Skanska**

Skanska includes sustainability as part of their values and strategies to reach their goals.

> *"We create sustainable solutions and aim to be a leader in quality, green construction, work safety and business ethics. We also aim to maximize the potential of Skanska with regard to returns."*
>
> *(Skanska, 2014)*

The group's definition of sustainability is the same as the Brundtland Commission's: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Commission, 1987). Skanska also recognizes the three pillars of sustainable development, namely environmental, social and economic. (Skanska, 2014)

They base their values on their Code of Conduct that they summarize in five quantitative targets named "five zeros":

- Zero loss-making projects
- Zero environmental incidents
- Zero work site accidents

- Zero ethical breaches
- Zero defects

To reach their goals, a part of their strategy is to be a leader in sustainable development, focusing especially on occupational health and safety and on the environment and ethics. (Skanska, 2014)

The group recognizes the possible adverse impact of the construction industry on the environment. They also recognize that a good management of constructions can have a positive impact. They thus see environmental management as a big opportunity, and have been proactive since the mid-1990s: they published their Environment Policy in 1998, and all their Business Units worldwide are ISO 14001. (Skanska, 2014)

A journey to Deep Green

Skanska called their sustainable work 'A journey to Deep Green'. They define Deep Green through six zeros relating to the main environmental issues of the construction industry (energy, carbon, materials and water). When it comes to buildings, the six zeros are the following:

- net zero primary energy
- near zero carbon in construction
- zero waste
- zero hazardous materials
- zero unsustainable materials
- net zero water

Together with their 'Journey to Deep Green', Skanska developed their "Color Palette™". Categorizing their project from Vanilla to Deep Green, this strategic framework aims to measure and guide the group's performance towards Deep Green.

> *"Vanilla – The construction process and product performance is in compliance with law, regulations, codes and standards.*
> *Green – The construction process and product performance is beyond compliance.*
> *Deep Green – The construction process and our product performance has a near-zero impact on the environment and thereby Future Proofs our projects." (Skanska, 2014)*

Skanska and LEED

Skanska has been in relation with the USGBC and LEED Green Building Rating System™ for more than a decade. In 2000, they became member of the USGBC. Four years later, the group had several LEED Accredited Professionals and counted ten LEED projects. A year later, in 2005, the number of LEED AP was of 30, and doubled the year after.

In Sweden, Skanska is the main company using LEED Green Building Rating System™ as a certification scheme (Lind *et al, 2013*). As of February 2014, only 9 buildings were certified as LEED platinum in Sweden (Table 4), all of them developed by Skanska. Only

one of them is located in Gothenburg: Remulus Gårda project, called Gröna Skrapan, which is the case study of the present research.

Table 4 LEED-Certified Platinum buildings in Sweden, as of February 2014 *(USGBC website, 2014)*

Building	City	Scheme			Date	Score
		Version	Rating System[1]	Project type		
Liljeholms	Stockholm	v2.0	BD+C	Core & Shell	Mar 2010	47/62
Osterport 7	Malmö	v2009	O+M	Existing Building	Dec 2010	83/110
Kv. Mastaren	Kalmar	v2.2	BD+C	New Construction	Jul 2011	53/69
Remulus Gårda (House A)	Gothenburg	v2.0	BD+C	Core & Shell	Aug 2011	49/62
Gangaren 16	Stockholm	v2009	BD+C	Core & Shell	Apr 2012	110/110
Remulus Gårda (House B)	Gothenburg	v2.0	BD+C	Core & Shell	May 2012	45/62
Kv. Nereus Bassangkajen	Malmö	v2.0	BD+C	Core & Shell	Dec 2012	45/62
Vala Gard	Helsinborg	v2009	BD+C	New Construction	Mar 2013	122/110
Ideon Gateway	Lund	v2009	BD+C	Core & Shell	May 2013	108/110
Rattscentrum	Orebro	v2009	BD+C	New Construction	Jun 2013	104/110

1.3. Gröna Skrapan

1.3.1. **The building**

Gröna Skrapan, situated by the E6/E20 motorway in Gothenburg (see figure 1), is an office building built by Skanska and inaugurated in February, 2011. It is the first commercial building in Scandinavia to have been pre-certified Platinum (Skanska Sustainability Case Study 82, 2011). As shown in figure 2, the building consists of two houses, A and B, linked by a catwalk. Figures 3 and 4 display pictures of the building, and the Table 5 below summarizes its principal characteristics.

Table 5 Principal Characteristics of Gröna Skrapan (Skanska, 2014 and emails with Gröna Skrapan's project leader, April 2014)

Gröna Skrapan Johan på Gårdas gata 5 – 412 50 – Gothenburg - Sweden	
Size	17 000 m² (approx. 183 000 square feet)
Height	60m
Buildings	2 connected (House A & House B)
Storeys	House A: 16 House B: 6
Type	Office building, mixed tenants
Architect	White
Finished in	2010
Inaugurated in	February 2011
Certifications	LEED Platinum, EU Green Building

[1] BD+C stands for "Building Design and Construction"; O+M stands for Operations and Maintenance

Skanska invested 500 MSEK (approx. 55.4 M€) in the building, with a construction contract of 350 MSEK (approx. 38.8 M€) (Personal communication with Skanska, April 2014). In 2013, the building has been sold 617 MSEK (approx. 68.3 M€) to the real estate company Stena Fastigheter (Fastigetssverige, 2013), which thus now owns and manages the building.

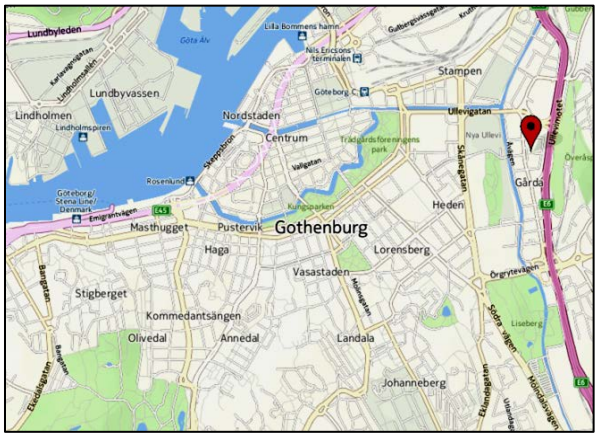


Figure 1 : Location of Gröna Skrapan

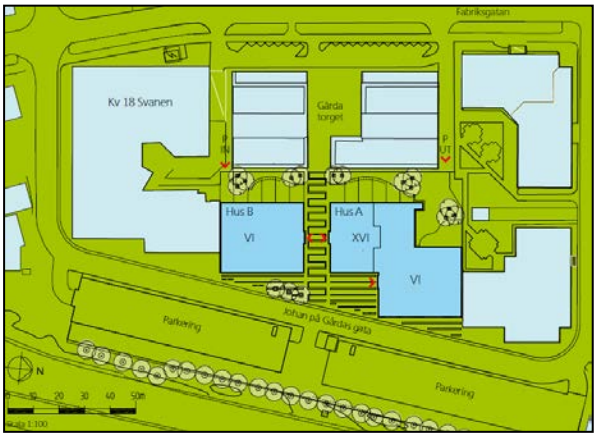


Figure 2 : Conceptual plan of Gröna Skrapan (Skanska)

Figure 3 : Gröna Skrapan seen from below (Skanska)

Figure 4 : Gröna Skrapan by the motorway (Skanska)

1.3.2. **Gröna Skrapan certifications**

EU Green Building

The EU Green Building certification is delivered when a building saves a minimum of 25% of energy against its reference value. As to April 2014, 963 buildings received this certification in the EU, including Gröna Skrapan.

LEED Green Building Rating System™

Both parts of the building are certified LEED Platinum v2.0 Core & Shell, BD+C (Building Design and Construction). More information on the certification is given in the Section 2 of this report.

1.3.3. **Skanska communication on the building**

On their international website, Skanska publishes “Case Sustainability” documents, to display their environmental work throughout the world. Gröna Skrapan is one of their dozens of case studies. The 3-pages document presents all solutions and technologies

toward sustainability that were implemented in the building. A quick analysis of the text resulted in interesting numbers: 27% of the words – after removing all common words[2]– are related to Skanska's good sustainable work on their building (see Annex 1A, 1B and 1C for the detailed lists of words and their frequency). The first page of the document displays an aura of tree leaves and grass, surrounding the building pictured from below.

Skanska also published a video on Gröna Skrapan, displaying the company's knowledge on communication about sustainability: earth, sky, water, sun, forest, wind power and other similar features are at the core of the video.[3] The figure 5 is a series of screenshot of the video, showing the thirteen images that can be seen one after the other, while an explanation (in Swedish) on the building is being said by a feminine voice.

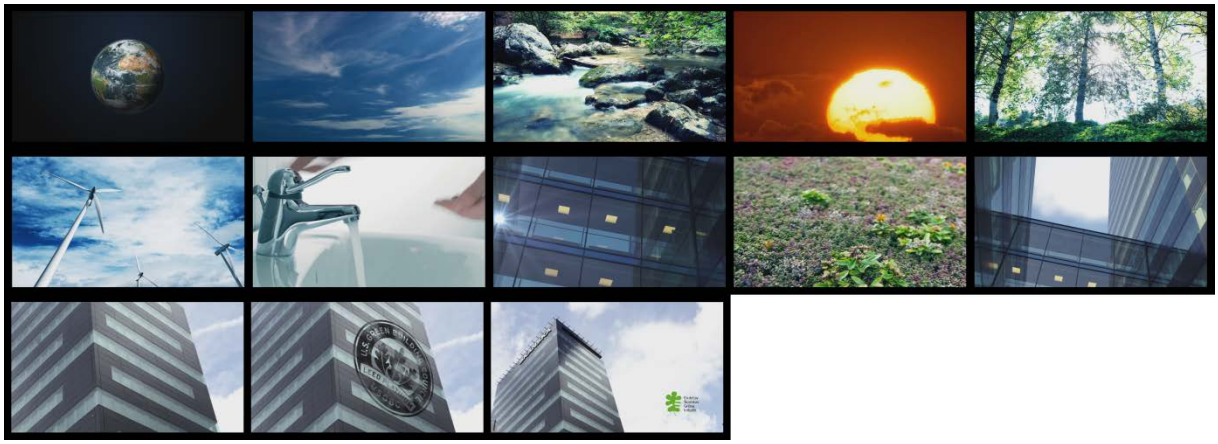


Figure 5 : Screenshots from the video "Gröna Skrapan" on vimeo.com (2012)

Such communication efforts and contents make the building a very interesting case to study, and brings different questions: how good is the sustainable work done on this building? What does the LEED certification mean?

[2] Common words are words used in any text, e.g. 'the', 'a', 'and', 'is'…
[3] The video can be found on <http://vimeo.com/28498705> ©Kajsa Arnoldson

2. General methodology

In order to study Gröna Skrapan and the meanings of its certification, three different aspects have been studied. The first focus is on the building and its LEED certification process and the impact of such a certification on the building's design, construction and operational phases. Then, to be able to judge the pertinence of LEED's use in Sweden, the BREEAM certification has been analysed and compared to LEED. To do so, a comparison between LEED and BREEAM certification systems has been conducted, and another similar building (in location, function, size, and age) studied - although in less depth: Ullevigatan 17-19. Built by NCC, Ullevigatan 17-19 is certified BREEAM Very Good. Finally, a third focus was put on the way occupants perceive and interact with the building. The study of the user experience is done through a survey focused on LEED credits. The methodology for this section was based – to great extent – on the article « A method for evaluating the performance of green buildings with a focus on user » (Kim *et al*, 2013).

The figure 6 displays the general methodology of the study. On the left, the communication axis pictures the amount of communication done by the construction companies about their buildings. In beige, the interactive parts of the research are displayed: an interview has been conducted with the project leader of Gröna Skrapan, about the LEED certification process of the building. Another interview has been conducted with a consultant for NCC who worked on the BREEAM certification of Ullevigatan 17-19. Then, an interview was conducted with a professional accredited to work both with LEED and BREEAM. Finally, a survey has been sent to the users of Gröna Skrapan. In grey, the main focuses of the study are shown. Literature reviews and/or gathering of data have been done for the elements in grey, e.g. literature review on LEED, on BREEAM, comparison on LEED and BREEAM, data gathering on Gröna Skrapan, Ullevigatan 17-19.

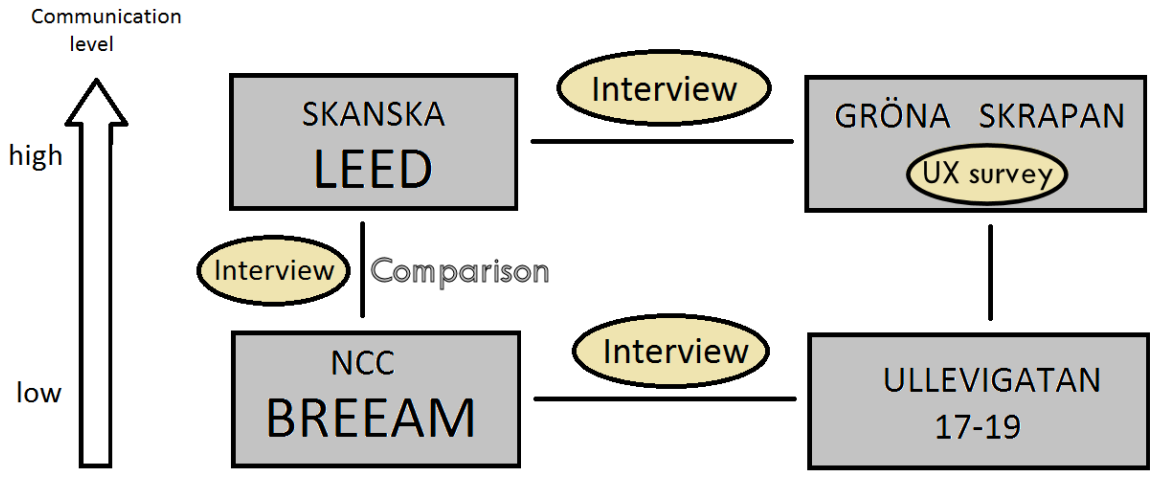
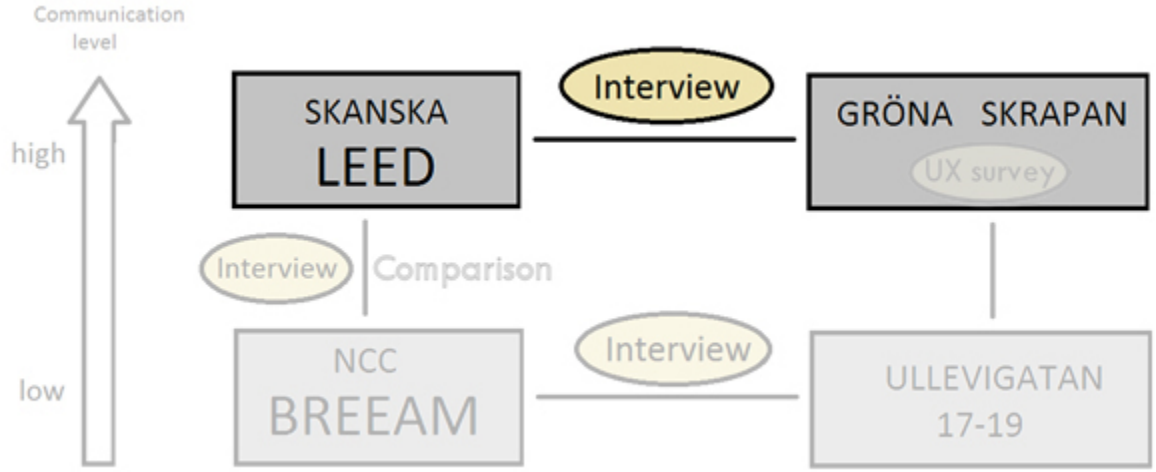


Figure 6: Overview of the methodology: interviews, survey have been conducted together with literature reviews and gathering of data.

Section 2

LEED and Gröna Skrapan



1. Background on LEED

1.1. The Certification process

The LEED certification process involves fours steps, namely Registration, Application, Review and Certification.

Step 1 - Registration

The registration of a project is realized by completing key forms and paying a registration fee. When those are completed, the project is accessible online, together with different tools and resources needed for the next step: the application.

Step 2 - Application

The application has to be prepared. The first thing to do is of course to assemble a project team. The team identifies which LEED credits it is willing to pursue, and accordingly collect information and documentation that will be used as proofs during the review process. USGBC advices the team to "double-check each credit to confirm details have been entered accurately and consistently" (USGBC, 2014). When everything is gathered, all documentations for each pursued credit have to be submitted online, together with a completed certification application and a certification review fee.

Step 3 - Review

This step, performed by the Green Building Certification Institute (GBCI)[4], involves a preliminary and a final review.

In the preliminary review, all credits from the application are reviewed to check their compliance. The team project then receives a preliminary rating from the GBCI, together with feedbacks and advices on the credits requiring additional revision. (USGBC, 2014)

The final review consists in checking all new information sent after the preliminary review. When this second review is completed, the project team receives a final decision on the pursued credits.

Step 4 – Certification

After the review process is completed, USGBC sends the certification decision to the project team, together with the level of certification (Certified, Silver, Gold, and Platinum) if the certification is awarded.

1.2. Cost of certification

Certifying a building by LEED has a cost, which depend on the size of the project, on the rating system applied for, and on the membership of the applicant company.

The typical costs of a LEED certification are as follow (Inbuilt, 2010)

- Registration: $750 to $3750

[4] The Green Building Certification Institute (GBCI) was established in 2008 within the framework of the USGBC's LEED Green Building Rating Systems ™. It provides independent review of the application documentations sent by project-teams wishing to get credits in LEED. (GBCI, 2014)

- Documents submission: $1500 to $7500
- Accredited Professional documentation gathering fee: $10 000 to $30 000
- Documentation costs for teams working on their first LEED project (as it was the case for Gröna Skrapan's project team): $30 000 to $60 000.

The total certification process thus cost between $42 250 and $101 250.

1.3. LEED in Sweden

Figure 7 pictures the number of LEED projects in Sweden and their level of certification. As of today, 89 projects are participating in LEED. 36 are registered and awaiting for the decision of the USGBC. The other 53 are already certified: 13 LEED Platinum, 33 LEED Gold, 3 LEED Silver and 4 LEED Certified.

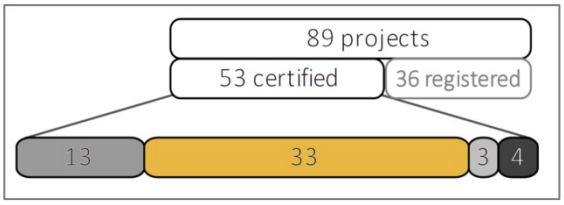


Figure 7 : LEED projects in Sweden as of 01.05.2014 (USGBC, 2014)

1.4. LEED v2.0

Gröna Skrapan is certified LEED v2.0 – i.e. the version of 2000 – Core & Shell, Building Design +Construction (BD+C). 62 credits (or points) can be achieved, spread among different categories (see category.

Table 6) that LEED considers as key areas of human and environmental health (USGBC, 2012). Each category also consists of mandatory prerequisites that are not giving any point. The table below shows which categories are considered by LEED, together with their aim, how many points can be achieved in each, and how much they weight in the overall result. See Annex 2B for the detailed credits of each category.

Table 6 Aim, available points and weight of the categories considered in LEED Green Building Rating System, for LEED v2.0 Core & Shell

Categories	Aim to	Available points	Weight (%)
Sustainable Sites	Preserve wildlife habitats and virgin land; ensure that buildings do not adversely affect their surroundings or create heat islands.	15	24.6
Water Efficiency	Prevent the depletion of fresh water sources	5	8.2
Energy & Atmosphere	Help slow the progression of global warming	14	23
Materials & Resources	Help preserve natural resources and manage waste	11	18
Indoor Environmental Quality	Enhance indoor environmental quality (e.g. health, comfort of the occupants)	12	18
Innovation & Design Process		5	8.2
Total		62	-

In LEED v2.0, the levels are set as shown in Figure 8:

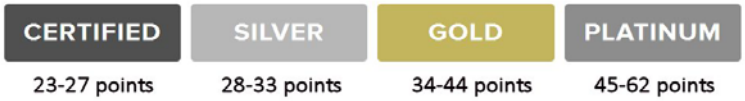


Figure 8: Levels of certification for LEED v2.0 (Adapted from USGBC.org - levels of certification for LEED v4.0, 2014)

2. Methodology

2.1. Data gathering

To analyse Gröna Skrapan, the first step was to find and gather all available information on the building: location, plans and layout, size, type of building, certifications, costs, selling price, technologies, energy consumption etc. By reviewing Skanska material on the building, some of this information was easily found, while other specifics data such as energy consumption data or price of the project proved trickier and necessitated many emails and phone calls to different persons, especially to the project leader of the building.

2.2. LEED certification process and outcomes

The LEED certification process of Gröna Skrapan has been analysed: how did it go, what did LEED bring to the planning and design process – positive as well as negative aspects.

To do so, the LEED Green Building Rating System™ has been studied through the USGBC website and many articles. The detailed scorecards of Gröna Skrapan (Annex 2B) were also studied, giving a good basis to evaluate the work done by Skanska in the building.

2.3. Literature review

Literature on LEED has been reviewed, since many articles criticise LEED Green Building Rating System™. After cross-checking all these articles, all main critiques on LEED have been summarised (see Literature Review), which proved very useful.

2.4. Interviews

Based on all these gathered information, the LEED certification process and outcomes have been discussed during an interview with the project leader of Gröna Skrapan, who worked with the whole certification of the building. The interview took place in the restaurant of the first floor of the building itself, at the morning. Another interviewer was present, and the questions of the two interviewers had been gathered before the interview to avoid double questions. The interviewee talked most of the time. The whole interview has been recorded. After the interview, the interviewee walked the interviewers through the building to show the different technologies and solutions in place in Gröna Skrapan.

3. Literature Review

The literature about LEED is extensive, and throughout the years many critiques were raised.

"Ensuring the Sustainability of Sustainable Design" (Stein and Reiss, 2004)

One of the first articles written on the issues associated with the use of LEED certification is "Ensuring the Sustainability of Sustainable Design - What Designers Need to Know About LEED" written by Jay Stein and Rachel Reiss in 2004. The authors did several critiques on LEED. The main ones were about the lack of weighted credits and the lack of regionalization. Indeed, until version 3.0, LEED credits were not weighted in a proper way: installing bike racks near the building is as rewarding as a 20% reduction of the overall water consumption. Project teams could then aim for the low-hanging fruits in order to get their certification. Secondly, there is no regionalization of credits: the climate in the U.S. in not the same everywhere, and some credits are more important than other in specific areas. For example, "saving water earns a point in Seattle just as it does in Tucson" (Kamenetz, 2007).

Out of all their observations and critiques, the authors raise three key problems:

> *"Buildings that earn more LEED credits do not necessarily provide more environmental benefits than buildings that earn fewer credits.*
>
> *Some of the techniques LEED encourages are not consistently a superior means of reducing environmental impacts.*
>
> *The costs and benefits associated with LEED certification remain undocumented and uncertain."*
>
> *(Stein and Reiss, 2004, p.1)*

"LEED is broken... let's fix it!" (Schendler and Udall, 2005)

The article that raised a lot of attention in the construction sector is "LEED is broken… let's fix it!", by Randy Udall and Auden Schendler in 2005. It was raising the following critiques about LEED:

- The whole LEED certification process costs too much.
- The prestige of being highly LEED-certified can make design team "LEED mongering": they become obsessively concerned with getting credits instead of focusing on these credits environmental value.
- Another issue is the "LEED brain", which occurs when the design process is only driven by the (potential) Public Relations benefits of being certified.
- Since the energy modelling is based on the ASHRAE and that USGBC accepts modelling executed on some specific software, it becomes "fiendishly complicated".
- The administrative side is a big part of the LEED certification process. Innovations or country-specific technologies are often difficult to get accepted by LEED, and the bureaucracy is defined by the authors as "crippling".

- Overblown claims of Green Buildings Benefits are misleading.

The following paragraph, extracted from their article, summarizes their straight-forward point of view on the LEED certification and the certification process:

> *"We're concerned that LEED has become costly, slow, brutal, confusing, and unwieldy, a death march for applicants administered by a soviet-style bureaucracy that makes green building more difficult than it needs to be, yet has everyone genuflecting at the door to prove their credentials. The result: mediocre "green" buildings where certification, not environmental responsibility, is the primary goal ... and a discouraged cadre of professionals who want to build green, but can't afford to certify their buildings."*
>
> *(Schendler and Udall, 2005, p.2)*

Rob Watson, head of LEED, reacted to the article by writing his own article "LEED Is Not Perfect, But It's Not Broken":

> *"Six months ago when the "LEED is Broken, Let's Fix It" article came out, I smiled a sad smile and nodded my head in agreement with about 80 percent of what the authors were saying. (…) I had seen first-hand that LEED indeed was "costly, slow, brutal, confusing and unwieldy".*
>
> *(Rob Watson, 2005, p.1)*

However, LEED had already evolved when the article was published, and Rob Watson claimed that "the article essentially was obsolete the day it was published." (Watson, 2005) Indeed, the version 2.2 had just been released.

"LEED: A critical evaluation by LCA and recommendations for improvement" (Humbert et al., 2007)

All LEED credits are not associated with the same type and degrees of benefit for the environment. The article goals are to "evaluate the actual extent of the benefits and burdens of LEED, identify the critical credits and develop a new scale that will correct these miscorrelations" (Humbert *et al.*, 2007). To do so, the authors conducted an LCA on 45 of the LEED credits, applied to an existing California office building. They evaluated different impacts: human health, ecosystems quality, climate change and resource consumption, and aggregated all of those in one indicator. This indicator was then used to design a new scoring system, which would assign each credit its correspondent amount of points shown by the indicator. Sensitivity studies have been conducted by also modelling a school and a residential building.

The table 7 gathers some of the results of Humbert's study: most beneficial, less beneficial credits and credits bringing more burden than benefits on the environment are displayed, together with the amount of credits they should be worth.

Table 7 Selected results of the article "LEED: A critical evaluation by LCA and recommendations for improvement" (Humbert *et al.*, 2007)

Most beneficial credits		Less beneficial credits		Negative credits – more burden than benefits	
Credit	Score	Credit	Score	Credit	Score
50% of green electricity	+606	Reduction of water use	+3	Construction of a multi-floor parking	-128
Reduction of energy consumption (10 points available)	+62/point	Reduction of land use	+1		
Reduction of employee commuting - Bike facilities - Public transport	+127 + 167	Recycling content in the furniture	+17		
Increased waste recycling	+172				
Reuse and recycling of X % of the building structure - X=75% - X=100%	 +199 +265				

From the credits that are always or most of the time implemented, the table 7 shows that:

- Operation, especially employee commuting and electricity consumption, dominates the impacts associated with the building's operational phase
- Waste generation has a limited but not-negligible impact
- Water consumption has small impacts
- Heating has a small impact (the building is located in California)

Other articles review

Still, even after this version, numerous critiques could still be found in the literature:

- The "Green Building" terminology is not well-defined, leading to misunderstandings on the aim of building a so-called green building. (*Murphy, 2009)*
- Energy savings are not always as high as expected. (*Scofield, 2009; Newsham et al., 2009)*
- LEED is only focused on design: even though it is stated in its name, the general public assimilates a LEED-certified building to a building that would be sustainable throughout its lifetime, and not just until the date of occupancy. *(Turner, 2010)*
- LEED bases its credits on energy simulations instead of real measurements. *(Diamond, 2011)*
- LEED has been developed in the U.S. and the assumptions proper to U.S. environment do not always hold in other countries, leading to scores that can be untrustworthy (*Parker, 2009)*

In 2007, Auden Schendler asserted that the energy credits of LEED were not enough: first, the energy credits were not mandatory, meaning that a building could be LEED certified without any energy measures. Secondly, the optional energy-related credits were seen as too low by Schendler. Indeed, getting all 10 points of the energy credits would mean an energy consumption reduction of 42% compared to the ASHRAE baseline. This is seen by the author as "achievable and frankly [not] even enough to solve the climate problem". (Kamenietz, 2007)

When it comes to the critiques about energy efficiency, Rob Watson had already answered in 2005, quoting Gandhi:

> *"By requiring minimum performance that is too far beyond the ability of the market to deliver, we risk ignoring the sage observation by Gandhi who once said: "A leader who is 100 paces ahead of his followers is revered and called a visionary; one who is a thousand paces ahead is stoned and called a heretic.""*
>
> *(Rob Watson, 2005)*

Since then, LEED addressed the problems of regional discrepancies in its version 3.0 and version 4.0 which have seen new credits implemented into a new category called "Regional Priority Credits". These credits are bonus points that can be awarded if the project is designed to deal with regional environmental issues: an example of such a credit could be the reward of the use of water efficient technologies in countries where water availability is a problem. LEED also changed the weighting of its credits to be more in concordance with the environmental loads they are associated with. However, these changes had not happen in the LEED v2.0 that is the certification of Gröna Skrapan. These changes have thus not be taken in account in this study, but were kept in mind for the discussion and conclusion part of this report.

In these two last versions, the weighting of each credit has been changed in order to be more in accordance with the environmental burden of each feature a credit focuses on.

As a final note on this literature review, it should be noted that even though many critiques were raised on LEED Building Rating System™, it is not evil. By being a huge centre of attention in the construction industry, it has spread the information that sustainability should be a major focus of the construction industry, and that building green is possible. After writing so much of what they call "tough love-criticism", the authors of "LEED is broken… let's fix it!" concluded by stating that "we need green building to triumph, to take over our culture … we need LEED – or something like it – to accelerate that transition", hoping that their article would be helpful to reform and fix the system (Udall and Schendler, 2005).

4. Gröna Skrapan – Data of interest

4.1. Public transport

The building is situated 700 meters away (approx. 8 minutes' walk) from the bus stop "Vagnhallen Gårda" deserved by the bus 60 which goes all the way through town from east to west. The tram stop "Ullevi Södra" is 800 meters away (approx. 11 minutes' walk) from the building. This stop is deserved by seven different tram lines. There also is a bike pool station at the foot of the building.

4.2. Energy Consumption

Gröna Skrapan received the EU Green Building certification. In order to receive it, a building should save a minimum of 25% of energy compared to the legislation. At the time of construction, the legislation was asking a building to have a maximum energy consumption of 119 kWh/m^2.yr.

For Gröna Skrapan, the following figures have been calculated by the EU Green Building:

Reference value: 119 kWh/m^2. yr
Primary energy demand: 89 kWh/m^2·yr
Energy savings: 25,2 %

As a benchmark, it is interesting to note that today, for New Construction projects in South of Sweden, the Swedish legislation asks for energy consumption to be below the total of the addition of 80 kWh/m^2.year plus increased airflows (BBR, 2012). Below a total energy consumption[5] of 45 kWh/m^2.yr, a building is considered as passive in South of Sweden (Swedish Energy Agency, 2007).

With an actual total energy consumption of 76,5 kWh/m^2.year, Gröna Skrapan has a good energy performance, better than the one calculated by EU Green Building. The table 8 shows the detailed energy performances of the building.

Table 8 Energy Consumption of Gröna Skrapan (Supplied by Gröna Skrapan's project leader, by email)

Energy Consumption (kWh/m^2.A_{temp}.year)	
Heating	34,5
Warm Water	3,0
Cooling	15,0
Operational	24,0
Total	76,5

[5] Total energy consumption includes Net Energy Supply buildings from district heating, warm water and purchased electricity (Swedish Energy Agency, 2007)

4.3. Technologies in the building

4.3.1. **Frame and envelope**

Gröna Skrapan, from ground floor and above, is a frame of prefabricated concrete and steel. Outer wall are non-load-bearing, covered with sheet metal between steel pillars (European Union, Joint Research Centre, 2011). The envelope of the building is well insulated. Ruuki, the steel construction company which supplied the external wall structures, gives the following leakage airflow rates and heat transfer coefficient for Gröna Skrapan (Ruuki, 2011):

Leakage airflow rate (q50): House A = 0.372 L/s.m^2
House B = 0.410 L/s.m^2
Heat transfer coefficient (U), wall elements = 0.207 W/m^2.K

Gröna Skrapan's heat transfer coefficient is well below the BBR requirements which set the maximum at 0.40 W/m^2.K (Boverket, BBR, 2011).

4.3.2. **Energy-efficient technologies**

The EU Green Building Projects Catalogue gives the following information on energy-efficient technologies in place in Gröna Skrapan:

- The energy for heating and cooling is supplied by the district heating system of Gothenburg.
- Air-handling units are equipped with a heat recovery system.
- A pre-heating coil[6] supplies the zone coolers with free cold water.
- To minimize the fan electricity in the ventilation system, this latter is designed for low velocities and pressure drops.
- The garage floors, below the building, are heated by the condenser heat from the chillers.

4.3.3. **"Innovative" technologies and solutions for sustainability**

In their document "Sustainability Case 82 – Green Tower Office Center, Gårda, Sweden", available on their international website, Skanska presents all the solutions and technologies they used in the building, and categorise them throughout the three pillars of sustainability: social, economic and environmental aspects. All citations in the following sub-chapter are extracted from the document.

Social Aspects

All project partners have been involved from the design phase: Skanska sees this as "crucial in meeting the challenging energy and environmental objectives of the project".

The site was classified as brown field, and Skanska remediated it. It thus "did not directly impact on natural ecosystems or green-field land"

Skanska designed healthy office environments with the following features:

- High quality ventilation, with optimised indoor airflow and fresh air only

[6] Coil: in chemistry, a coil is a spiral-shaped tube used to cool steam and condense it in liquid form.

- Access to natural light and external views from all workspaces
- Large windows and high ceilings, so that natural light enters
- Only non-toxic and low-emitting materials

The offices were designed to be "functional and flexible":

- Various sized tenants can occupy 200m^2 to 2 300m^2 on each floor, and decide the organization of their space: open or closed office layout, materials, colours; these can easily be changed for new tenants.
- Reception, restaurant services and conference facilities are shared.
- Offices equipment are ensured to be "the latest and most robust technical solutions"

Skanska says they promote "more sustainable modes of transport" through:

- The location of the building, close to two tram stops, and some minutes' walk from the central train station
- Pedestrian access through and around the site
- Indoor bicycle parking, and showering and changing facilities
- Environmental vehicle pool available for tenants
- Charging possibilities for electric vehicles
- Video conferencing facilities

Economic Aspects

"Approximately 115 workers" were involved at the peak of the project, a majority of them coming from Gothenburg's region.

Thanks to the reduced energy consumption of the building – "almost 30 percent less energy than the Swedish building code" – significant financial savings are made throughout the lifespan of Gröna Skrapan.

Sub metering of tenant spaces help them to follow their energy use, creating an incentive for further savings.

Environmental Aspects

To minimize their environmental impacts during construction, the site has been certified according to Skanska's Internal Green Workplace environmental management system, based on Skanska Sweden's ISO 14 001 certification. These certification systems have higher standards than the Swedish building regulation when it comes to site machinery, energy efficient indoor and outdoor site lighting and chemicals and waste management.

"Where possible", environmentally certified materials were used, such as paint, ceiling panels, flooring, low-VOC adhesives, sealants, paints, coating, carpets, halogen-free electric cables. All timber used in the project was "environmentally certified".

During construction, waste was sorted: 94 percent of the material was diverted from landfill. The waste contractor used recycling strategies and sent all non-recyclable waste to a local Combined Heat and Power plant, to be used as fuel.

The building has been designed to consume 85 kWh/m^2.yr, while the Swedish building code asks for a maximum of 119kWh/m^2.yr. "Skanska calculated that the annual energy saved equates to each of Gårda's occupants saving energy equivalent to one average Swedish person's annual domestic electricity consumption."

Many solutions have been implemented in the building to increase its energy efficiency:

- Good insulation
- "A unique window solution", where sunshades are integrated to windows. The triple glass windows contain a 20cm cavity equipped with an automatic sunblind. The outer glass reflects excess solar radiation, to reduce overheating and thus need for cooling in the summer.
- Efficient ventilation and heat recovery system

80% of the roof area is covered with sedum green roofing, which gives additional thermal insulation and protects the roof from weathering and ultraviolet light, thus extending its lifespan. This green roof is also said to "provide habitats for birds and insects, filter airborne pollution and reduce storm water runoff."

The drought tolerant plants used for the roof and the site vegetation do not need any landscape irrigation.

To reduce the urban heat island effect [7], "much of" non-pedestrian areas are covered in grass. Parking spaces are underground. Here again, the green roofing is mentioned, contributing to the reduction of the heat island effect.

100 percent of the electricity comes from a local wind power plant.

[7] Urban Heat Island Effect is a phenomenon whereby urban regions have greater temperatures than the rural areas around. Such thing happens because buildings, roads and infrastructure replace natural vegetation. The characteristics of the surface are thus changed (albedo, moisture, permeability), leading to the increase of temperature.

5. Findings

This part presents the findings on Gröna Skrapan's LEED certification process and outcome. First, the literature review is summarised to keep in mind the main issues associated with LEED. Then the LEED scorecards of Gröna Skrapan are analysed. Finally, the main points from the interview of the project leader of the building are presented.

5.1. From the literature review

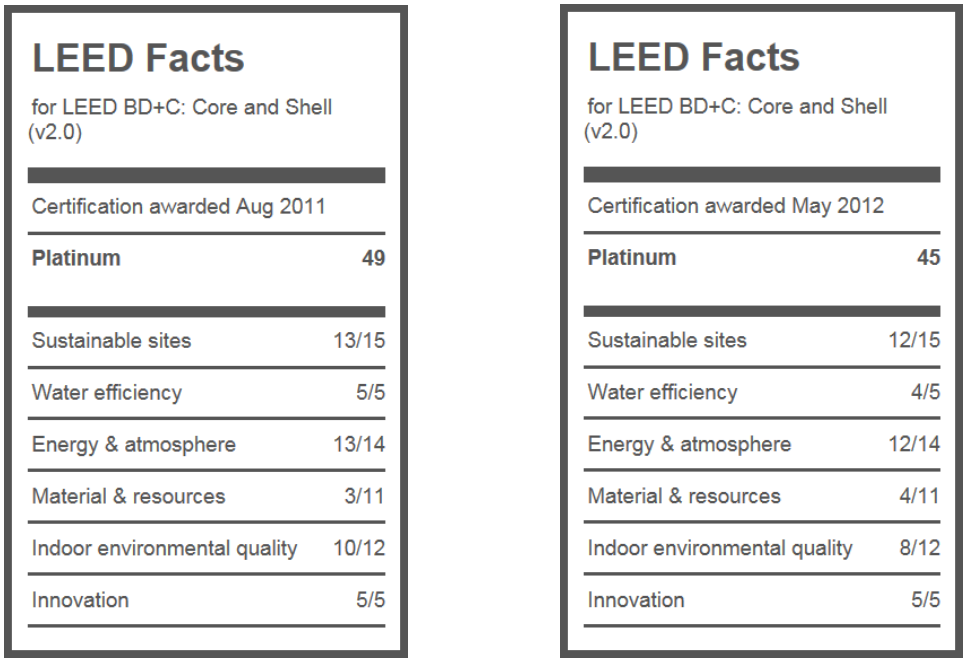
The following summary of critiques against LEED can be drawn from the literature review:

- Lack of weighted credits (Stein and Reiss, 2004)
- Lack of regionalization (Stein and Reiss, 2004)
- The costs and benefits of the certification are undocumented and uncertain (Stein and Reiss, 2004)
- The certification costs are too high (Schendler and Udall, 2005)
- Project teams can become LEED mongering (Schendler and Udall, 2005)
- Project teams can develop a "LEED brain" (Schendler and Udall, 2005)
- The bureaucracy is crippling (Schendler and Udall, 2005)
- There can be misunderstandings on the aim of "going green" in the building industry, since the terminology is not well-defined (Murphy, 2009)
- Energy-related credits are based on energy simulations instead of real measurements. (Diamond, 2011)
- Complicated energy modelling (Schendler and Udall, 2005)
- Energy savings are not always as high as expected. (Scofield, 2009; Newsham et al., 2009)
- A building keeps its certification forever, even if its energy performance is not as calculated during the design (Turner, 2010)
- Some of the techniques encouraged are not better solutions for the environment (Stein and Reiss, 2004). For example, building a multi-floor parking lot brings more burden than benefits to the environment (Humbert et al., 2007)

5.2. From Gröna Skrapan's Scorecard in LEED

Figure 9 shows the scores obtained by Gröna Skrapan within the LEED Building Rating System™ scheme. These figures are available on the USGBC website.

The house A, which got certified in August 2011, got a score of 49 out of 62. The house B, certified in May 2012, got 45 out of 62. It is clear that, for both houses, the major part of the missing points comes from the category "Material and Resources". For both houses, maximum points were awarded for the category innovation.



LEED Facts

for LEED BD+C: Core and Shell (v2.0)

Certification awarded Aug 2011

Platinum	**49**
Sustainable sites	13/15
Water efficiency	5/5
Energy & atmosphere	13/14
Material & resources	3/11
Indoor environmental quality	10/12
Innovation	5/5

LEED Facts

for LEED BD+C: Core and Shell (v2.0)

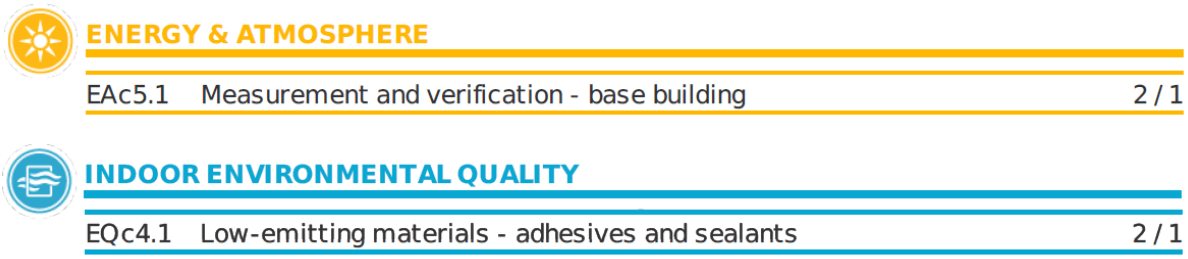
Certification awarded May 2012

Platinum	**45**
Sustainable sites	12/15
Water efficiency	4/5
Energy & atmosphere	12/14
Material & resources	4/11
Indoor environmental quality	8/12
Innovation	5/5

Figure 9: LEED Scorecard of Gröna Skrapan. House A (on the left) and House B (on the right) *(USGBC, 2014)*

A score of 2 out of 1 on some credits

When the detailed scorecards (Annex 2B) are analysed, odd scores can be found on two credits. Indeed, as shows the figure 10, the credits EAc5.1 and EQc4.1 were awarded to the house A with a score of 2out of 1. The same happened for the credit EQc4.1 in house B. It is very unclear how this scoring can happen in LEED.



ENERGY & ATMOSPHERE

EAc5.1 Measurement and verification - base building 2 / 1

INDOOR ENVIRONMENTAL QUALITY

EQc4.1 Low-emitting materials - adhesives and sealants 2 / 1

Figure 10 : In the house A of Gröna Skrapan, credits EAc5.1 and EQ c4.1 have been awarded 2 points out of 1. (Adapted from the detailed scorecards of the house A, available on the USGBC website)

Missed credits

Figure 11 shows the credits that have not been accorded to Gröna Skrapan. But, when compared to the technologies and systems presented in the "Sustainability Case 82" (see subchapter 4.3.2 of the current section), it seems that some of these missing credits should have been rewarded to both houses of the building. Although the Skanska Sustainability case has been written on May 2011, which is before the certification of the house B, some statements on house A are not in concordance with the LEED credits missed:

- EQc4.2, 4.3 and 4.4, which ask for low-emitting materials in the building, and credit MRc6 on certified wood:

  "The project complied with Skanska's Restricted Substance List and environmentally certified materials were used where possible,

including paint, ceiling panels and flooring. Other environmentally responsible materials included low-VOC (Volatile Organic Compound) adhesives, sealants, paints, coatings and carpets, and halogen-free electric cables that avoid the use of PVC (polyvinyl chloride). Only environmentally certified timber was used on the project."

(Skanska Sustainability Case 82, 2011)

- The credit EAc5.2 on measurement verification and tenant sub metering:

  "Tenant spaces are also sub metered to help them to monitor their energy use and to encourage further savings."

  (Skanska Sustainability Case 82, 2011)

- The credit MRc2.2 on construction waste management, asking for a minimum of 75% of the waste diverted from disposal:

  "Construction waste was sorted on site and 94 percent of the materials were diverted from landfill."

  (Skanska Sustainability Case 82, 2011)

Both houses A and B

- Sustainable Sites
  - SSc8 Light pollution reduction
  - SSc9 Tenant design and construction guidelines
- Energy and Atmosphere
  - EAc2 On-site renewable energy
  - EAc5.2 Measurement and verification - tenant sub metering
- Material and Resources
  - MRc1.1 Building reuse - maintain 25% of existing walls, floors and roof
  - MRc1.2 Building reuse - maintain 50% of existing walls, floors and roof
  - MRc1.3 Building reuse - maintain 75% of existing walls, floors and roof
  - MRc3 Materials reuse - 1%
  - MRc4.1 Recycled content - 10% (post-consumer + 1/2 pre-consumer)
  - MRc4.2 Recycled content - 20% (post-consumer + 1/2 pre-consumer)
  - MRc6 Certified wood
- Indoor Environmental Quality
  - EQc4.2 Low-emitting materials - paints and coatings
  - EQc4.3 Low-emitting materials - carpet systems
  - EQc4.4 Low-emitting materials - composite wood and agrifiber products

House B

- Sustainable Site
  - SSc5.1 Site development - protect or restore habitat
- Water Efficiency
  - WEc3.2 Water use reduction - 30% reduction
- Indoor Environmental Quality
  - EQc5 Indoor chemical and pollutant source control
  - EQc8.1 Daylight and views - daylight 75% of spaces

House A

- Material and Resources
  - MRc2.2 Construction waste management - divert 75% from disposal

Figure 11 : LEED credits missed by Gröna Skrapan (adapted from LEED Scorecards of the building, USGBC, 2014)

5.3. From the interview with Gröna Skrapan's project leader

All the facts presented below have been formulated by Gröna Skrapan's project leader, during the interview conducted in 2014.

Overview of the project development

Gröna Skrapan is a part of Skanska's project development business. This development unit work on the owner-side of things, which means that they have been developing the site from dirt up to the office tower. The history of the project is as follow

- 2004: acquisition of the site
- 2004-approx. 2006: Zoning of the site and design concept. Although the zoning advised for a building of 6 or 7 stories, Skanska decided to take down the house B level to 5 stories, and to rise up the tower to 16 stories, in order to create a landmark and to use the exposition of the site, situated near the highway. Out of 3 design concepts, only one did not follow the zoning: the one designed by White Architecture.
- 2008: Construction
- 2010: end of the construction

The initiative for a "sustainable building"

The initiative for making Gröna Skrapan a sustainable building came from Skanska. It was a market-related initiative: when developing their sites and offices, Skanska look at the market, since they want to create the most long-term value. Both customers (investors and tenants) want the building to be economically profitable, and thus want a low operation cost. This is directly related with the energy consumption of the building: purchasing energy is getting more expensive, and environmental regulations are becoming tougher and tougher. The regulations are a concern for the customers, who do not wish, in some years, to pay taxes because of their building's related CO2 emissions. Another argument for such a concern with energy is that "it's a bill you pay every month", and that it is simple to connect good energy efficiency to a cheaper energy bill for the tenants. Although it took many years to happen, energy efficiency is on customers' agenda. More than actually talking to tenants in the project, more than the economic part of things, it was the branding thing. Such concerns for energy efficiency were already part of the work in Skanska, which had internal goals set up for energy consumption in their buildings for several years, apparently associated with their ISO 14 001 certification that the project leader stressed at this point of the conversation. However, for Gröna Skrapan, Skanska thought "it cannot just be sustainable in the energy way and economical way", arguing that sustainability is more than that. After summarizing all the concerns of sustainable development – from environmental concerns to health and quality of life – the project leader concluded that Skanska "has done [their] homework" since they have now lists and lists of what to do and not do when working with a project. From the project leader's point of view, such knowledge of sustainability within Skanska is "great", because when it comes to the tenants and investors, although very few of them understand why, they know the building is a good product. The economic part in Skanska's sustainability branding is big: although "most folks" start to talk about their CSR and brand, their real concern is money. They would not do anything if it is not worth the money, it is all about economics.

A shift in the market

When Skanska started with Gröna Skrapan project, a shift in the market was happening: when the company presented the project, potential clients did not ask for much information on sustainable solutions. But after a while, the market had matured and potential clients was asking for energy efficiency and proofs for it. This is why Skanska decided to certify their building with EU Green Building. However, when they went back in the market with this certification, the market had matured even more, and energy efficiency was not the only big deal any longer. Potential clients were asking what else did this building have. Skanska then understood that they needed some kind of framework to show their sustainable work to their clients. This is when they decided to certify with LEED, which provide the scores as a simple cracker box (see figure 9), easy for clients to understand because not too detailed.

By certifying their building, Skanska thought they could get paid a premium for providing a certification. Although this might have been the case for some months, when the building was finally launched on the market, the investor market did not see certifications as a big deal from developers anymore. Even more, the investor market was asking for a discount if the building was not certified. "So the market turned from having a premium, a green building, to penalise you by not having a certified building 6 months later I would say. It went so fast." In the Retail Centre in Malmö, during the negotiation of the contract, Skanska had millions of Swedish Crowns in penalties if the building was not certified at least LEED Gold. Such a switch in the market is great since it puts pressure on developers.

Why deciding to certify the building?

After the first shift in the market, when investors were asking for proof of energy-efficiency, Skanska certified EU Green Building. "To be honest that was not a big deal. We did nothing. We took the design we had, run all numbers and said OK we are an EU Green Building." However, it now became tougher to get such a certification, since the regulations changed since then.

But, as said before, the investor market shifted again, asking for proof on the sustainable work done in the building. Skanska then asked colleagues in US, in Finland, in other Nordic Countries, and they heard of LEED and building certification systems. After filling out the different check lists, the project leader realised the building was at the Platinum level. This being said, the US is way behind, and such a standard building is uncommon there. Skanska thus pre-certified the building – and were the first ones to do so in Nordic Countries – and got the "cracker box", that he says is a great tool for presenting the building to clients, since it allows easy comparisons between buildings. Later on, they certified the building: "Super simple."

About the solutions and technologies implemented in the building

Innovative according to LEED might not mean what [I] consider to be innovative. However, there had been problems with the low-flow water tabs and toilets. The project team thought it would be easy to get this point, by fine tuning the toilets and all the water circuit. But since the pipes dimensions were set up for a specific flow of water, the

lower flow made the circuit work bad, and the water went out in the street and everywhere.

Bike facilities & showers – Skanska built bike racks and a gym with showers and lockers. However, there are not many people actually using it, since most people live in the city and do not need to have a shower after they biked. Most employees drive their car to the office. About five people who bike are using the shower afterwards. Every floor also has a shower in the biggest bathroom, although rarely used because the shower from the gym is better. It is interesting that such facilities are asked for by the tenants, but rarely ever used. However, the implementation of these bike racks and shower is a way to avoid any possible argument against biking from the tenants: "Everything is in place, so if [they] choose to do it, it's there, it's available."

The video conferences centre is not used much. All companies already have their own conference facilities in their office.

The CAV of the building has an extremely low speed through the parallel heat recovery units, which makes it highly efficient. A building needs to be built "at perfection so that there is no need to do [...] things" such as opening the windows or moving the sun shades. The latter are automatic, but if somebody needs to take the shades up or down, they can, although Skanska made it tricky "so it's such a hassle that people won't do it": the person has to go up, go back to the entrance door, put in a number and code in a certain panel, push down the button for the sunshade and go back to the desk. This way, if a person needs to be able to control the environment, it's still possible. However, the tenants are not supposed to open the windows. To avoid such a disturbance of the building system, Skanska stole all the window handles of the building (figure 12).

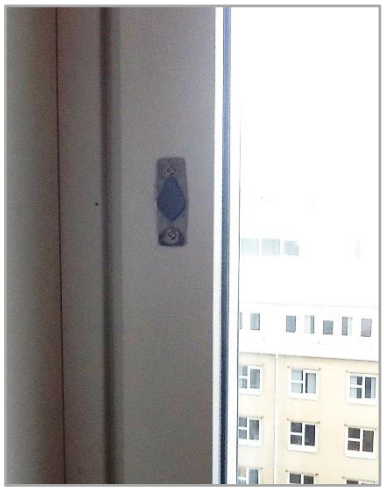


Figure 12 : Windows handles have been removed by Skanska, making it impossible for the users to open the windows. (Picture taken during the tour in the building)

Wind power off-site – Skanska buys all the electricity for the building from a wind power farm within Västra Götaland (Gothenburg region). However, no energy is produced on site, since Skanska do not "believe in producing energy on site if it's not a perfect spot for it. Wind should be where it's windy, PV where it's sunny".

The garage is situated in the two levels underneath the building. The parking has 140 spots, which was not enough for the municipality of Gothenburg[8]. After long discussion with the municipality, Skanska had to sign an agreement with other parking garages in the surroundings of the building. However, thanks to this low number of parking spot in the building, LEED gave the corresponding credit to the building.

[8] Depending on the area of the city, the Building Code changes. In certain areas, there is a maximum of parking spot to provide, in others it's a minimum.

Plugs – In the community-based workspace of the building, employees are not allowed to sit at the same desk every day. This has an unintended consequence: they always unplug their computer and chargers, which is an avoided unnecessary loss of energy.

Screen captors – On the computer of the company, there are captors to shut off screens when the user goes away.

Scorecard analysis

When asked about the scores of 2 out of 1 on some credits, the project leader did not give any answer, except that the system evolves, and that Gröna Skrapan was certified in 2011 and registered in 2009, when the system was in the version 2.0. The building would not be certified LEED Platinum if it was to be certified today.

On the scorecard of house A, it is visible that the building did great on Energy, on Water and on Sustainable Sites. It is terrible on Materials. There are two reasons for that. First, there was no building to re-use, since the building was a New Construction, so this is responsible for the major part of the loss of points in this category. Then, the credits awarded for recycling content within the building materials are not achievable in Sweden, "because the way everything is set up."

It is thus impossible to get a maximum score within the LEED system, because "some things are contradictory", which means that there are credits impossible to get, and other where a choice need to be made, which makes other credits impossible to get.

Finally, the building got 10 out of 11 at the Indoor Environmental Quality category. The only point the building did not achieve is the one for urea formaldehyde: although it is a zero tolerance in the LEED system, this kind of material is not to be found in Sweden, and thus is not looked upon as a big problem. Project teams "are focusing on different things in different countries."

Energy consumption: data, monitoring, "total deal"

By designing very complex systems, a building can be very efficient on paper. The issue is then to find persons able to manage such complicated systems. After trying such things in Skanska and having failed, the company decided to go back to basics and to install "the most robust, simple system" they could find: a CAV. [9]

At the time the project was designed (around 2007), the regulation stated that a building should not consume more than 100kWh/m^2·yr plus increased airflows during winter time, which bring the number to 119kWh/m^2·yr for Gröna Skrapan.

Skanska was working with an ODR (Owner Design Requirements) stating that the project should be 22% better than the code – today Skanska standard is 30% better than the code. Since they had stretched up this 22% in the project design, it was no problem to get the EU Green Building certification, which was asking for 25% reduction in energy consumption compared to the code, so a maximum of 89kWh/m^2·yr for Gröna Skrapan.

[9] CAV stands for Constant Air Volume. It is a type of HVAC (Heating, Ventilation and Air-Conditioning) system that supplies a constant air flow rate to the room, but varies the temperature of this air to maintain comfortable thermal conditions. (Bearg, 1993)

In 2013, the building's energy consumption was of 75kWh/m^2.yr, so the actual energy performance is even better than the one calculated during the design stage. Such precise data on the actual energy consumption of the building is possible thanks to the "in-depth way of monitoring and tracking [the] building".
However, the design is set up so that each and every employee can have access to daylight and to a view to the outside, which is not energy efficient, especially for the tower part of the building. Even with such an inefficient design, the building has been able to meet the EU Green Building requirements.
When focusing on the CO2 emissions in the building, it is interesting to calculate it per desk. A typical workspace in Gröna Skrapan has an area of 14m^2 (see plan in Annex 3) and the CO2 emission rate per capita has been calculated as of 220 kg per desk per year. Skanska compared this value to an office building from the 1980s, where a typical workspace size is double, and where the building's CO2 emissions is twice higher than Gröna Skrapan's. This means that the CO2 emissions from the old building's workspaces are four times higher than Gröna Skrapan's: twice because of the factor 2 between the workspace sizes, and twice more because of the doubled carbon emissions. "Here is where we have the difference. It is not just about the energy consumption per m^2, it's the total deal." For the customers, it is interesting since they realise that the cost should not be thought in terms of price per m^2, but in term of price per workspace. Thus, although the price per m^2 is higher than other buildings, less area is needed to fit all employees, and the total rent ends up less expensive than in the former companies' buildings. Instead of feeling packed, the employees are satisfied since these kinds of open rooms are actually what building's users ask for nowadays. This is called "activity based workspace", where nobody has its own desk, but has different nice cosy areas where to work or have meeting or take a break.

What about follow up on energy performances?

Although LEED gives a credit for writing down a measurement and verification plan, LEED does not follow up the performances of the building after it has been certified; neither do they check if the measurement and verification plan is being used.
However, Skanska decided to use the plan. Since they decided to include heating and cooling in the rent for the tenants, it is up to them to measure and verify the energy consumption of the building, and thus save money. This decision – that was taken for the first time in Gothenburg – comes from their will of being a true role model: ""If we're going to be a true role model, then why don't we pay for it? Because then we can spend money on it, because every money we spend, we will get back, in terms of saved energy."
Interestingly, EU Green Building asks for such a follow-up, and come back to the building within the first two years of its operation. Skanska then have to provide them data about the energy performances of the building. In 2012, the building had an energy consumption of 75kWh/m^2.yr, which is actually better than what they had designed.

The social side of the building

Although they were aware such a design was not energy efficient, Skanska wanted to attract companies and their employees by building a "modern nice space with great

views, daylight, like a “feel good” space”, so that employees would be as efficient at the end of the day as they were at the morning. To do so, they also decided to be well above code when it comes to ventilation rates, to end up with the best building for companies to be in, and thus to get the most out of employees.
These employees, since there is no special way to use the building, did not get any explanative booklet on any specific behaviour to adopt. When they moved in, they got information on how to care of their space, how to recycle, which is “for Swedes, super basic”. For the rest, the project leader asserted that Skanska take care of everything, e.g. heating and cooling, airflows, air quality, temperatures... This is what the company want: to know that the building work, and to only focus on their core business.
Skanska also decided that, since the building would be hosting a mix of tenants, common spaces in the ground floor (bistro and restaurant) and first floor (conference centre) should be built. The conference centre is opened to public use, but tenants of the building get a big discount on the renting fee. Skanska wanted the bistro to be used for meeting and mingling. But this never happened, because of the difference of culture in Sweden compared to e.g. the US: “In Sweden, all companies have their own coffee, and it’s free [...]. No one walks down here, it takes time and it’s going to cost you money [...].” However, since “Swedes, for lunch, go out”, the restaurant is crowded at this time.

LEED administration and bureaucracy

Working with LEED was highly frustrating and tough. The building has the standard for some of the credits, but could not get them because they could not prove it in the way LEED was asking for. A striking example is the Volatile Organic Compounds: in the US, they measure it as the amount of VOC per litre of paint, while in Sweden, the VOCs content is accounted through the amount used to paint a wall, and how much this emits in the air over time. The information on the paint box is thus missing in Sweden, and the suppliers could not supply Skanska with the data neither. For these reasons, the project missed the point related to VOCs. In this cases where it is not possible to provide data for what the LEED administration asks for, there is a possibility to write an CIR, where the project team can ask for LEED administration to give the point in a different way. However, writing this CIR is taking a lot of time and “tons of documentation to prove why they should admit that” has to be written and sent.
In general, the amount of paperwork is already big: it is difficult to know what LEED administration asks for, and when the documentation on a credit is sent, LEED comes back ask for specific proofs to be sure that the credits applied for have been worked on and will be put in place. Their requests can end up being very extensive. LEED approach on some credits is: “provide us with all the information; I want to see every single sheet, everything that was used in the building.”

The case of the district heating in Gothenburg

It took two years for Skanska to get LEED account for District Heating[10] and to reward them for it, since district heating was seen by the LEED administration as an inefficient process used in developing countries. Skanska, together with other companies, wrote a whole document – now adopted worldwide – explaining the way district heating works in Gothenburg, and how to treat it within the LEED system. The reason why it took so long to write this document is that LEED became actually interested in this technology when they understood what it was about, and wanted to be able to use it in other places than Sweden. In order to do so, the whole system had to be thought through very thoroughly, and the person in charge of the document – including Gröna Skrapan's project leader – had to "teach [the persons from USGBC] how primary energy is and how that works[11]". For example, they assigned primary energy factors to different sources of energy, and talked about carbon, "and not just the cost of bought energy as LEED used to do". The team who worked on this document "totally managed to give [the persons from USGBC] a different mind-set and accept the different ways of doing things".

What did LEED bring to the project?

What LEED principally brought to the project is the insurance that nothing planned at the design stage would be taken away because of financial reasons. First, the car pool, that seemed like a good idea but proved to be more complicated, with contracts to be signed, monthly fees to pay. It was economically risky to invest in such a service: "if everything works out, it's going to get used, we are going to get the money back, but if not, we are going to get hit by a substantial amount of money." Since LEED was giving a credit for it, the project team decided to take the carpool anyway. In the same way, the project team decided to keep the Green Roof. Although it was a good way of storm water runoff, it was expensive. But they learnt that it had many other advantages that would benefit the building in the long run: insulation and protection of the roof, additional green space in the city, and decrease of heat island effect.

Another thing LEED brought to the project is the tenant fit-out which is about providing them "a platform on how to fit out the space in a sustainable and green way", which furniture to buy. This way of thinking "goes outside what usually is [Skanska] scope of work: to help [their] tenants". Since it was something tenants asked for a long time, Skanska included Green appendix to their lease contract. Such a green appendix came out – although not solely – from LEED, and "talks about recycling. ; a bunch of stuff".

When asked if LEED brought a feedback process and discussions between the different actors of the project – such as architects, builders etc. – the project leader answers that they sat down, at the end of the project, to summarise what they learnt along the way. Such a learning process, which is part of Skanska's business model, is satisfying. A

[10] Through a 1000 km-long network, the District Heating System of Gothenburg provides heating to more than 90% of the city's apartments and to 9 000 houses. Most of the heat is surplus heat from industrial processes, and the rest is produced from bio fuels and natural gas. (Göteborg Energi)

[11] In LEED, energy credits are based on US $: the reduction in energy consumption is calculated according to the reduction in purchased energy price.

project team never start from scratch, but at the contrary, start where they ended the last time.
Finally, one thing LEED actually brought to the project is a whole department, Skanska Teknik, composed of many different professional such as structural designer or project leader. Such a group now deals with building certifications on a daily basis. When Gröna Skrapan was being designed and constructed, this department did not exist yet. It now includes around 10 persons.

Feedback from tenants

The tenants gave three different feedbacks. In one company, the employees decided to go to work instead of working from home. For the project leader, it means that the employees like going to work and are not feeling ill in the building.
Another company realised that the new space allowed them to innovate much more, a fact that the project leader summarised by "So by creating more innovative space, in a way, people got more creative. And that also means that you can't get better than that".
Finally, a third company claimed that "It's so easy to be green without even realising it. We're green by doing what feels natural, just by being in this building." This green image from the building they were based in helped them to build their brand and to gain trust from the market.

6. Analysis

Some of the critiques raised on LEED have proved to be accurate in Gröna Skrapan's case, while other have been proved wrong, according to the project leader of the building.

Indeed, the bureaucracy described as crippling by Schendler and Udall (2005) was actually helpful with the project team when it came, for example, to describing and explaining the District Heating System of Gothenburg. It is interesting however that Skanska and other companies decided to write a whole document on this technology during two years, to be able to get the credits related to the reduction of energy consumption. Since LEED calculate this reduction in terms of money, the number of credits would probably not have been as high if such a document on the District Heating System had not be written for and explained to USGBC. Spending so much time and energy on getting credits seems to well relate with the "LEED mongering" disease described by Udall and Schendler, which happens when a design team gets obsessively concerned with getting credits instead of focusing on environmental issues. However, it could be argued that such a document is now used worldwide by the USGBC, which may mean that the Gothenburg's District Heating technology could be spread easier if the USGBC decides to focus on it. It is unclear if the team in charge of the document was actually more focused on getting the credits or on spreading the knowledge on the technology. Another "LEED mongering" case is the example of the carpool, where the project team decided to go through contract signing and financial risks to get the credit.

The critique of Scofield (2009) and Newsham *et al.* (2009) on the energy savings being not always as high as expected has been proved wrong as well. Indeed, Skanska aimed for an energy reduction of 22% compared to the regulation, but decided to stretch this aim up, and finally ended up with an energy consumption of 75 kWh/m^2.yr, which is close to 37% better than the 119kWh/m^2·yr regulation in place at this time – thus even higher than the rule of thumb of 30% given by the project leader during the interview. Although LEED does not calculate such a reduction in energy in comparison to the regulation, it does not change the fact that the energy savings calculated at the design stage ended up lower than the actual ones.

The fact that the building keeps its certification forever was not an issue from an energy performance point of view, since Gröna Skrapan was also certified EU Green Building, and thus had to prove that the building was saving energy in its operational phase. Since Skanska decided to be the ones purchasing the electricity, there is a big incentive for them to consume as less energy as possible to avoid a loss of money. It is interesting that the EU Green Building, less renowned than LEED, actually follows up the performance of the certified project. Such a follow-up in LEED would give the building owners more incentive to keep some of the technologies or solutions that were finally discarded after a while. It is unclear, for example, if the toilets are still on a low-flow mode since it got clogged up and leaked in the surroundings of the building.

An interesting credit is the one of the underground parking lot. Although it was built underneath the building to get the credit on the reduction of Heat Island Effect, the environmental burden of such a digging are much higher than the ones associated with heat island effect (Humbert *et al.*, 2007). Such an example brings doubts about the actual advantages of using LEED, especially since Skanska did not seem to think about LEED in the early design phase. Indeed, if Skanska is able to design an environmentally efficient building, it seems useless to bring environmental burden to the project in order to get one credit in LEED. Such behaviour could then only be explained by the LEED mongering disease diagnosed by Udall and Schendler: the prestige of being highly LEED-certified can make design team obsessively concerned with getting credits instead of focusing on these credits environmental value.

Such a fame of LEED certification seems to spread beyond the construction industry: by taking for granted that LEED buildings are actually green sustainable buildings, companies renting their office in Gröna Skrapan use the certification as a way to green their brand. Such a thing can be related to Murphy's critique on LEED, stating that there can be misunderstandings on the aim of a green building since the terminology is not well-defined. Indeed, it is still unclear nowadays if a LEED-certified building is actually a sustainable building per se, and using the sustainability profile of a building to green one's company is anyway not the purpose of a green building.

The lack of regionalization of the certification system seemed to be an issue to get some points to Gröna Skrapan. The project leader, however, seemed somehow fatalistic, concluding that when working with LEED, one should be ready to give up on some credits that do not hold for Sweden. A relevant example here is the one of the urea formaldehyde content wood and agrifiber product: since it is not seen as a problem in Sweden, the information on formaldehyde content are missing and apparently nearly impossible to get. Similarly, the VOC content of paint, coatings, carpets and rugs are not displayed on the technical information of such products in Sweden. Although the project leader asserted that only 1 point had been missed in the Indoor Environmental Quality category, it was actually a total of 3 credits missed in this section. The credit EQ c4.1 however got a score of 2 out of 1 – which could not be explained by the project leader who seemed to avoid the question – and while the project leader told that the IEQ category was out of 11, it is specified as out of 12 on the scorecards. Such differences between the scorecard and the project leader explanations made the IEQ category scores somehow unclear, but a logical explanation of these missed points is coming from the differences of environmental issues between Sweden and the US.

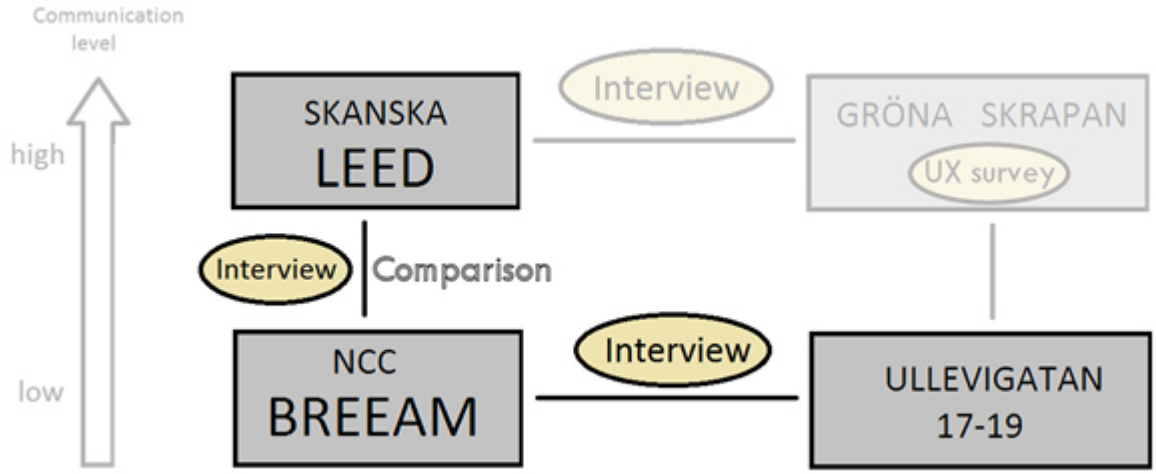
This section presented the building and Skanska work to make it environmental friendly from their point of view. It is clear that Gröna Skrapan is a good building compared to the construction industry work worldwide. However, the project leader himself is aware that the work needed to make such a building in Sweden is not as extensive as it would have been in the US' coal belt for example. Indeed, Gothenburg District Heating System is recognised as almost carbon neutral, and wind power farms are easy to find in Sweden. Swedes have environmental friendly habits: recycling, biking etc. And last but clearly not

least, Skanska seems to have extensive knowledge on technologies, systems and solutions towards a more sustainable construction industry. The project leader, during the interview, pointed out that the project team had done the major part of the design before even thinking about the LEED certification. When asked about innovative technologies, he admitted that what is innovative for LEED is not such a big deal in Sweden. It thus seems that Skanska did not put too much effort in designing and constructing a LEED certifiable building, but still uses the certification level as a strong proof of their sustainability work. It could mean two opposite things: whether Skanska is already doing a very good sustainable work and thus cannot make it better, and do not need the LEED guidelines to get a project LEED certified; whether Skanska used the LEED certification fame as a good way of advertising their company's environmental work, regardless of the easiness of getting such a certification in Sweden. In the case of Gröna Skrapan, the first assertion seems to be what Skanska want their client to think, while the second assertion seems to be the actual right one. In other words, Skanska seems to use LEED as a powerful tool of communication, since being LEED platinum can seem impressive, and even more when the project team thought about a certification at the end of the design phase. But getting LEED certified in Sweden is not as much of a hassle as it is in the US for example. Swedish know-how and Swedish energy systems are already available to Skanska. It does not seem that Skanska aimed to highly raise their standards and sustainable aims when building Gröna Skrapan. Otherwise, why would they build a high rise office tower if they are aware it is not an energy efficient design? Why would Skanska build a whole new building instead of re-using an old one, and recycling its materials? Why would Skanska spend two years to prove the efficiency of the Gothenburg District Heating System if not just to make such a municipal technology recognised in LEED, instead of using this workforce and work time to work on sustainable issues? Why would Skanska advertise about the building's bike facilities, showers, or efficient insulation while those are common in Sweden?

The project leader, however, is being honest when saying that building sustainable projects is a market-based decision in Skanska, and that clients need proofs of such a work. It is thus clear that Skanska needed a certification to be able to prove and explain their sustainable work to their potential clients. Skanska Sweden chose LEED because it was already being used by the US branch of the company. But it is also clear that LEED has several major issues, especially when used in Sweden: the USGBC did not know the District Heating System technology, which made the certification process very long. Furthermore, differences in culture between the US and Sweden make some credits impossible to get, which probably explains why the design team becomes LEED mongering in order to get a high certification. One question thus arise from these two findings: is LEED the best green building certification system to use in Sweden? The next section focuses on this question, by comparing the uses of LEED and BREEAM certifications in Sweden.

Section 3

The relevance of using LEED in Sweden



1. Background on BREEAM Certification

1.1. General information

The Building Research Establishment Environmental Assessment Method (BREEAM) is an environmental assessment method for buildings and community scale development. It was developed in the UK by the BRE in 1990, and is now the world's leading certification scheme for measuring sustainability of a building and setting the standard for best practice in sustainable design and specification (BREEAM, 2014). It is used in more than 50 countries. Over 15 000 projects have been BREEAM certified, and 40 000 are registered for certification. (BREEAM, 2014)

BREEAM assesses a building through a scoring system: different criteria are listed throughout 10 categories (see Table 9). Each achieved criteria corresponds to a certain amount of awarded credits. These credits are then accumulated in order to give a final rating to the building. BREEAM has 5 levels of rating: Pass, Good, Very Good, Excellent and Outstanding.

Table 9 BREEAM Categories (adapted from "A Short Guide to BREEAM", MES Building Solutions)

Category	Aim
Management	Encourage effective building operation (best practice commissioning, effective use of operating manuals…)
Health & Wellbeing	Design the environment to maximize occupant control
Energy & CO_2	Reduce CO_2 emissions from operation of the building
Transport	Minimize CO_2 emissions from transport (cycle facilities, public transport…)
Water	Minimize water consumption (water efficient appliances, water metering…)
Material	Use materials with a low environmental impact
Waste	Manage waste appropriately (during construction and use)
Land Use & Ecology	Enhance ecological effect on the site, protect ecological features…
Pollution	Use environmentally friendly insulation, attenuate surface water run-off…
Innovation	

There are two important steps in the BREEAM certification process, apart from registration.

- The Design Stage Assessment is based on design drawings, specifications and commitments, and provides an Interim Certificate of Compliance.
- The Post Construction Review is the second step. It includes site records and inspections, and aims to confirm that the Design Stage Assessment has been achieved. Only then is the final BREEAM rating issued.

All types of building can be assessed under the BREEAM schemes. Many standards schemes already cover most building types, such as Offices, Retail, Healthcare etc., while less common buildings can use BREEAM Bespoke, which assess the project with tailored criteria.

1.2. BREEAM International New Construction

In the early days of BREEAM, the scheme was designed to be used in the UK, and thus the weighting of the credits and categories were done so that the assessment was as relevant as it could be for the country conditions.

Today, the BREEAM International schemes have been developed and are to be used when the assessment is conducted in another country than UK. Four schemes can be found under BREEAM International, namely BREEAM International New Construction (NC), BREEAM International Refurbishment, BREEAM In-Use International and BREEAM Communities Bespoke International.

BREEAM International NC can be used for the assessment of new commercial buildings. This scheme includes all the categories listed previously in Table 9, as well as the Design Stage Assessment and Post Construction Review. But BREEAM International NC also includes an important feature: the means of adapting the weighting of categories to make the assessment as relevant as possible to the country it is used in. On the BREEAM website, the following explanation is found:

> *"A key feature […] is the capacity to recognize local context and issues, such as culture and climate, and to reward design teams for implementing local best practice codes and standards. Approved standards are available for each country and the BREEAM Assessor and design team can add to these by proposing local best practice construction codes not yet recognized."*
>
> *BREEAM, 2014*

1.3. Country-specific schemes

Some countries even have their own BREEAM schemes. As of today, Austria, Germany, Netherlands, Norway, Sweden and UK have their BREEAM National Schemes, "adapted to local social, cultural, climatic etc. conditions, translated in the local language with local assessors and aligned with the country's building regulations." (BREEAM, 2014)

By developing these country-specific schemes together with the respective government body, national Green Building Council or other relevant organization, BREEAM aims at influencing the local construction industry and drive them above and beyond building regulations.

In Sweden, BREEAM SE has just been launched this year. Before that, all New Construction projects had to be assessed under BREEAM International NC.

2. Methodology

After reading the articles criticizing LEED, and since other certification systems are available on the market, the next focus of the study is to question the choice of LEED as a certification system for Gröna Skrapan. To do so, the LEED Green Building Rating Program™ has been compared to the BREEAM one.

2.1. Literature review

The literature on BREEAM and LEED comparison is not extensive, but the few articles written about this subject give a good overview on the differences and similarities on the two systems, as well as the strengths and weaknesses of each of them. However, all articles have been written based on the UK context. Some of the arguments within this literature should thus be considered with caution.

2.2. Interview with a professional working both with LEED and BREEAM

The literature on BREEAM and LEED comparison gave a good background for comparing LEED and BREEAM use in the UK. However, the focus of the present research is on the use and PERTINENCE of such certification systems in Sweden.

To have a professional comparison on their use in Sweden, an interview has been conducted with an assessor accredited to work with both LEED and BREEAM certification systems.

2.3. Comparison with Ullevigatan 17-19

At this point, two insights were then available: the one of Gröna Skrapan's project leader from Skanska about the LEED certification of Gröna Skrapan, and the one of the assessor on the differences between LEED and BREEAM, with a focus on their use in Sweden. To complete the comparison of these two certification systems, a BREEAM certified building was analysed. The idea of such an analysis was to get information on the building in itself, e.g. its performances, technologies, solutions for sustainability, and also to get an insight on the BREEAM certification process.

To do so, information were gathered about the building through NCC website, NCC press release. An interview was conducted with a consultant for NCC who works with their BREEAM certification processes and was involved in Ullevigatan 17-19 project. The interview took place in the office of the consultant, near the construction site of the soon-to-be-inaugurated new building built by NCC, near Ullevigatan 17-19. The interview lasted about half an hour and was recorded. A quick tour of Ullevigatan 17-19 followed.

3. Findings

3.1. Literature review: LEED & BREEAM – comparison within the UK context

BREEAM and LEED are the two main rating systems used nowadays to certify the environmental profile of a building (Parker, 2009). Both schemes are credit-based, deliver different level of certification according to the number of credits awarded to the building, and "drive the market to improve building design" (Parker, 2009). Both have developed different schemes to enable the certification of a wide range of building construction, from offices to healthcare centres. Although they have similarities, there are important differences between the two systems.

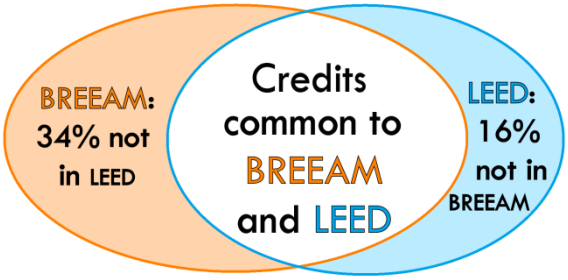


Figure 13 : Overlapping between BREEAM and LEED v3 schemes. Adapted from Inbuilt, 2010.

As shows the figure 13, most of the credits (84%) from LEED can be found in BREEAM, while 66% of the BREEAM credits can be found in LEED.

3.1.1. **Main differences**

When BREEAM was conceived in 1990, the Building Research Establishment was a government funded research body. (BREEAM website)

LEED was conceived as a part of the USGBC commercial mind-set. Indeed, the USGBC is a national non-profit membership body constituted of 19 957 member organizations from the industry such as corporations, governmental agencies and non-profit organizations. By attracting more than 6 500 paying members, USGBC gets more than US $ 24 million per year. LEED, registered trade mark and brand name, is consensus-driven with committee-based development. Since the committee is mainly formed by corporations and organizations, this consensus-based approach has been accused to "cater to manufacturer rather than basing credits on scientific research, factoring in the life cycles of construction materials and climate variations. (Inbuilt, 2010)

The process of certification is the main difference between BREEAM and LEED. On one hand, BREEAM trains assessor who go on site to assess the evidences against credit criteria, report these evidences to the BRE; who in turn decide to validate or not the assessment, and, if validated, who issue the certificate. On the other hand, LEED awards one credit if an Accredited Professional (AP) is part of the project team. No training is required for this AP, who takes an examination online. The AP helps to gather evidence, and to advise the project team. All the gathered evidences are then sent to the USGBC

who perform the assessment and issue the LEED certificate. (Parker, 2009) In other words, contrarily to BREEAM, the audit of the assessment is not independent in LEED.

The table 10 summarizes the principal differences between BREEAM and LEED: while the latter is based on US $, BREEAM is based on CO2. The thresholds are quantitative in BREEAM and based on percentage in LEED. While the American ASHRAE standards are the reference in LEED, BREEAM is based on the UK and European legislation.

As Parker (2009) points out in his article, BREEAM and LEED are very different when it comes to dealing with local contexts:

> *"BREEAM has long been able to adapt to local contexts. (...) LEED, however, has not been created with this level of adaptability and it is not run that way. Instead it is fixed to the ASHRAE standards and the US way of thinking."*
> *(Parker, 2009, p.2)*

When it comes to prescriptivism, LEED is less prescriptive than BREEAM, which means that designers are freer in the ways to meet the standards, whereas BREEAM links its prescriptive credits to specific solutions and technologies. Consequently, LEED's calculation methods are very rigorous, and the amount of work to prove accreditation is high. But BREEAM prescriptive credits are generally more onerous that LEED's ones.

Table 10 Main differences between BREEAM and LEED Rating Systems. Adapted from Parker, 2009.

BREEAM	**LEED**
Legislation/best practice	Optional standards
Quantitative thresholds	Threshold based on percentage
Based on CO2	Based on US $
Main application in UK	Niche application in UK
Assessor involvement	Team involvement

3.1.2. **Weaknesses and Strengths**

The table 11 summarizes the strengths and weaknesses of both rating systems.

Table 11 Weaknesses and strengths of BREEAM and LEED. Adapted from Parker, 2009

	Weaknesses	Strength
BREEAM	Very exact requirements	Comparison and benchmarking of different buildings is possible
	Complex weighting system	Buildings are independently audited
	Market profile	Adjusted to UK legislation and culture
	Costly certification	Bespoke version to assess any building
LEED	Based on the US system	Strong marketing: the message gets through
	Intense documentation	Many information are available
	The audit of the assessment is not independent	No need for a training or an assessor
	Building with mixed function and form are difficult to assess	

Saunders' study (2008) compared BREEAM 2006 and LEED v2.2 (2005), both superseded by the current versions, and was undertaken before the BREEAM Outstanding rating was introduced in August 2008.

Saunders compared the application of different certification schemes, including BREEAM and LEED, when it comes to assess buildings in the UK. The main finding of the study, illustrated in figure 14, was that

> *"It is tougher to meet the highest rating in BREEAM than it is to meet the requirements of the alternative schemes when building in the UK. If a building is designed to meet the highest LEED (Platinum) [...] it is only likely to achieve a BREEAM result of Very Good or Good which are the second and third highest ratings respectively."*
>
> *(Saunders, 2008, p.42)*

For Saunders, such results were caused by the fact that certification schemes travel difficultly, especially when they are not tailored to adapt to local context. LEED system has been based on local regulatory minimum standards, USA Building Code standards, which are lower than UK Building Regulation. For example, LEED assumes that buildings use mechanical ventilation and air conditioning, and that building's surroundings systematically lack of public transport alternatives. In most countries, H alones are banned from refrigerant systems, but since it is still allowed in the US, a credit is awarded for not using it, which makes it a 'free' credit in the UK. (Saunders, 2008) The same holds for Sweden where the use of H alones is forbidden as well.

Although Saunders highlights that such a comparison is approximate since credits can be more or less difficult to get, it is clear that a LEED Platinum Building is not the highest sustainable building rank existing in the certification schemes world. It should also be noted that Saunders study is based on LEED NC version 2.2 (dating from 2005), and BREEAM Offices 2008. Gröna Skrapan was certified LEED v2.0, so Saunders paper is accurate enough to be taken in serious consideration in the present study.

Figure 14 : Approximate rating comparisons for a building constructed in the UK. (Adapted from Saunders, 2008)

3.2. LEED and BREEAM uses in Sweden: interview with a professional

All the facts presented below have been formulated by a LEED and BREEAM accredited professional, during an interview conducted in 2014.

A good way to keep the spirit

Green Building certifications is a good way to keep the spirit during the whole design and construction process, by not giving up on some solutions or technologies because of their price. However, a building can be as good and cheaper to design and construct, since the whole price of the documentation and certification would thus not apply. But certifying a building allows third-party verification, and makes a building easier to sell on the actual market. Indeed, nowadays, such certifications are the only ways to proof possible clients that the building has been designed and constructed following sustainable criteria. Without such a certification, the claim of a sustainable building seems untrustworthy on the market.

Marketing value

The market asks for such buildings because tenants ask for such building, since their clients are part of the overall society, and the society becomes increasingly interested in becoming sustainable. As a result, the main reason for companies to certify their building is the marketing value associated to the certification, since a non-certified building is difficult to sell. However, the certification has no direct impact on the price of the building. As the project leader of Gröna Skrapan pointed out, certifying a building does not impact on its price, but on the ability of being able to sell it or not.

The certification process

The best time to start the certification process is at the very start of the design, since then the certification cost is then cheaper than otherwise: modifications are easier to do on a plan than on an already constructed building. The design team do not start from scratch by checking which credits they want to get. They know from the beginning which amount of credits they want to get, and also know want kind of building they want. The team then design the building as they imagined it, then do the pre-assessment stage of the chosen certification, and check which credits they got. Only after this pre-assessment, the design team decides to upgrade the building if not enough credits have been obtained. In some cases, the design team also decides to upgrade the level of certification, since the amount of credits is close enough to the level up.

Effects of the certificate on the habits of users

When it comes to the effects of the certificate on the habits of the building's users, the following ones are not affected:

- Amount of employees commuting by bikes, because it has more to do with the site location and the cycling networks. Also, having showers in Sweden is very common, as well as bike racks. The certificate does not have any influence on such things. The lockers are actually not ideally placed, since they are near the showers and not close to the user's office.

- Use of public transport, since it is also related to public transport infrastructures around the site. A site is rarely chosen by the developer: there are only few places constructible at a time, and the developers have to work with the available sites. It is thus not possible to make an impact on the distance from the office to the closest bus or tram stop. Ways to impact the frequency of use of public transport would be to have less parking spots, and signs showing when the next bus is leaving.
- Conferences facilities are also common in Sweden, since it is a good way of saving time.
- Recycling rate is not affected since Swedes already have good recycling habits.

The green roof solution is often promoted by LEED, although it actually asks for a lot of maintenance.

The BREEAM Good Certificate is not difficult

BREEAM Good certificate is not difficult to get in Sweden, except from the paperwork and price of the certification process. There are not many things to add to the already-designed building.

Main differences between BREEAM and LEED

Since they are from two different countries, there are very big differences. However, although both systems focus on the same areas, the BRE (in charge of the BREEAM assessment) is more thorough in the documentation.

LEED also has a totally different way of looking on materials than BREEAM. The latter uses the Green Guide specifications: all standards materials are compared, based on LCA analysis, and given a level from A to G. All different structures are then added, and a final result is calculated. It is a very different way of looking on material than the Swedish one, where all materials are checked through the Miljöbyggnad[12] credits. In LEED, materials are classified into credits on percentages of regional materials, of rapidly renewable materials, of reused/recycled content of materials. The big difference is that all of these percentages are based on US dollar. Although it is still not the way to do it in Sweden, it is easier.

Energy simulations are also based on US dollar in LEED, which is very difficult to handle for the calculations on the Gothenburg's District Heating System. The BRE bases its calculations on CO2 emissions, while Swedish legislation asks for energy data on kWh. The conversion from kWh to CO2 takes about half an hour to an hour to perform, while LEED energy calculations take lots of time, and cannot be used for any other purpose. The interviewee also thinks that basing energy on dollars is stupefying in Sweden, but that when it comes to these US dollar-based issues for energy or material calculations, one has to accept such an American ways of looking at things and to get used to the fact that these are not optimal ways to think about such environmental issues.

[12] Miljöbyggnad is a building certification system based on the Swedish construction and government regulations and Swedish construction practices. (Miljöbyggnad, 2014)

Problems in the process

The certification process, both for LEED and BREEAM, is really complicated. The main problems come from the fact that BREEAM and LEED have been developed in other countries. For example, BRE works with Life Cycle Costs (LCC): in one specific project, the project team had to write long and many emails to the BRE to understand the way to use such LCC tools. Eventually, the project team decided to give up on the credits related to LCC, because they could not understand BRE answers. When it comes to LEED, the District Heating System is difficultly understood by the USGBC. This latter is causing fewer problems for BREEAM since UK has similar kinds of system. Both schemes promote the ability of the occupants to adjust light and temperature in the building. Such a degree of freedom for users is not common in Sweden, where the focus is on saving energy by having the best compromise between light, temperature and user's comfort, but independently of the users' specific requirements. Such issues clearly have to do with a difference of culture between countries.

Sweden vs. UK/US

Differences in priorities are also bringing issues when a team project is checking which credits to achieve. LEED promote natural ventilation, while Sweden is a cold country and prefers to install air conditioning to transfer the heat from the air going out to the air going in. Such a credit is thus often skipped. LEED also gives credits for saving cold water. Such a thing does not really make sense in Sweden, where the focus is actually on saving hot water. These credits can thus be achieved if a design team want them, but it would be a non-sense and a loss of energy.

BREEAM is better on the assessment stages

When it comes to pre-assessment and final review, the BREEAM system is better. Indeed, although it takes more times, checking all the credits after the design-stage and after the construction is more thorough and thus trustworthy than splitting all credits assessment in two as does LEED. Indeed, in LEED, the first review gives answer on which credits have been documented enough or not. For the credits already accepted, LEED does not ask for any other proof. Thus, only the ones missed are checked during the final review. There is no review on-site since the AP is supposed to have given all the necessary documentation to USGBC. But, by not checking all the credits together in the final review, the USGBC may miss important things.

The absence of follow-up and the ever-lasting certificate

Neither BREEAM nor LEED asks for any follow-up during the operational phase of the building, unlike EU Green Building or Miljöbyggnad. Since a BREEAM- or LEED-certified building can keep its certification forever, such a follow-up should exist. The ever-lasting certificate is also an issue, since LEED v2.0 and LEED v4 are very different. The only thing the certificate tells is then that "it was the best built at the time of the certification".

Gröna Skrapan's score of 2 out of 1

The only explanations for such scores are whether a regional priority bonus, whether an exemplary performance: both of these had not been implemented yet in LEED v2.0, and

anyway, regional priorities in latest versions of LEED concern energy and water, which are not the credit scored 2 out of 1.

The use of US dollars as a performance indicator

The unrealistic use of the US dollar as an indicator of energy performance or material environmental quality is not something clients are aware of. Clients do not seem to really know what certification system they choose and why. Since it sounds and look good, they go for it.

The choice of the certification scheme

Skanska, first one to use these certification systems, went for LEED since they are an international company with parts in the US. Then, NCC chose BREEAM since Skanska is one of their main competitor. Since they all seem satisfied with their decision, they do not seem to question it or try to compare schemes.

BREEAM Outstanding or LEED Platinum

A BREEAM certified building can be LEED certified, and the same holds the other way around. However, the most sustainable building of both systems is a BREEAM Outstanding: only a very few of these buildings exist, and this level is very hard to reach since almost all credits need to be fulfilled, and aiming for the low hanging fruits is clearly not enough.

BREEAM is better to use than LEED in Sweden

The most suitable rating system to use in Sweden is BREEAM. LEED is "not good to use in Sweden, but Skanska will use it of course, and they kind of seem to like it".

3.3. Reference building: Ullevigatan 17-19

Ullevigatan 17-19 is an office building located in Gothenburg and constructed by the Nordic Construction Company (NCC).

3.3.1. **Background**

Nordic Construction Company

NCC is one of the three biggest construction companies in the Nordic region (Sweden, Norway, Denmark, and Finland), its main products being construction, housing, roads and development. The Table 12 below shows some key data on the company for the year 2013.

Table 12 Key data on NCC for the year 2013

NCC in 2013	
Sales *(Billions SEK)*	58
Employees	18 000
Profit(Million SEK)	2 679
Market share in Nordic Countries	7%

As Skanska, NCC has to deal with environmental problems resulting from building construction. NCC's define its vision as follow: "to renew our industry and provide superior sustainable solutions" (NCC annual report, 2013).

The company asserts that "a fundamental component of [their] strategy is to promote a sound and sustainable living environment for people, animals and nature, while generating business characterized by long-term profitability". To do so, NCC focuses on four different areas:

- Climate and energy
- Resource efficiency, recycling and waste minimization
- Chemicals and sustainable material choices
- Environmental classification of buildings and civil engineering structures

This latter is the most interesting for the present study. In the Nordic market, NCC aims to be a driving force for environmentally certified buildings and civil-engineering structures. On the long-term, they wish to only deliver environmentally certified projects. They are also one of the founders of the Green Building Councils of Denmark, Estonia, Finland, Norway and Sweden. When it comes to commercial buildings (including office buildings) and city districts, NCC chose to certify its projects with BREEAM. The internal policy of the company was, until recently, that all new office buildings should be certified BREEAM Very Good. This level has now been upgraded to BREEAM Excellent. (Interview NCC, 2014)

The building

Ullevigatan 17-19 (figure 15) is located approximately 700 meters away from Gröna Skrapan, in Ullevi neighbourhood. The construction started in 2011 and tenants started to move in the building in 2013. Ullevigatan 17-19 was certified BREEAM "Very Good" under the BREEAM International NC scheme. The building has the same general characteristics as Gröna Skrapan's, as shown in the Table 13, which makes it a good comparison case. Both buildings have been designed by the same architect, White.

Table 13 Principal Characteristics of Ullevigatan 17-19 (NCC, 2013)

Ullevigatan 17-19 – 411 40 – Gothenburg - Sweden	
Size [13]	ca 14 000 m^2
Height	-
Buildings	2 connected (Tower & low part)
Storeys	Tower: 16 Low part: 8
Type	Office building, mixed tenants
Architect	White
Selling price	580 MSEK
Finished in	December 2012
Inaugurated in	2013
Certifications	BREEAM Very Good, EU Green Building

[13] The actual area of the building is 16 797 m² (E-mail conversation with a project leader of NCC, 2014)

In 2012, NCC sold the building to Alecta for 580 million SEK (Fastighetsvarlden, 2012).

Figure 15 : Picture of Ullevigatan 17-19 (NCC, 2013)

3.3.2. **Energy efficiency**

In the last calculations performed on the building, the projected energy consumption for 2013 was of 67 kWh/m^2.year. (Personal communication with the interviewee, NCC consultant)

3.3.3. **Technologies and solutions for a sustainable building in Ullevigatan 17-19**

In their press release (Mynewdesk.com, 2012), NCC points out that several technical solutions have been implemented in the building to make it environmentally friendly by providing and facilitating environmental adaptation. Such solutions are:

- Separate measurements for water, electricity and heat consumption
- Carbon dioxide controlled ventilation
- Clear monitoring of environmental work
- Education for the tenants, on how to optimise their use of the building
- Climate-smart solutions for the materials
- Climate-smart solutions for indoor air quality
- Site location close to public transport and to the train station
- Good cycle routes

The concept plan of the building (see Annex 3) shows that 33 workspaces, two meeting rooms for five persons, phone rooms and other facilities are spread over 500m^2 on each floor. A quick calculation thus shows that a typical workspace area is of about 10 m^2.

The interviewee from NCC pointed out more specific solutions and technologies:

- Big focus on the insulation of the building and on its energy efficiency
- Use of the District Heating system of Gothenburg
- Elevators that regenerate power
- Waste treatment at the building to sort out wood, metal, etc.; this demand actually comes from NCC construction, since it is a good way to save a non-negligible amount of money.

- Since bike rack in the cellar, as well as at the ground level. Two parking spots also have been turned into bike parking by one of the tenants.
- Change rooms
- Showers at all floors
- Conference rooms in most of the offices, coupled with a bigger conference room at the restaurant in the bottom of the building
- Informative booklet to the tenants when they sign their contract, together with maintenance instruction (e.g. how to clean surfaces) and a tour of the building with the electricians when the tenants move in. Unfortunately, such tour of the building has not been passed on by the new owners of the building.

3.3.4. **The BREEAM certification process of the building**

The interviewee works as a consultant for NCC Property Development. He has been working on Ullevigatan 17-19 at the end of the process, and now works on the new building built by NCC some meters away from Ullevigatan 17-19. Since the project leader of the reference building was on maternity leave, a colleague of hers answered the interview. Since he worked on Ullevigatan, he has a good knowledge of the building, as well as BREEAM thanks to his actual work on the new building.

All the facts presented below have been formulated by the consultant during an interview conducted in 2014.

Why a certification, and why BREEAM

Certifying buildings is a company policy. For NCC development, at the time of Ullevigatan 17-19 construction, the requirement was to get at least 'Very Good' under the BREEAM International scheme. Today, this policy has been lifted to Excellent under BREEAM SE.

The decision of using BREEAM and not e.g. LEED came from NCC. LEED and BREEAM are not that different, although he admits that BREEAM covers a bit more ground than LEED. The choice has probably been influenced by Skanska who is focused on LEED.

Market and certificate

The certification process of Ullevigatan started in 2011 and the building got certified in 2012. The certification of a building is important since companies owning buildings do not wish to buy uncertified building. Which certification system is used is not important however. The market is developing towards the common understanding that a non-certified building is not desirable. This comes from the tenant companies who want to set environmentally friendly offices to have a good image and thus attract young adults.

The certification process

As for Gröna Skrapan with LEED, the BREEAM-certification of Ullevigatan 17-19 has not gone easily. The amount of time spent in the process is high, because the project team needs to get answers for many questions, since they have different ways than BRE to achieve the same goal. A positive answer from BRE then takes time to get.

However, because of the economics driver of getting a certificate, the team focuses on getting the credits and the approval from the design stage. Credits requiring the workspace to be within seven meters from the façade, or to have a window, are of course influencing the layout of the building. But getting a building approved 'Very Good' in the kind of location of the project (in the centre of town) is easy enough. To get Excellent, a bit more of striving is need, but it can be achieved by adjusting the design. It is only if a team decides to aim for Outstanding that team project need to design after BREEAM credits, and to though the whole project through from the very beginning. In other words, apart from when a project team aims for Outstanding, BREEAM affects the design by making the design team fit in some credits afterwards. The design is not based on BREEAM from scratch. The learning process is important as well: as people get more used to work with BREEAM, they start to think in BREEAM terms and credits, which then affect the design from the very beginning.

Illogical credits

Concerning the BREEAM credits, some are not always logical. As in LEED, points are lost from not having a previous construction on the ground. Opening the windows for natural ventilation is not perceived as reasonable in Sweden, especially for a 17-stories high building. An acoustic credit asks for a minimum of noise in the office so that phone conversation cannot be overheard. But separate rooms where to go to speak on the phone where built in the building, with soundproof walls. Such points are given up. However, these illogical credits are clearly counterbalanced by the energy-wise ones, easily and naturally fulfilled since NCC already worked a lot on reducing energy consumption. To get even more points and because they agreed it could be useful, the project team looked into systems to let the tenants know about their energy consumption. But such systems require many measuring instruments and technologies, and end up being too expensive to install. Tenant sub metering was thus not implemented.

District Heating System

The District Heating System seemed to be problematic as well, because the UK did not seem to understand the system so well, especially on one credit focused on NO_x, where the design team could not prove that they actually had higher performance than BREEAM demands.

Regional issues

When it comes to focusing on regional issues for sustainability, Sweden as well as Gothenburg has high and explicit demand on water treatment and consumption, which makes such issues mandatory to take care of. Insulation is a big focus of NCC on Ullevigatan 17-19.

About the third party assessor

Since most of the work for BREEAM accreditation has to be done early in the process, the post-construction review is easy to get once the design-stage has been approved.

Follow-up on consumption

Although BREEAM does not ask for a follow-up on energy consumption, NCC does it since it is a requirement of the EU Green Building certification. NCC, anyway, want to have the information on energy consumption in all the houses they build.

Thermal comfort

NCC had lots of problems with the thermal comfort in Ullevigatan 17-19. However, it was not a consequence of BREEAM requirements: entrepreneurs have not done a good work and that the systems supposed to control the heat and ventilation did not work well. The consequences were problems of temperature – both too cold and too hot – in the rooms. Such a problem has been taken care of since. A new building needs adjustments at the beginning of its operational phase.

4. Analysis

As already perceived in section 2, the construction industry in Sweden is nowadays clearly driven by environmental certification systems. Indeed, both interviewees in this section pointed out that the certification of a building makes it easier to sell on the market, since it is so far the only ways to prove that the building was designed and constructed following sustainable principles. The market asks for such green buildings because the tenants ask for it, and the tenants ask for it because society – including the tenants' company's clients – is increasingly focused on sustainability issues. Such a chain reaction thus seems to have begun from society opinion all the way to environmental certifications as market drivers. The main reason for certifying a building is thus the marketing value associated with a certificate, which influence the ability to sell a building or not. Which certification system is used does not matter however. Companies build their certification policy on the market value associated with it, and not on the actual performance linked to such a certification: when Skanska first chose to work with LEED because the company has parts in the US, NCC decided to work with BREEAM since Skanska is one of their main competitors.

All the interviewees for this report pointed out that being certified in Sweden is not really difficult – aside from the amount of paperwork and of time – especially for buildings located in centre of cities as Gröna Skrapan and Ullevigatan 17-19 are. Sweden and Gothenburg have high and explicit demand on e.g. water treatment and consumption, making such issues mandatory to manage. Design teams already know how they want the building to look like, and which level of certification they want to reach. Typically, they start to focus on the credit lists after the pre-assessment stages. Usually, there are not many things to add to the building when the aim is e.g. BREEAM Very Good or LEED Gold. In some cases, if the pre assessment showed that the amount of credit is close to the level up the one decided at the beginning, design teams would discuss if they are willing to upgrade, and which credits they could get, what to change and what to implement. This way, BREEAM Excellent or LEED Platinum can be reached in Sweden. Only if a team is aiming to BREEAM Outstanding the whole project should be thought through based on BREEAM requirements from the beginning. Such a typical way of going through the certification process happened in Ullevigatan 17-19 and in Gröna Skrapan. Except from the documentation and economic sides, none of the three interviewees in this report pointed out any difficulties to e.g. have low energy consumption, or a good indoor environment quality.

BREEAM and LEED certification systems have a strong focus on users and aim to change their habits of transportation and of waste management. However, in Sweden, rewarding credits for bike racks, showers, public transport proximity or recycling areas do not influence the users' habits and behaviour since such things have been implemented in buildings for years and are not new for Swedes, who already bike, take public transport and recycle more than the average in Europe or developed country.

Another thing both schemes have in common is that they award an everlasting certificate. Two problems arise from this. Firstly, since changing in schemes are made to better them more and more, a building certified LEED v4 is more in concordance with sustainable principles than a LEED v2.0 certification. Gröna Skrapan would not be ranked as LEED Platinum if it was to be certified with LEED v4, and neither would it be with LEED v3. Secondly, the everlasting character of the certificate is an issue since neither BREEAM nor LEED asks for any follow-up on performances. This means that a building can be awarded a certificate but not actually perform as good as planned without any sanction.

When it comes to the differences between LEED to BREEAM, it is clear that many can be found, and some issues appear on the actual LEED's view of sustainability. The fact that LEED has been created as a part of a commercial mind-set supports the hypothesis of a certification system catering to manufactured instead of basing credits on scientific research. As the project leader of Gröna Skrapan pointed out during its interview, LEED is market based. Many LEED credits are based on percentage reductions, and such percentage calculations are based on US dollars. For example, reduction in energy consumption is calculated in LEED as the percentage of reduction of purchased energy between a base-building energy simulation and the designed-building energy simulation. Such way of calculating is thus closely related to monetary issues: if the exchange rate is unfavourable, credits could be missed for no significant reason. BREEAM calculations on reduction in energy consumption are quantitative and based on CO_2 emissions, making the results more transparent and logical. Materials are also analysed through percentage and US dollars in LEED, while BREEAM bases its credits on LCAs comparison. Again, the BREEAM way is more relevant from a scientific point of view. BREEAM also stands better than LEED when it comes to the assessment process: while LEED split the credits review in two, and thus makes it possible to miss important issues on some credits, BREEAM checks all credits both at the design stage assessment and at the post-construction review.

The only issue that can be drawn on BREEAM is its lack of freedom when it comes to technologies and solutions: "LEED project teams" are freer as long as they meet the standard. But such a freedom has a cost: the calculations methods to prove that all credits have been fulfilled are complicated and demand a lot of paperwork in LEED. The best example is the District Heating System, which had to be explained point by point to USGBC. Only after two years and a whole written document could the USGBC accredit Gröna Skrapan for its energy performance. Here again, the US-dollar-based way of calculating energy related issues did not help. In Sweden, energy performance is calculated in kWh. It is thus easier to deal with the District Heating System since the conversion from kWh to CO2 emissions is straightforward enough.

It is clear that BREEAM is a more accurate choice than LEED for the questions of energy performance and materials. Such a conclusion holds anywhere in the world. But this third section also showed that there are issues related to the use of LEED in Sweden, which could be bettered by using BREEAM instead.

Since BREEAM covers more ground, and since Sweden already performs well in sustainable buildings techniques and solutions, certifying a building with BREEAM would be a better and more sustainable achievement. Indeed, BREEAM is adaptable to local issues, while LEED is focused on the US. Interestingly, such a lack of adaptability was seen as a problem by the project leader of Gröna Skrapan, since he asserted that Skanska believes in neighbourhood development. He, however, preferred to adopt what seemed to be a fatalistic approach, and focused on the goal: getting the LEED certification. The question of changing of certification scheme, or even consider it as an option, does not seem to be a priority for Skanska.

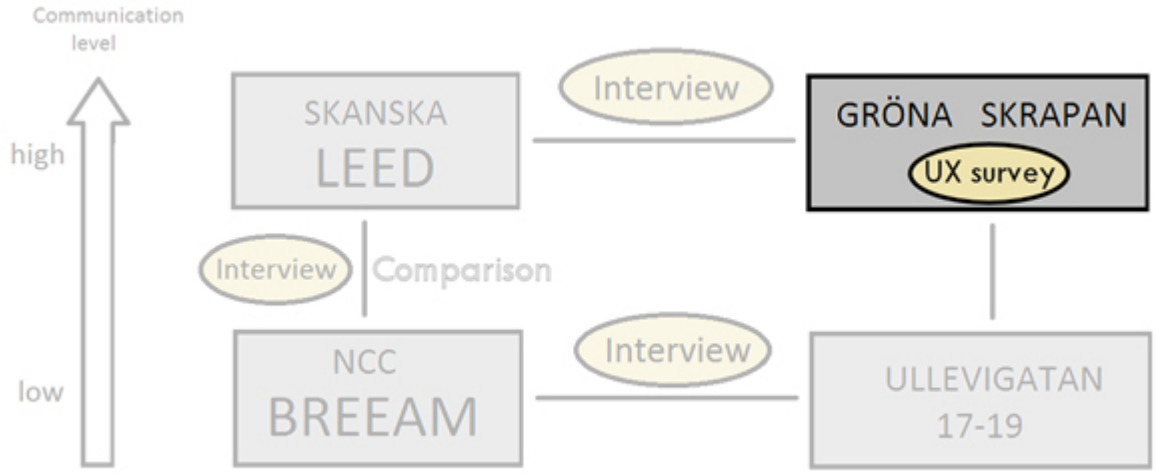
It is important to highlight that both LEED and BREEAM have some credits that do not make sense when used it Sweden. Both promote natural ventilation – which would be an issue during the many cold month of a Swedish year – and want the occupants to be able to adjust light and temperature. LEED promotes saving of cold water. BREEAM gives a point if there is a minimum of noise in the office. Such credits do not concord with Swedish habits or Swedish office layouts. However, such issues as VOC content in paints or coating, of urea formaldehyde content in wood, would not have been encountered by Skanska if they had used BREEAM. The interviewee accredited for both LEED and BREEAM indeed asserted without hesitation that LEED is not good to use in Sweden.

The comparison of the schemes thus brought many interesting conclusions. The study of the reference building Ullevigatan pictured very efficiently the points made previously in this analysis: BREEAM-certified "Very good" Ullevigatan 17-19 seems to be at least as good a green building as Gröna Skrapan. Indeed, its projected energy efficiency is of 67 $kWh/m^2.yr$, against 75 $kWh/m^2 \cdot yr$ in Gröna Skrapan. Showers and change facilities, cycle network and bike racks, public transports, building's conference facilities, conference rooms in offices are all available in Ullevigatan 17-19. All technologies and systems that can be found in Gröna Skrapan are also implemented in Ullevigatan 17-19, except from the sun shades in the windows, the green roof, the carpool and the electric vehicle recharging stations. Ullevigatan 17-19 has a system of elevators regenerating power, and an efficient waste treatment at the building to sort out wood, metals etc.

But NCC did not make any fuzz about their building, and little information can be found on the internet. The building is not even in the Green Book Live, which lists many BREEAM certified projects. It proves again that Skanska clearly used the LEED Platinum certification of the building as a tool to communicate not only with clients, but also on the whole sustainable work of the company, while such a certification is not as difficult to get in Sweden as it could appear. Although BREEAM also has some issues to fix, it is a more accurate scheme to use in Sweden, and since the Outstanding level is difficult to reach, a BREEAM Outstanding certificate for Gröna Skrapan would have been more impressive, would have ended up in a more sustainable building, and could have served the same communication purposes for Skanska.

Section 4

User Experience Survey



After those analyses, a focus has been brought on qualitative data about the users experience in the building. Those are frequently dismissed while studying a certification scheme and a building, but "it is critical that [a green building rating system reflects understanding of end-users' needs". Thus, the user experience has been dealt with through a post-occupancy evaluation: a survey focusing on user needs and satisfaction. That way, the occupancy phase of the building was studied and gave qualitative data to complement the previous analyses from sections 2 and 3.

1. Background & Literature Review

In their article « A method for evaluating the performance of green buildings with a focus on user », Kim *et al.* develop a method aiming at evaluating green building performance through quantitative data as well as qualitative data. Quantitative data are derived from the building's rating in its chosen certification scheme, while qualitative data results from survey questionnaire sent to buildings users. The strength of this method is that it can be customized to the certification scheme in focus, here LEED.

To develop such a method, the authors started by assuming that there are three inter-related issues to take in account when analysing sustainable buildings: people, products and processes (Kim *et al.*, 2013). People include owners, tenants and any occupant of the building. Products include concrete objects such as materials, structures, equipment, as well as controls and services, while processes include works relative to the building itself, such as its maintenance, management and performance.

Further on, the authors specify that to reach an optimal combination of sustainable values –environmental, social and economic – the following factors should be at their best in the building: safety, security, well-being, reasonable cost, convenience, long-term adaptability and environmental friendliness. Certification schemes such as LEED are conceived to rate these factors. However, these can as well be rated on a more qualitative manner by users, although it can prove difficult to do. Indeed, while many other researches on assessment of green building performance have already been conducted, the authors focus on the fact that measuring attitudes of people to the natural environment is very difficult, since "people's feelings about the natural environment are incorporated into wider cultural predisposition that includes beliefs, intentions and characteristic behaviours". (Kim *et al.*, 2013)

To tackle this difficulty, Kim *et al.* propose a method focusing on the user's experience (UX), which refers to the user's emotions, thoughts, feeling, cognition resulting from their interaction with objects (in a building's case, these objects can be products as well as processes). UX is a central concept in product development when it comes to analysing users need and satisfaction. One of the most important concepts of UX is usability, defined in ISO 9242-11 as "the extent to which a product can be used by

specified users to achieve specified goals with efficiency[14], effectiveness[15] and satisfaction in a specified context of use". More generally, usability can be defined as "the user's ability to utilize resources for performing a given task successfully" (Kim *et al.*, 2013). Usability metrics thus cover three distinct aspects: the efficiency, effectiveness and satisfaction with which a user interacts with an object.

Thanks to these three aspects, the authors show that the green building metrics from the green buildings rating system can be widened to cover the usability, satisfaction and user interaction with the building. Kim *et al.* assume here that if it is possible to trace the relationships between Green Building rating systems and user's ratings of satisfaction and usability, then it is possible to evaluate the UX of a green building. To analyse such a relationship, the authors divide the assessment fields of green building performance into three categories: user characteristics, UX and green building elements (Figure 16).

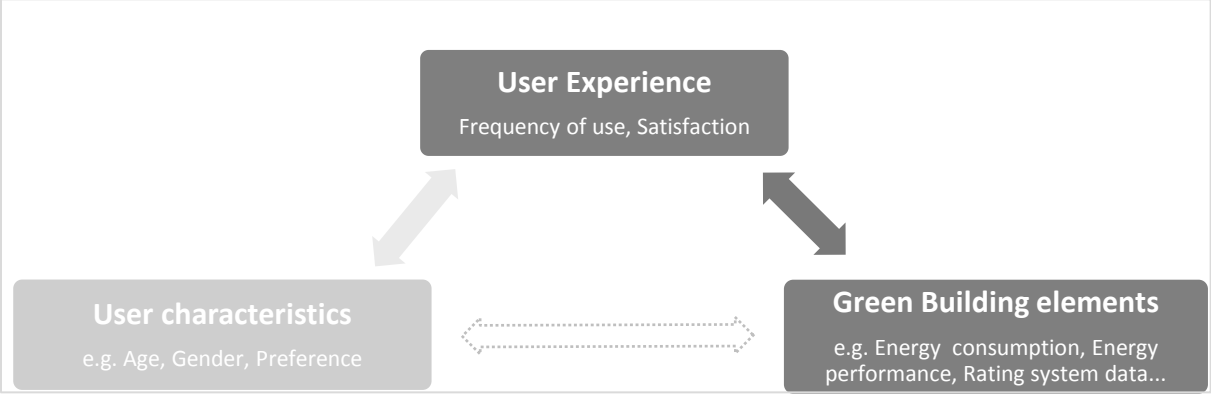


Figure 16 : Relationship between User Experience, User Characteristics and Green Building Elements. The focus in the present study is on the two elements in dark grey: User Experience and Green Building Elements. Adapted from Kim *et al.*, 2013.

The evaluation of the building performance can then be conducted by clarifying the relationships between users and UX categories, and between UX categories and Green Building categories. This latter proves to be the most complicated. The solution proposed by the authors is to centre all Green Building factors from the Certification scheme on UX.

To do so, they developed their method and illustrated it through the case study of a Korea's Green Building Certification Criteria (KGBCC)-certified apartment complex. The following summarizes the step by step method explained in the article. For the purpose of the present study the method has been adapted to the LEED-certified Gröna Skrapan. The relationship between user characteristic and user experience has been omitted. Indeed, since the survey was sent by email, the number of questions had to be optimised so that the answer rate would be significant enough. The focus has thus been put on the relationship between green building elements and user experience.

[14] Efficiency: resource expenditure in relation to effectiveness (Kim *et al.*, 2013)Effectiveness: accuracy and completeness with which users achieve specified goals (Kim *et al.*, 2013)
[15] Effectiveness: accuracy and completeness with which users achieve specified goals (Kim *et al.*, 2013)

2. Methodology

The User Experience survey and analysis has been conducted through the several following steps.

Step 1: Classification of indicators

To design the survey, the first step was to classify all Green Building indicators into different categories, depending on how they could be assessed by the users: satisfaction, usability and/or need. It is important to specify that users can assess one single Green Building indicator through different way. For example, the showers of the building can be analysed through their frequency of use, but also through the user's satisfaction with it. This first step thus aims at centring the Green Building indicators on UX. This classification was done through the following method:

- (1) Division of evaluation indicators of LEED in 2 groups: indicators that can be evaluated by users (UX) and indicators that cannot (UN).
- (2) UX group includes indicators rating users' usability and satisfaction. Usability will be determined in the survey through the user's activity, which is its frequency of use of a specified object. Two groups can be formed from the UX group. A first one (UA+US) includes UX indicators allowing to rate satisfaction as well as usability. A second one (US) includes indicators that can only evaluate satisfaction.
- (3) Finally, usability indicators are divided into two sub-groups: UA_D includes indicators directly related to the activities of users, while UA_I includes the ones indirectly related to users' activities.

Such a classification is summarized in Figure 17 below. The end-indicators are pictured in clear grey, while the steps to categorize the indicators are pictured in darker grey. All Green Building indicators classification can be found in Annex A1.

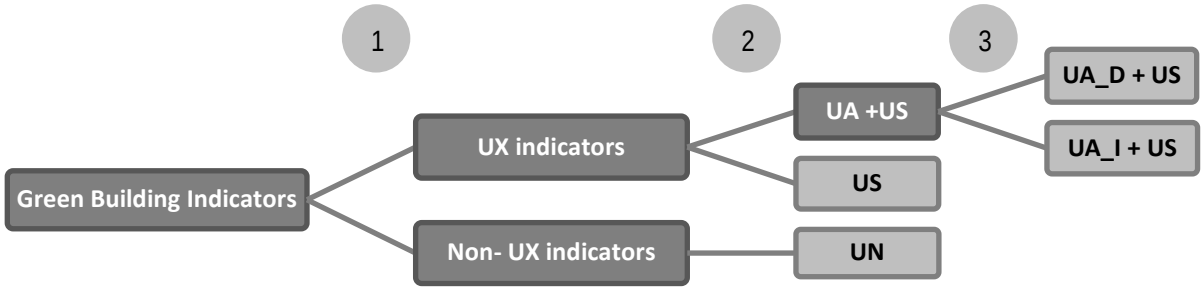


Figure 17: Classification of indicators. Adapted from Kim et al., 2013

Step 2: Establishment of the questionnaire

The survey is divided into three parts. The whole survey questionnaire is presented in Annex 4A.

The first part asks about demographic information such as user's gender, age and level of education, how long has the user been working in the building and job title. (Questions 1 to 5)

The second part of the survey aims at getting some information on the user's knowledge on Green Building certification schemes (Question 6 to 8).
The third and core part of the survey (Questions 9 to 48) questions the user about its point of view on the different features of the building. After the classification into indicators, the establishment of this part of the questionnaire was quite straight forward. Below are presented the typical questions asked in the survey depending on the indicator category of the feature in focus.

- UA_D: How frequently do you use (*feature in focus)*?
- UA_I: How much does (*feature in focus*) influence your frequency of use of (*related feature*)?
- US: How satisfied are you with (*feature in focus*)?
- UN: How satisfied are you with (*feature in focus*)?

The correspondence table between the survey question number and the surveyed indicator can be found in Annex B3.

Step 3: Sending of the survey by email.

The email addresses of the users have proved difficult to gather. After several attempts, the contact from Stena Fastigheter did not send any information. It was then decided to find which companies have their offices in Gröna Skrapan, and to gather the emails of their employees. Some companies had this information already available on their website, while others were contacted by phone. The latter then whether refused to give the information – and did not participate at the survey – whether sent their mailing list, whether asked for the survey link to send it themselves to their employees. In total, 176 email addresses were gathered.

Step 4: Results and calculations

When gathered, the results were presented in a scale from 1 to 5, as follow:

	1	2	3	4	5
Frequency of use	Never	Very rarely	> twice a month	> twice a week	Everyday
Influence	Not at all	To a little extent	To some extent	To a moderate extent	To a great extent
Satisfaction	Very dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied
Need	Very unimportant	Unimportant	Neither	Important	Very Important

Figure 18 : Scale of the answers in the survey

Diagrams of the figures 26, 27 and 28 have then been designed following a colour scale: green for 1-2.33, orange for 2.33 to 3.66 and red for 3.66 to 5. This way, it is easy to quickly see the overall result of each indicator. This colour code is explained in more details in subchapter 3.2.

Step 5: Analysis of the results. Evaluating user experience of green buildings: adaptation of AttrakDiff evaluation method to visualize the results

The figure 19 displays the AttrakDiff evaluation method, adapted to the present study.

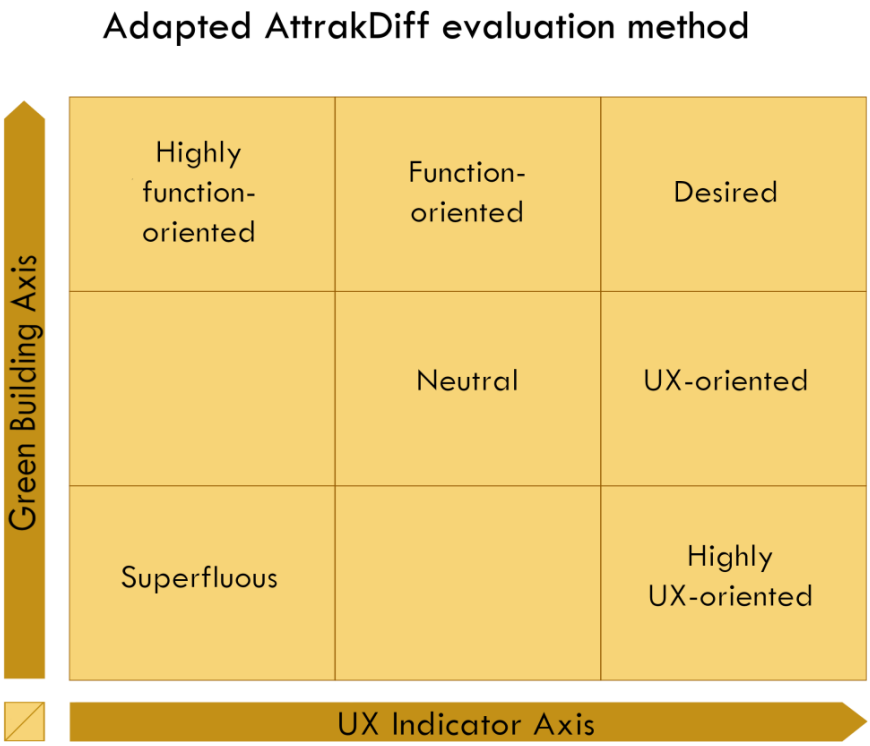


Figure 19 – AttrakDiff evaluation method, adapted from Kim *et al.*, 2013

On the left vertical axis, the Green Building Indicators have been splat between the ones accredited for both houses of Gröna Skrapan, the ones accredited for one house, and the ones not accredited to any of the houses.

On the horizontal axis, the user's experience indicators have been splat in three different sections depending on their mean value from the survey. The scale is as follow (figure 20):

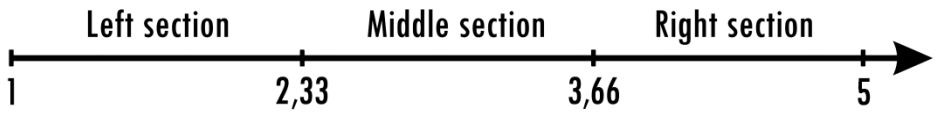


Figure 20 – Scale of the horizontal axis in AttrakDiff evaluation method.

3. Findings

3.1. Demographic results and respondents knowledge on green buildings and their environmental certification schemes

The survey requests have been sent by email, via Survey Monkey, to persons working in Gröna Skrapan. In total, 176 persons have been reached. Since Skanska constructed the building, the 27 identified employees working for the company received the same survey but on a different link. This way, their answer could be analysed separately or jointly with the others.

The response rate is of 17%:

- 176 reached: 27 from Skanska, 149 from the other companies
- 30 answers: 0 from Skanska, 30 from the rest

Figure 21 and Figure 22 present the demographic results of the survey. Out of the 30 respondents, 9 are females and 21 males. The respondents' ages span from 25 to 64 years old. 33,3% are 25 to 34 years old, 40,0% are 35 to 44 years old. The other 26,7% are 45 years old or older.

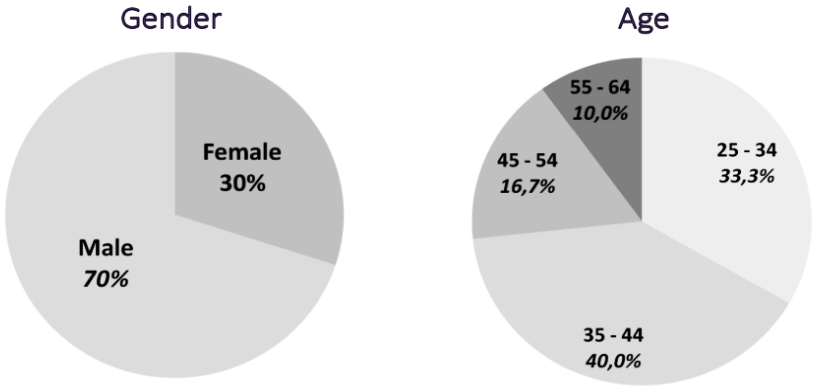


Figure 21: Gender and Age of respondents

As figure 22 displays, half of the respondents have graduated a Master Degree, and almost a quarter have graduated from a Bachelor Degree. Figure 22 also shows that the respondents have been working in Gröna Skrapan for different time. Half of them have been working in the building for more than 2 years.

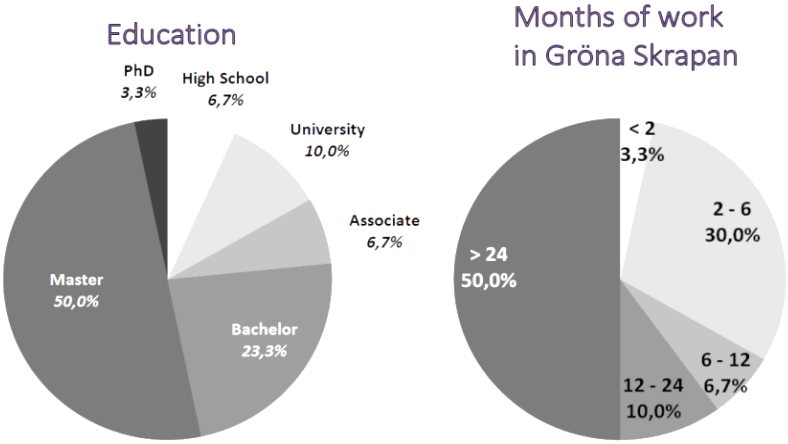


Figure 22: Education and Months of work in Gröna Skrapan of respondents

Figures 23 and 24 below show the survey results on the knowledge of the respondents on Green Buildings, and on their knowledge of different certification schemes. Figure 25 pictures the knowledge of the respondents on LEED.

2 respondents consider that they know a great deal about Green Buildings, and 6 consider they know a lot. 3 respondents think they know a moderate amount on Green Buildings. 14 of them consider knowing a little and 3 do not know anything about Green Buildings.

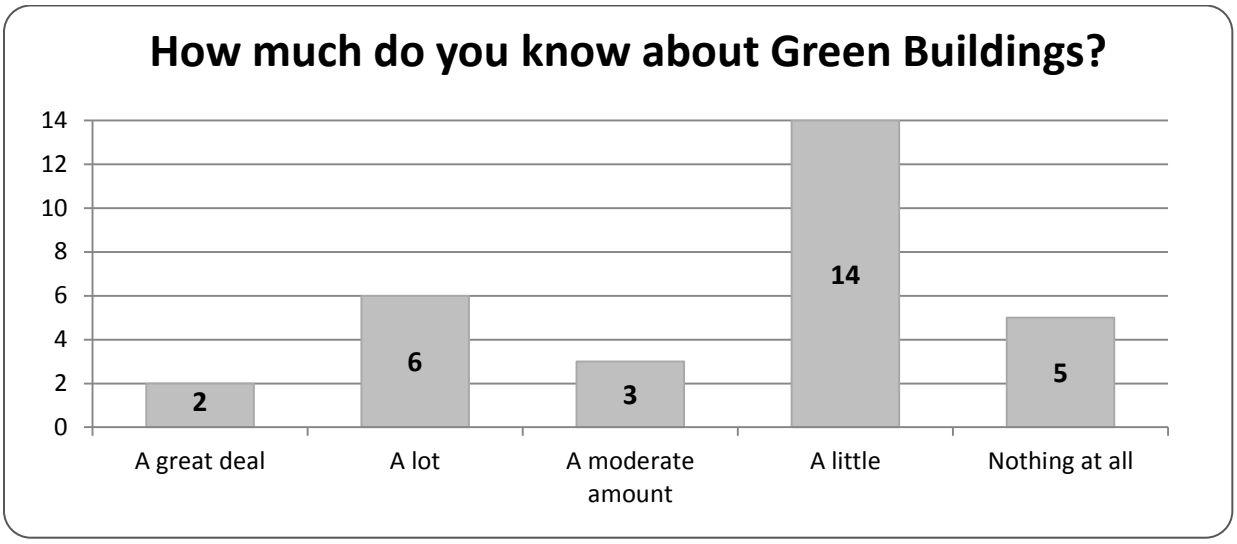


Figure 23 : Respondents knowledge on green buildings

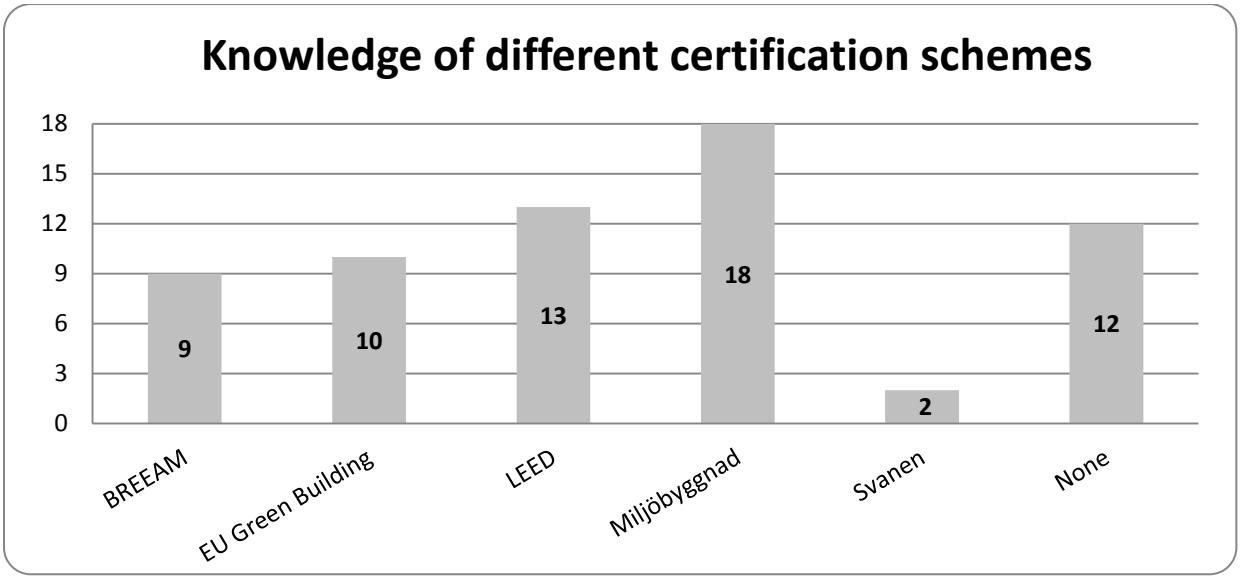


Figure 24: Respondents knowledge on certifications

Out of the 30 respondents, 12 of them did not hear about any Green Building certification schemes. The 18 others all heard about Miljöbyggnad. 13 of them heard about LEED, 10 about EU Green Building, 9 about BREEAM and 2 about Svanen[16].

When it comes to their knowledge of LEED, 17 respondents answered knowing nothing about it. 4 consider knowing a lot (three of them answered knowing a lot about Green Buildings), and one considers knowing a great amount on LEED. The 8 other respondent consider knowing a little (5 of them) or a moderate amount (3 of them) on LEED.

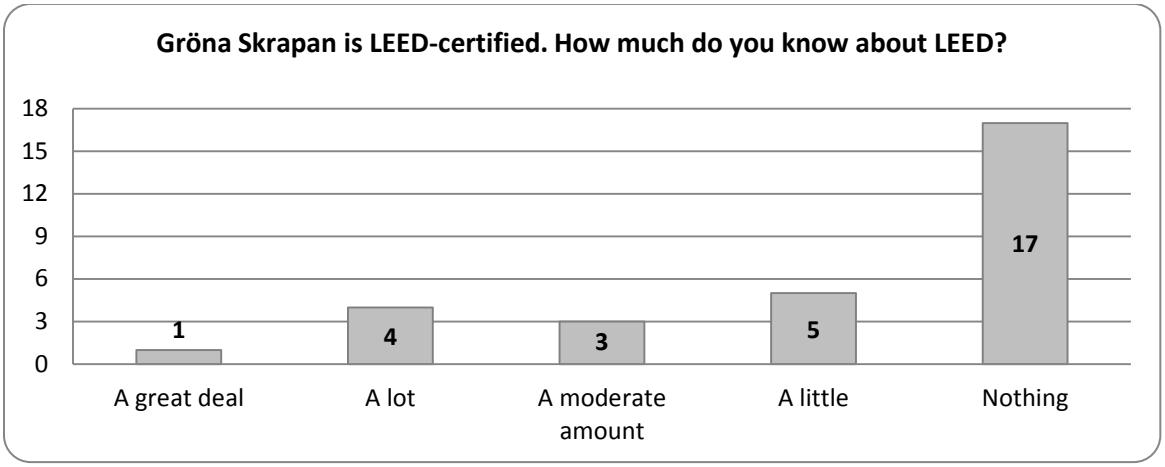


Figure 25: Respondents' knowledge on LEED

3.2. Users' frequency of use

The figure 25 displays the mean value for each user's frequency of use (UA) indicator surveyed. As explained in the methodology part of this section, the colour code on the diagram is as follow: red (resp. orange and green) for mean value between 1.00-2.33 (resp. 2.33-3.67 and 3.67-5.00). The aim of such a colour code is to quickly show the overall results of the survey. For example, in figure 26, each red indicator got a mean result between 1 and 2.33, meaning that the associated green building feature is not frequently used by the users. The same colour code holds for figure 27 and 28.

The answers of the respondents on their frequency of use of the different technologies or solutions towards sustainability are the ones which were analysed the most in detail, since it is not enough to focus only on the average answers to get a good overview of the habits of the users. Indeed, for e.g. the cycling habits, it is interesting to have an idea of the number of persons cycling every day.

[16] Svanen ('swan' in Swedish): The Nordic Ecolabel – or Nordic Swan – is the official Ecolabel of the Nordic countries. Established in 1989 by the Nordic Council of Ministers, its purpose is to provide a voluntary labelling scheme contributing to a sustainable consumption. (http://www.nordic-ecolabel.org/about/)

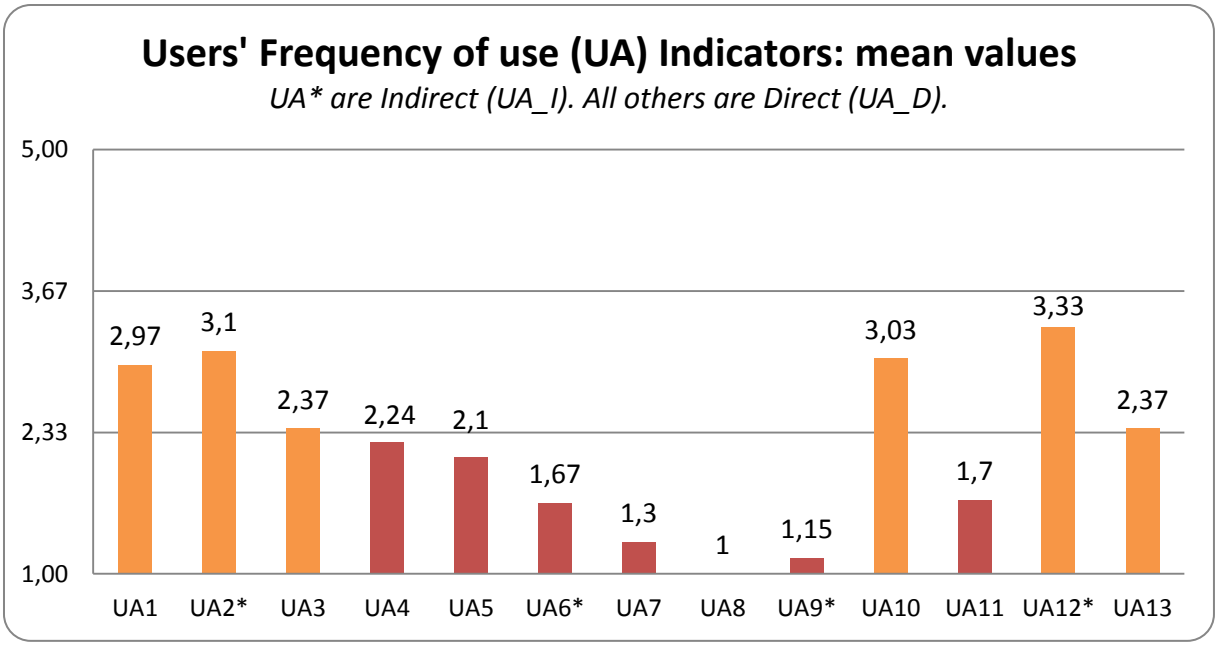


Figure 26 : Users' frequency of use indicators: results

Table 14 Users frequency of use (UA) indicators and their corresponding green building elements. UA* are indirect indicators of the frequency of use of the green building element in focus.

UA	Green Building element	UA	Green Building element
UA1	Public transport	**UA8**	Electric vehicle recharging station
UA2*	Public transport	**UA9***	Electric vehicle recharging station
UA3	Cycling	**UA10**	Conference facilities in offices
UA4	Means to secure bikes	**UA11**	Building's conference facilities
UA5	Change/shower facilities	**UA12***	Site located in a developed area
UA6*	Size of the parking lot	**UA13**	Recycling area
UA7	Carpool		

Public transport

UA1 and UA2 are related to the use of public transport, respectively frequency of use and influence of the distance to public transport on the habits of the user. 23% of the respondents use public transport every day. 40% use it very rarely, and 10% never use it. Two third of the respondents answered that their use of public transportation is influenced by the distance from the office to the tram or bus stop.

Cycling habits

For UA3 on cycling habits, 19 respondents never or rarely bike to work. Only 4 respondents out of 30 bike more to work every day. When it comes to the use of the means for securing bicycles in and around Gröna Skrapan (UA4), the answers of the respondents with the previous answers on their biking habits: the average frequency of use corresponds to Very Rarely – More than twice a month. The Change/Shower facilities (UA5) are never or very rarely used by 21 respondents. Only 2 of them use it every day. 3 of them use it more twice a week.

Car driving habits

The size of the parking lot does not seem to influence the driving habits of the respondents (UA6). Indeed, only 2 of them answered "to a large extent", while 21

answered “not at all”. 7 others answered “to little extent” or “to some extent”. The average influence is thus quite low, with a value of 1.67. When it comes to the frequency of use of the carpool (UA7), out of 30 respondents, 25 never use the carpool, and 2 use it very rarely. Only 3 respondents use it on a regular basis: 2 more than twice a month and 1 more than twice a week. The rating average of carpool frequency of use is thus of 1.30: the carpool is overall never or very rarely used. The electric vehicle recharging stations have never been used by any of the respondents (UA8). The fact that these charging stations exist in the building do not seem to affect the electric car use of the respondents (UA9): 25 answered to not be influenced at all by the existence of these stations, while 2 answered “to some extent” and 3 skipped the question. The average answer is of 1.15, which ranges between “Not at all” to “little extent”.

Video conferencing facilities

Video conferencing facilities are available in Gröna Skrapan, as well as in most company offices. While tenants seem to use their company’s video conferencing rooms, they do not seem to use the ones from Gröna Skrapan. Indeed, the rating average for the companies’ conference rooms (UA10) is of 3.03 against 1,70 for Gröna Skrapan’s (UA 11). Half of the respondents never used Gröna Skrapan conference rooms, and the other 15 use it “very rarely” or “now and then”. 2 respondents use their office’s conference room every day, and 6 of them use it more than twice a week. 16 use it “now and then”. Only 6 respondents use it “very rarely” or “never”.

Site located in a developed area

The location of the area seems, to some extent, to influence the regular day of the respondents (UA12). 14 respondents answered to be influenced by the site location, 10 to some extent and 6 to a little extent or not at all.

Recycling area

With an average of 2.37, the respondents seem to not use the recycling area (US13) that much: 16 of them use it never or very rarely, while 6 use it more than twice a month, 4 more than twice a week and only one respondent out of 30 use it every day.

3.3. Users’ Satisfaction

The users’ satisfaction (US) varies between the technologies and solutions asked about, as shows the figure 26. Many comments were raised on the satisfaction indicators by the respondents.

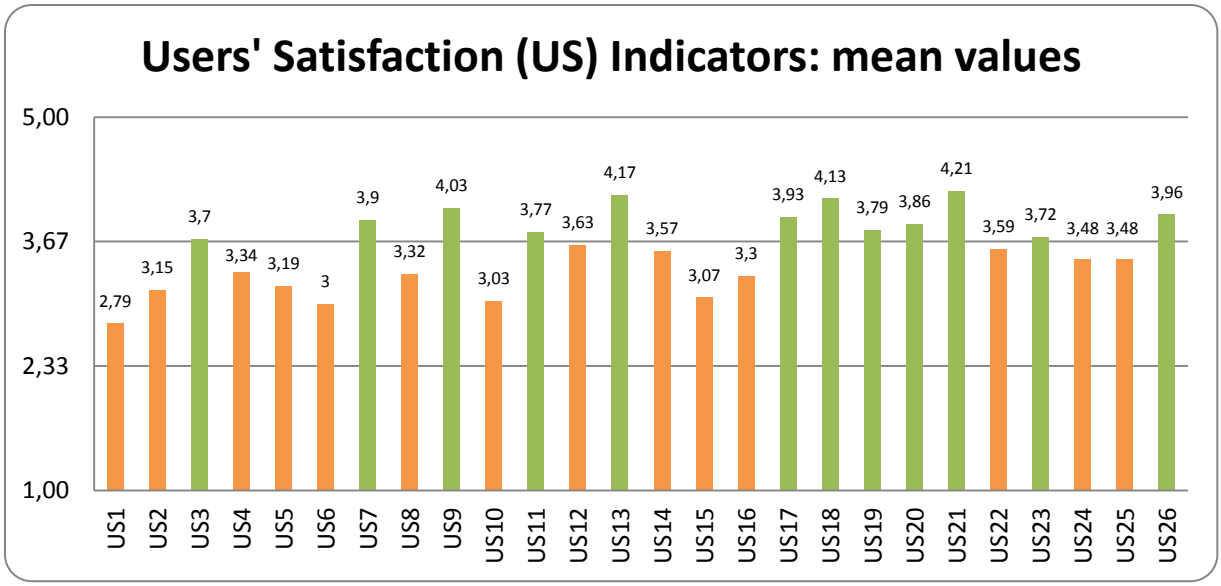


Figure 27 Users' satisfaction indicators: results

Table 15 Users' satisfaction indicators and their corresponding green building elements.

US	Green Building element	US	Green Building element
US1	Public transport	**US14**	Amount and quality of fresh air
US2	Means to secure bikes	**US15**	Ability to control comfort conditions
US3	Change/shower facilities	**US16**	Thermal comfort
US4	Size of the parking lot	**US17**	Access to daylight
US5	Carpool	**US18**	Line of sight to vision glazing
US6	Electric vehicle recharging station	**US19**	Light sensors
US7	Conference facilities in offices	**US20**	Insulation
US8	Conference facilities of the building	**US21**	Windows with integrated sunshade
US9	Site located in a developed area	**US22**	Ventilation and heat recovery system
US10	Amount of vegetation	**US23**	Energy management system
US11	Low flow taps & toilets	**US24**	No window handles
US12	Adapted plant species on the roof	**US25**	Recycling area
US13	No exposure to tobacco smoke	**US26**	Regionally manufactured material

Public transport

Almost half of the respondents are dissatisfied with the distance from their office to the public transport facilities (US1), while a third are satisfied. As seen with the UA indicators before, many respondents answered to be influenced by such a distance, which can explain why only 23% of the buildings' users use public transport every day. This question raised many comments from the respondents:

"There is no bus close to the office that can get you to the Central Station"
"Could be closer to nearest stop."
"A bus from Korsvägen to Gårda would be great"
"There are no buses in Gårda. Closest is Ullevi Södra with a 7 min walk."
"The only bus was revoked by Västtrafik - heaven knows what they think!"
"Over 1 km to my nearest bus stop"

Cycling

When it comes to the mean for securing their bicycles (US2), the overall satisfaction of the respondents is of 3.15. 16 of them are neither satisfied nor dissatisfied. 3 are very

dissatisfied to dissatisfied, and 8 are satisfied. No respondent is very satisfied of the means. The respondents entered the following comments on the subject:

"My bike was stolen."
"I´m using the rental bikes "Styr & Ställ". Sometimes, in the mornings there aren´t enough free bike racks"
"A little bit too few..."
"Very crowded and I'm missing roof/weather protection"

14 of the respondents seem satisfied with the change and shower facilities of the building (US3). Only 2 of them are dissatisfied with it. However, since 21 of the respondents answered to never use these facilities, it can be suspected that many of them answered to be satisfied even though they do not use them. The following comments have been written on the subject:

"Don't know about them"
"Are there any?"
"Should be found on every floor."
"Shower in our office"

Driving habits

Almost half of the respondents are neither satisfied nor dissatisfied about the parking lots of the building (US4). 4 are dissatisfied, while 11 are satisfied or very satisfied. The average satisfaction on the parking lot is of 3.34, which is between "Neither satisfied nor dissatisfied" and "Satisfied". 2 respondents commented they are never using the parking lots, although they answered to rarely commute by bike or public transport to the office.
About the satisfaction with the carpool service (US5), 4 respondents skipped the question since they do not use it. Out of the 26 respondents, 22 answered being neither satisfied nor dissatisfied. The 4 other respondents, including the 3 using the carpool on a regular basis, are satisfied or very satisfied. The satisfaction average is of 3.19, meaning that respondents are neither satisfied nor dissatisfied. Regular users of the carpool are however satisfied with it.
As seen for the use of electric vehicle recharging stations (US6), none of the respondent uses it. When asked about their satisfaction with such stations, 5 respondents skipped the question, and, logically, the 25 others answered being neither satisfied nor dissatisfied of the charging stations. This means that the quality of the recharging station is not the issue for its lack of use. Respondents seem to not own such an electric car, as their comments tend to prove:

"Haven't used it"
"Don't have such a vehicle"
"Never used"

Satisfaction

Respondents seem to be satisfied with their company's conference rooms (US7), with a rating average of 3.90. The rating average of their satisfaction with Gröna Skrapan's conference room (US8) is of 3.32, which means they are neither satisfied nor dissatisfied. Such a result makes sense since the building's conference rooms are rarely used (the frequency of use indicator value is of 1.7 on this subject).

Location of the site

The respondents are satisfied with the location of the site, although one respondent entered the following comment:

> *"Not so many shops around here- sometimes I miss the possibility to do errands during lunch break"*

On average anyway, the US9 value is of 4.03, which rates the building location between very satisfying and very satisfying.

The users are not too satisfied with the amount of vegetation on the site (US10): this indicator got the second lowest value, with 3.03.

Environmental Indoor Quality

The respondents seem satisfied with their non-exposure to tobacco smoke (US13). Indeed, 23 of the 29 respondents answered to be satisfied, while only 2 answered to be dissatisfied. Only one comment was raised on the issue:

> *"Every morning when I arrive there are smokers standing at the corner of the building (facing Gårda Torget) – that´s the first I see – not satisfying"*

When it comes to the amount and quality of fresh air (US14) however, respondents are not highly satisfied. While 19 of them answered to be satisfied, 6 of them said to be dissatisfied, and the following comment was raised:

> *"We have problems with the air change"*

The user's thermal comfort indicator (US16) average value of 3.3 seems to show that this issue is not entirely satisfying for the users. 8 respondents answered to be unsatisfied, 15 satisfied, and 7 neither. Two comments were raised:

> *"Cold in winter time"*
> *"Cold office area during the whole year"*

One of the lowest user's satisfaction indicator values is for the ability to control comfort conditions (US15). With a value of 3.07, the respondents do not seem to be too satisfied.

Energy management system

Respondents seem satisfied with the energy management in Gröna Skrapan (US23). 23 of the respondents indeed answered to be satisfied, while 2 answered to be dissatisfied and 4 answered neither. However, one respondent commented about the information available on such energy management system:

> *"Have no information about it"*

Absence of window handles

The absence of windows handle in Gröna Skrapan (US24) does not seem to be highly satisfactory neither for the building's users. While 18 of the respondents answered to be satisfied of it, 5 answered the contrary, and 6 of them were neither satisfied nor dissatisfied. One comment was written:

> *"We bought one of our own."*

Recycling area

Surprisingly, the areas for recycling are not completely satisfying (US25). With an average value of 3.48, 12 respondents are neither satisfied nor dissatisfied, 2 of them are dissatisfied, and 13 of them are satisfied. The comments on this subject are as follow:

"No recycling at all in the office!"
"Didn't know there was one..."

3.4. Users' Need

The Users' Needs (UN) Indicators values are difficult to analyse in depth. Indeed, all the questions concerned specific technologies. However, since the questions were simplified as much as possible, it can be drawn from the figure 28 that the respondents see all the specified solutions and technologies as important, except from UN1 and UN3, concerning respectively the location of the parking underground, and the green roof.

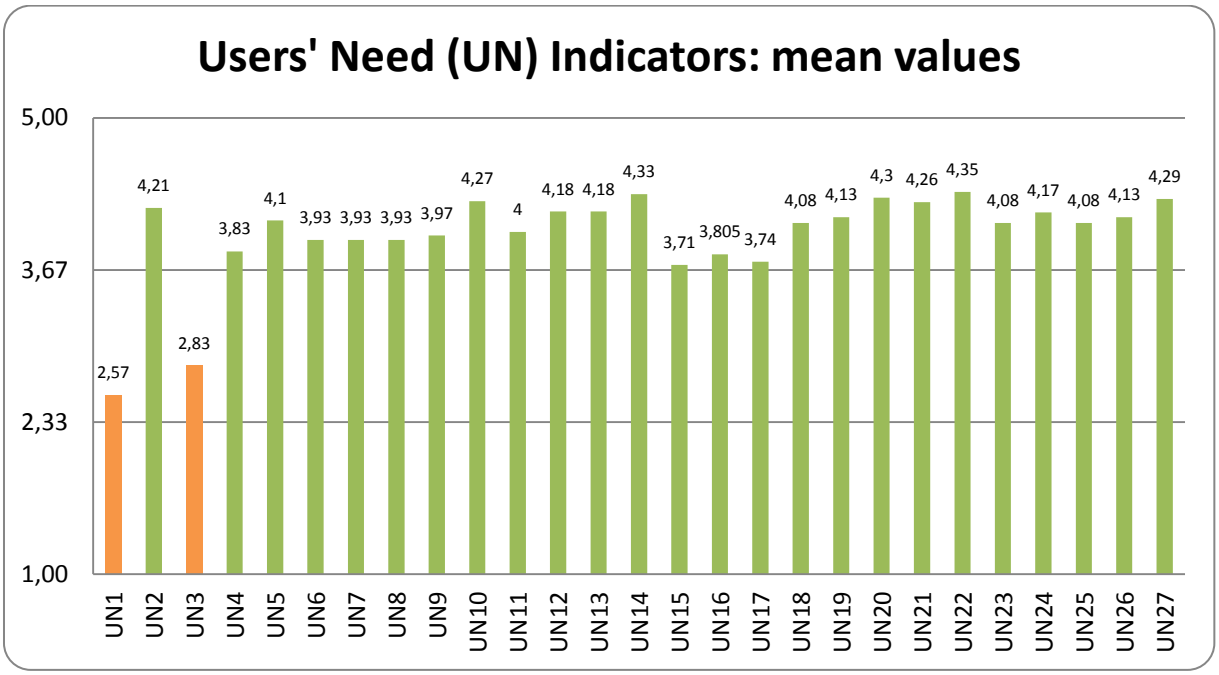


Figure 28: Users' Need Indicators: results

Parking lot located underground

The parking lots of Gröna Skrapan are underground (UN1), concordant with the credit SSc7.1 on Heat Island Effect. 7 respondents consider important the parking lots are underground. The other 23 answered from "very unimportant" to "neither". The average rating on this subject is of 2.57, which places this UN indicator as the less important one in the respondents' opinion.

Green Roof

Out of 29 respondents, 11 consider important that the roof is vegetated (UN 3). 11 consider it as unimportant. 7 answered "neither important nor unimportant". With a value of 2.83, this UN indicator is the second less important one for the respondents.

4. Analysis

The survey results have been analysed through an adapted AttrakDiff evaluation method, in order to analyse the relationships between green building elements and frequency of use, satisfaction and need, and to spot which building attributes are not frequently used or do not meet the users' satisfaction or need.

In the following figures (figures 29, 30 and 31), the numbers displayed on the AttrakDiff visualizations are linked to the indicator numbers. For example, in figure 29 (resp. 30 and 31), the number 4 stands for UA4 (resp. US 4 and UN 4).

4.1. Relationship between green building attributes and frequency of use

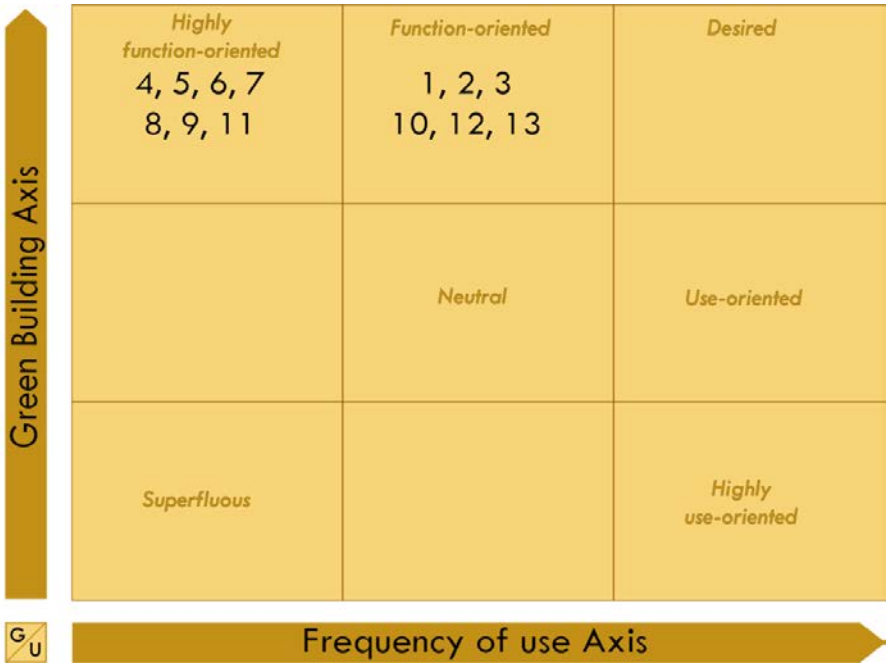


Figure 29 : AttrakDiff visualization of the relationship between green building attributes and frequency of use

None of the frequency of use of the studied green building attributes is high, which means that none of them are, in average, used more than twice a week. All of these attributes, however, have been implemented for both houses of the building. Apart from the conference rooms (US 10 and US 11), all of these attributes were rewarded by LEED.

The figure 29 shows that, among other elements, the carpool (UA7), the electric recharging stations (UA8) are very rarely or never used: they belong to the "Highly function-oriented" category. It could be argued that the presence of electric vehicle recharging stations could serve as an incentive for building's users to buy or use electric vehicles, but UA9 relative to such a possible influence is also categorized in the "highly-function oriented" category: electric vehicle recharging stations do not have any influence on the building's users driving habits. Neither do the size of the parking lot (UA6).

Although LEED rewards such green building elements, they do not seem to be very useful for the users, and thus for the building.

The building's conference facilities (UA11), not asked by LEED but communicated on by Skanska, are almost never used as well, since all companies have their own conference facilities. These rentable building's conference facilities are thus unnecessary in a mixed-tenants office building, and such an area could be used for other purposes.

The public transport infrastructures around the building (UA1), the location of the site in a developed area (UA12) and the recycling area (UA13) are green building elements that were awarded by LEED. Although they can be found in and around both houses, and thus are high on the green building axis, such features are moderately used by the users. They are thus categorized as "function-oriented" elements, together with the UA2 on the influence of the public transport infrastructure on commuting habits of the users. Indeed, these infrastructures influence only moderately the users, which means that even if the bus or tram stop were closer to the building, it is not sure that much more people would use public transport.

Although none of the elements studied in the frequency-of-use part of the survey are categorized as "Desired", it is important to point out that none of them are "superfluous" neither. To become desired, these elements should be used more frequently by the users. This could only happen by a change in the users' habits, whether through a societal change when it comes to carpool and electric vehicle station, whether through more informations on the building's feature.

Indeed, one very surprising element that, in Sweden, would have been suspected to belong to the desired category is the recycling area. Recycling is clearly part of the Swedish habits, but nonetheless the recycling area is only moderately being used. A comment such as "Didn't know there was one..." shows that users lack of knowledge on some important and easy to use building's features. The fact that offices do not recycle – "No recycling at all in the office!" is surprising as well.

4.2. Relationship between green building attribute and users' satisfaction

As can be seen in figure 30 below, ten indicators belong to the desired category. These are change/shower facilities (US3), conference facilities in offices (US7), site located in a developed area (US9), no exposure to tobacco smoke (US13), line of sight to vision glazing (US18), technologies aiming to reduce energy use such as light sensors (US19), insulation (US20) and windows with integrated sunshade (US21), energy management system of the building (US23), and finally regionally manufactured material (US26). These are green building elements that are both implemented in the buildings and accredited by LEEDS, and very satisfactory for users. Thus, such elements do not need to be improved or changed.

The features categorized in the 'function-oriented' category have been implemented in Gröna Skrapan and accredited by LEED, but are not fully satisfying for users. Some

elements have been rated as moderately satisfactory because they are not being used, e.g. carpool, electric vehicle recharging stations or building's conference facilities.

Figure 30 : AttrakDiff visualization of the relationship between green building attributes and users' satisfaction

Other elements are at least moderately being used or are part of the users' daily life, and their categorization in 'function-oriented' is thus meaningful. Used elements are the ones related to public transport, the means to secure bikes, the recycling areas. Daily elements are the amount and quality of fresh air, the ability to control comfort conditions, users' thermal comfort, and the absence of windows handles. Such elements are 'function-oriented', and could be improved to reach the 'desired' category.

The amount of vegetation belongs in the 'neutral' category: it is neither function-oriented nor satisfaction-oriented. Indeed, the credit related to the amount of vegetation has only been rewarded by LEED to one of the two houses of Gröna Skrapan. There is vegetation around and on (green roof) Gröna Skrapan, but to reach the 'desired' category, the amount should be increased, which would probably improve the users' satisfaction with the building's green area.

Low flow taps and toilets, together with access to daylight, are satisfaction-oriented on the diagram. They have been implemented in one house only, but are very satisfying for users. By implementing them in both houses, these indicators would reach the desired status.

4.3. Relationship between green building attribute and users' needs

Most of the need-indicators are classified as desired, meaning that they are recognized by users as critical for the building's green performance. Some of these indicators are: location of the site in a developed area (UN2), 2-years contract for renewable energy (UN23), permanent entry systems that captures hazardous chemicals (UN5), reduction

of contaminant by treatment systems (UN19), implementation of fundamental best practice commissioning procedures (UN27)…

Figure 31 : AttrakDiff visualization of the relationship between green building attributes and users' needs

When it comes to toxic compounds, most of the issues are categorized as 'desired' as well: Limited amount of VOC in adhesives (UN6), no CFC-based refrigerants (UN20), and no HCFC's or H alones (UN21). The only indicators not categorized as such are UN7 (Limited amount of VOC in Paint and coatings), UN8 (Limited amount of VOC in Carpets and rugs) and UN9 (No urea formaldehyde in wooden products): since Gröna Skrapan project team could not prove the USGBC that the amounts were below the limit set by LEED, the corresponding credits were not awarded. However, if these amounts are actually under the limits, UN7 UN 8 and UN9 could be categorized as desired as well. Since it is impossible to actually verify the information, these three indicators were left in the 'highly-need oriented category'.

Eight indicators have been categorized under 'highly-need oriented'. Except from the three concerning toxic compounds, these indicators are related to the following green building elements: reused material from other projects (UN11) recycled content of material (UN12), 50% of wood environmentally certified (UN13), on-site renewable energies (UN24), tenant sub-metering of energy and water consumption (UN25). Although recognized as critical by the building's users, such elements have not been implemented at all in Gröna Skrapan.

Since the waste from construction has been recycled or salvaged in one of the two houses, this indicator has been classified under the 'need-oriented' category, since it is perceived by the users as a critical element of a green building. As seen in subchapter 2.5.2, it is unclear whether or not almost all waste from construction has actually been

managed, since the Sustainability Case Study on Gröna Skrapan asserts that construction waste has been managed very efficiently.

Finally, the indicators relative to the location of the parking lot underground and the green roof are considered as moderately important by the users. These two elements, which were implemented for both houses, are thus categorised under 'function oriented'. As seen in the former chapters, these two elements are very interesting when it comes to green building: parking underground brings more burden than benefits to the environment, and the green roof is one of the flagship sustainable elements of Gröna Skrapan.

4.4. Summary of the analysis of the UX-survey

Many satisfaction-indicators and need-indicators are classified under desired. However, the following main issues have been found for Gröna Skrapan, from the UX survey:

- The carpool and electric vehicle recharging stations are very rarely or never used and do not influence the building's users driving habits. A societal change is needed to increase the use of this elements.
- Public transport infrastructures influence only moderately the users commuting habits.
- The rentable building's conference facilities seem unnecessary in a mixed-tenants office building, and such an area could be used for other purposes.
- Users lack of knowledge on some important and easy to use building's features – for example recycling areas. There should be more informations on the building's features.
- Daily-dealt-with elements such as amount and quality of fresh air, the ability to control comfort conditions, users' thermal comfort, and the absence of windows handles could be improved.
- The amount of vegetation on and around the building could be increased.
- The actual VOC content in Paint and coatings, carpet and rugs and the formaldehyde content in wooden are unclear and thus difficult to analyse.
- The construction waste management is unclear as well.
- Many Material & Resources credits have been skipped by Gröna Skrapan project leader, but are recognized as critical by the building's users. The same holds for on-site renewable energies and tenant sub-metering of consumption.
- The location of the parking lot underground, which bring more burden than benefit to the environment, is considered as moderately important by the users.
- The green roof, sustainability flagship element of Gröna Skrapan, is also considered moderately important only by the users. Some of them did not even seem to know it exists, showing again a lack of knowledge of the users on the building.

Section 5

Discussion & Conclusion

The present study has investigated the use of LEED Green Building Rating System by Skanska in Sweden. Through a study of the building, of its score in LEED, through interviews with professionals and through a comparison with a similar building, several outcomes have been found. This section aims at pointing out some uncertainties in the study, before summarising the conclusions from the whole report and some possible improvements that could be made by the construction sector as well as by when it comes to certifying building on an environmental and/or sustainable perspective.

Uncertainties in the study

This research has mainly been based on empirical findings from interviews, a questionnaire and literature reviews, and focused on one building. Gröna Skrapan is already some years old, and the construction industry changes rapidly. Some specific findings might be out of date, but the overall comparative discussion stays accurate enough.

The certification systems are also in constant evolution. LEED v4, for example, has included regional priorities, although optional. USGBC seems to understand the critiques rose against LEED, and might change their certification system even more.

One interesting subject that could not be studied in depth because of the lack of accessible information is the contribution of the Gothenburg's district heating system to the number of credits rewarded to Gröna Skrapan.

However, the present study highlighted many problems linked to the use of LEED in Sweden. The case study of Gröna Skrapan pictured many of these problems, and linked such a use of LEED to Skanska mind-set when it comes to sustainability as a whole, but also to their communication on sustainability.

Conclusions from the study

Section 1, 2 and 3 showed that Gröna Skrapan is a good building when compared to the average new office building in e.g. the US, but is not as astonishing when compared to the average new office building in Sweden. The comparison with Ullevigatan 17-19 showed that many of the technologies and solutions toward sustainability implemented in Gröna Skrapan are not as incredible as they seem to be while reading the building's press releases, the sustainability case study or while watching the building's introductive video. It is clear that Sweden's level on sustainable building knowledge is high, and Skanska uses such a fact to feed its sustainable branding.

The use of LEED Rating Building system as a certification system is not the best choice, and it seems that Skanska only chose LEED because the company's branch in the US uses it as well. LEED lacks of focus on regional issues, and their use of US dollar-based indicators on energy reduction or material content does not make much sense from a sustainable perspective. Credits from LEED are based on the US culture, such as the lack of public transport or the use of urea-formaldehyde in refrigerant systems. Rewarding such credits to a Swedish project is free points. Together with other low-hanging fruits

credits, the LEED certification in Sweden is easy to get, and the Platinum level only require some minor modifications of the basic design.

As seen in the report, such a Platinum level is the maximum level of LEED, but can be compared to a 'Very Good' level in BREEAM. Such a comparison holds when Ullevigatan 17-19 is compared to Gröna Skrapan: the two buildings are very similar in energy efficiency, technologies and location.

Another main finding of this research is the environmental certification-driven status of the building industry in Sweden. Society is increasingly focused on sustainable development, companies thus will to have their office in a green building. To please their tenants, owners ask developers to certify their buildings. Developers have no other choice than certifying their building to be able to sell it on the market. Two problems are arising from this chain reaction.

Firstly, developers and their project teams become point mongering, and focus more on getting credits than on their environmental values. Such behaviour explains why Skanska decided to build Gröna Skrapan's parking lots underground, even though it is a clear environmental burden. It also explains why Skanska implemented electric vehicle recharging stations while it is not being used, and does not create any incentive for using such vehicle. As analysed before in the report, electric vehicle will be used only if a societal change happens, and when it happens, implementing such recharging stations is not too much of a hassle and could be done easily by developers. Instead, Skanska implemented such stations, and used it as a communication argument for their sustainable work.

Secondly, tenants see green building as a good way to give their company a sustainable profile. Such rebound effect is clearly not what was intended when green building certification systems were launched.

Possible improvements in the construction industry

The construction industry is increasingly driven by certification schemes. The question is: is such a driver for the construction industry a good thing? Green building certification systems are expensive and time-consuming, and such money and time could be spent on actual pertinent environmental work. Since the construction industry is accountable for 40% of energy consumption, it is clear that a driver toward sustainability is needed. The fact that building's owners want their property to be environmentally friendly is clearly positive. Governments and industries need to find a way to ensure owners, tenants, and society as a whole that sustainability is a main focus while designing, constructing and operating a building. Nowadays, the amount of money and time spent on proving such a focus on sustainability is a big issue, and even more problematic when the certificate becomes so famous that it ends up being the main aim of a project team, regardless of inconsistencies between the scheme requirements and the country-specific issues.

It is understandable that Swedish developers use LEED, BREEAM or other main environmental certification schemes, since their final goal is to sell their construction. Environmental certification schemes will be used for some more time in the close future. Skanska should clearly think about switching to the BREEAM certification if they wish to stay the leader in the Swedish construction industry and to be leader in sustainable development, as they state in their goals (Skanska, 2014). The use of the LEED certification in Sweden is not the optimal choice, and the fuzz made by the company about being certified LEED Platinum is not consistent with the actual signification of such a level of certification. A BREEAM outstanding building would be a better goal to aim. Even though LEED upgrades its versions to include a better weighting of credits or regional issues, the base of the scheme is still clearly focused on USA legislation and habits.

Especially now that the SGBC has launched BREEAM SE, LEED may become less and less trustworthy in Sweden. BREEAM SE is adapted to Swedish legislation, and low-hanging fruits or free-credits will no longer be an issue. Hopefully, the SGBC will also focus on implementing mandatory follow-ups.

The Swedish construction industry needs to switch its focus back on actual efficient sustainable work: environmental certification schemes should be a tool, not a goal.

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Annex

Annex 1 – Related to Section 1 ..... b

Annex 1.A: Lexical study of Skanska Sustainability Case 82, and frequency of spotted words ..... b

Annex 1.B: Total number of words, of primary words, of common words, and of spotted words c

Annex 1.C: Share of spotted words depending on which words are considered in the text: all the words or only the primary words c

Annex 2 – Related to Section 2 ..... d

Annex 2.A: Concept plan of Gröna Skrapan, floor 4 – Furnishing example (adapted from the plans available on Skanska.se) ..... d

Annex 2.B: Scorecard LEED v2.0 Core & Shell for Gröna Skrapan –Houses A & B ..... e

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Annex 4.A: User Experience survey – questions and summary of results ..... h

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Annex 1

Annex 1.A: Lexical study of Skanska Sustainability Case 82, and frequency of spotted words

Annex 1 - Table 1

Verbs		Nouns		Adjectives		Superlatives		Actors	
use	14	energy	15	green	10	more	4	Skanska	16
reduce	8	waste	7	environmental	9	first	3	Tenants	10
provide	7	leed	5	sustainable	7	good	2	**Subtotal**	**26**
promote	6	management	5	efficient	5	high	2		
contribute	5	system	4	healthy	4	highest	1		
employ	4	savings	4	responsible	3	most	1		
meet	4	impact	4	flexible	3	latest	1		
avoid	3	certification	3	available	3	well	1		
encourage	3	need	3	renewable	3	**Subtotal**	**15**		
ensure	3	strategies	3	opportunity	2				
save	3	involvement	3	certified	2				
achieve	2	standards	3	quality	1				
allow	2	efficiency	3	properly	1				
become	2	precertification	2	distinctive	1				
help	2	platinum	2	social	1				
incorporate	2	solution	2	economic	1				
involve	2	practice	2	useful	1				
minimize	2	objective	2	large	1				
offers	2	emission	2	**Subtotal**	**59**				
accommodate	1	landmark	1						
calculate	1	aim	1						
clean	1	**Subtotal**	**76**						
clean up	1								
comply	1								
conduct	1								
construct	1								
facilitate	1								
guide	1								
maintain	1								
optimize	1								
seek	1								
Subtotal	**88**							**Total**	**264**

Annex 1.B: Total number of words, of primary words, of common words, and of spotted words.

Annex 1 - Table 2

Total of words	**1529**
Primary words	975
Common words	554
Spotted words	264

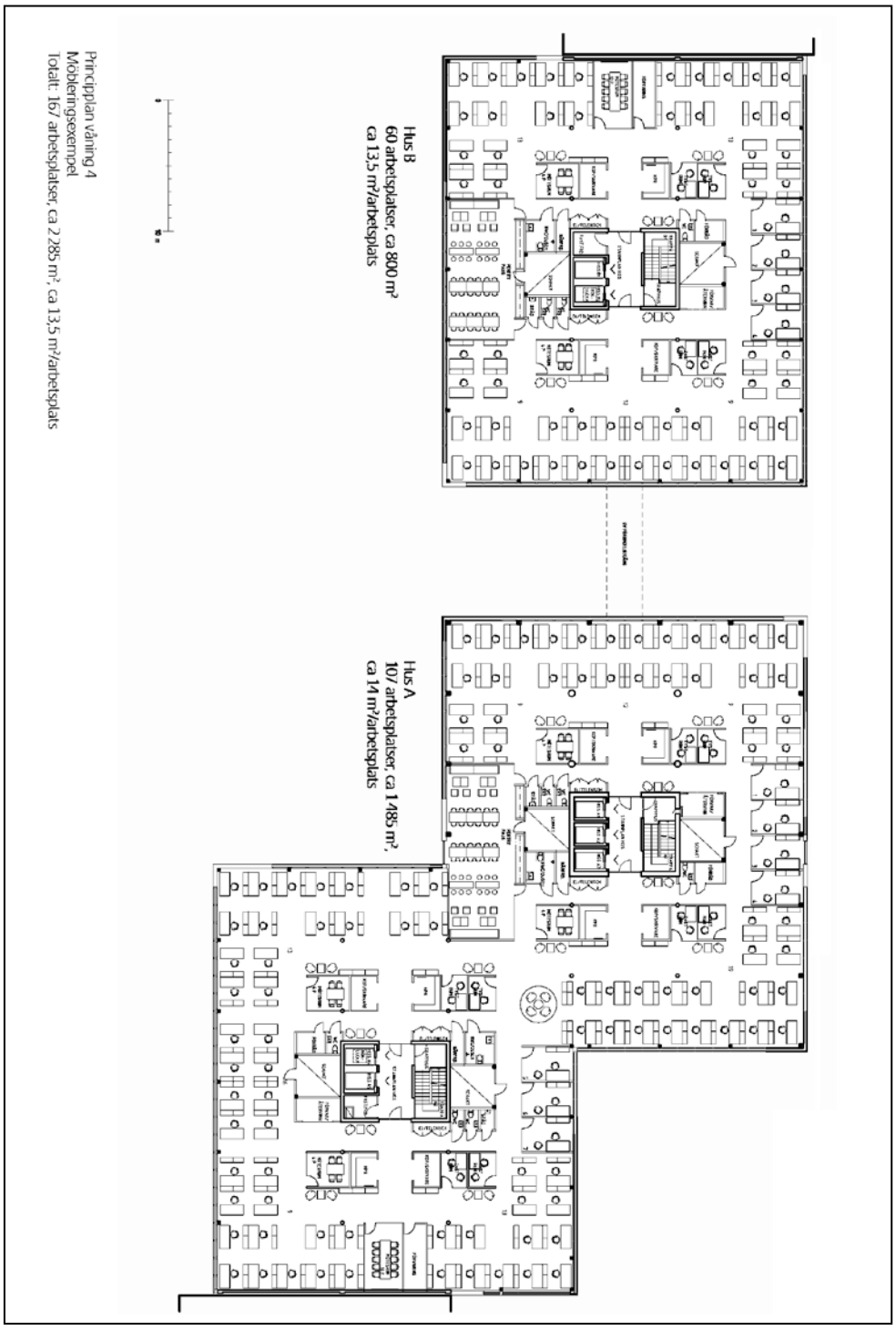
Annex 1.C: Share of spotted words depending on which words are considered in the text: all the words or only the primary words

Annex 1 - Table 3

Share of spotted words (%)		**Total in the text 1529 words**	**Primary words 975**	**Common words 554**
Spotted words	264	17,3 %	27,1%	-

Annex 2

Annex 2.A: Concept plan of Gröna Skrapan, floor 4 – Furnishing example (adapted from the plans available on Skanska.se)



Annex 2.B: Scorecard LEED v2.0 Core & Shell for Gröna Skrapan –Houses A & B

SUSTAINABLE SITES (15 AVAILABLE POINTS)

Credit	Description	Available points	House A	House B
SSp1	Construction activity pollution prevention	Required	✓	✓
SSc1	Site Selection	1	1	1
SSc2	Development density and community connectivity	1	1	1
SSc3	Brownfield redevelopment	1	1	1
SSc4.1	Alternative transportation - public transportation access	1	1	1
SSc4.2	Alternative transportation - bicycle storage and changing rooms	1	1	1
SSc4.3	Alternative transportation - low emitting and fuel efficient vehicles	1	1	1
SSc4.4	Alternative transportation - parking capacity	1	1	1
SSc5.1	Site development - protect or restore habitat	1	1	0
SSc5.2	Site development - maximize open space	1	1	1
SSc6.1	Storm water design - quantity control	1	1	1
SSc6.2	Storm water design - quality control	1	1	1
SSc7.1	Heat island effect - non-roof	1	1	1
SSc7.2	Heat island effect - roof	1	1	1
SSc8	Light pollution reduction	1	0	0
SSc9	Tenant design and construction guidelines	1	0	0

WATER EFFICIENCY (5 AVAILABLE POINTS)

Credit	Description	Available points	House A	House B
WEc1.1	Water efficient landscaping - reduce by 50%	1	1	1
WEc1.2	Water efficient landscaping - no potable water use or no irrigation	1	1	1
WEc2	Innovative wastewater technologies	1	1	1
WEc3.1	Water use reduction - 20% reduction	1	1	1
WEc3.2	Water use reduction - 30% reduction	1	1	0

ENERGY & ATMOSPHERE (14 AVAILABLE POINTS)

Credit	Description	Available points	House A	House B
EAp1	Fundamental commissioning of the building energy systems	Required	✓	✓
EAp2	Minimum energy performance	Required	✓	✓
EAp3	Fundamental refrigerant management	Required	✓	✓
EAc1	Optimize energy performance	8	8	8
EAc2	On-site renewable energy	1	0	0
EAc3	Enhanced commissioning	1	1	1
EAc4	Enhanced refrigerant management	1	1	1
EAc5.1	Measurement and verification - base building	1	2	1
EAc5.2	Measurement and verification - tenant sub metering	1	0	0
EAc6	Green power	1	1	1

MATERIAL & RESOURCES (11 AVAILABLE POINTS)

Credit	Description	Available points	House A	House B
MRp1	Storage and collection of recyclables	Required	✓	✓
MRc1.1	Building reuse - maintain 25% of existing walls, floors and roof	1	0	0
MRc1.2	Building reuse - maintain 50% of existing walls, floors and roof	1	0	0
MRc1.3	Building reuse - maintain 75% of existing walls, floors and roof	1	0	0
MRc2.1	Construction waste management - divert 50% from disposal	1	1	1
MRc2.2	Construction waste management - divert 75% from disposal	1	0	1
MRc3	Materials reuse - 1%	1	0	0
MRc4.1	Recycled content - 10% (post-consumer + 1/2 pre-consumer)	1	0	0
MRc4.2	Recycled content - 20% (post-consumer + 1/2 pre-consumer)	1	0	0
MRc5.1	Regional materials - 10% extracted, processed and manufactured regionally	1	1	1
MRc5.2	Regional materials - 20% extracted, processed and manufactured regionally	1	1	1
MRc6	Certified wood	1	0	0

INDOOR ENVIRONMENTAL QUALITY (12 AVAILABLE POINTS)

Credit	Description	Available points	House A	House B
EQp1	Minimum IAQ Performance	Required	✓	✓
EQp2	Environmental Tobacco Smoke (ETS) control	Required	✓	✓
EQc1	Outdoor air delivery monitoring	1	1	1
EQc2	Increased ventilation	1	1	1
EQc3	Construction IAQ management plan - during construction	1	1	1
EQc4.1	Low-emitting materials - adhesives and sealants	1	2	2
EQc4.2	Low-emitting materials - paints and coatings	1	0	0
EQc4.3	Low-emitting materials - carpet systems	1	0	0
EQc4.4	Low-emitting materials - composite wood and agri-fiber products	1	0	0
EQc5	Indoor chemical and pollutant source control	1	1	0
EQc6	Controllability of systems - thermal comfort	1	1	1
EQc7	Thermal comfort - design	1	1	1
EQc8.1	Daylight and views - daylight 75% of spaces	1	1	0
EQc8.2	Daylight and views - views for 90% of spaces	1	1	1

INNOVATION (5 AVAILABLE POINTS)

Credit	Description	Available points	House A	House B
IDc1	Innovation in design	4	4	4
IDc2	LEED Accredited Professional	1	1	1

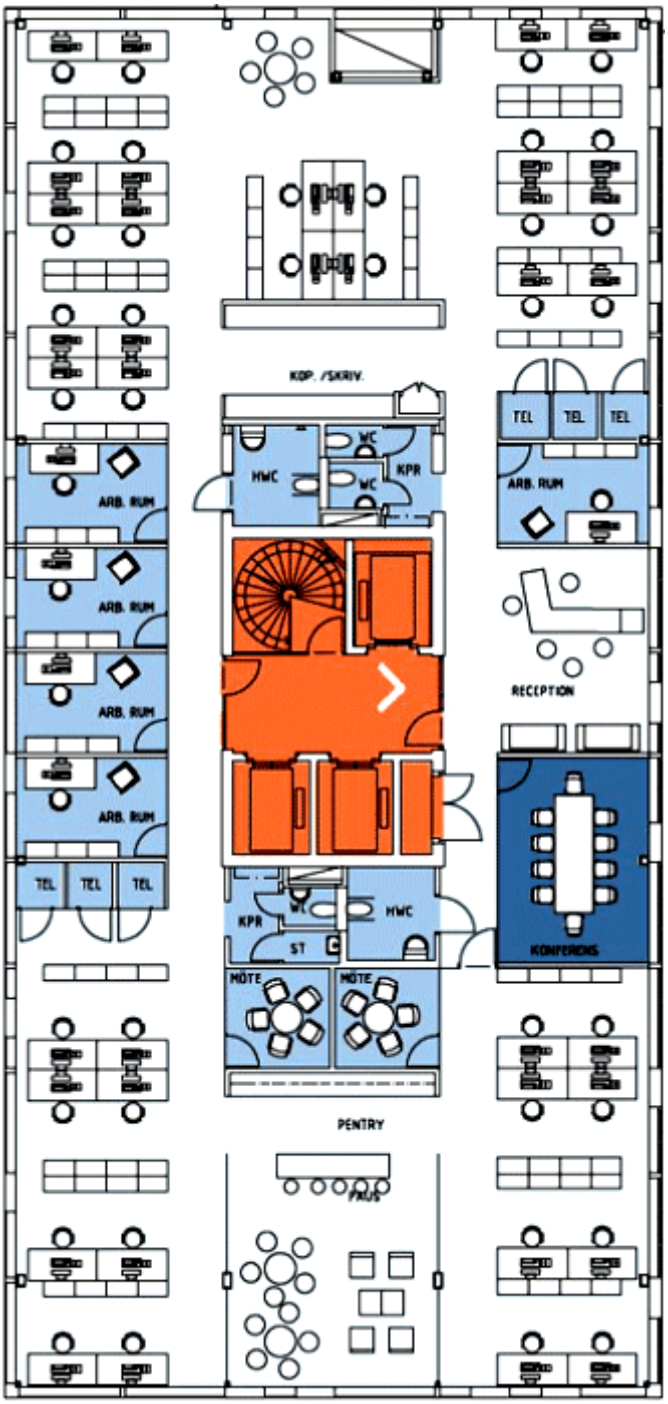
TOTAL (62 AVAILABLE POINTS)

House A: 49/62 - PLATINUM, AWARDED AUG 2011

House B: 45/62 - PLATINUM, AWARDED MAY 2012

Annex 3

Annex 3: Concept plan of Ullevigatan, floor 4 – Furnishing example (from NCC.se) – Total area = approx. 500m²



Annex 4

Annex 4.A: User Experience survey – questions and summary of results

Page 1: Presentation of the survey

"Hi! Thank you very much for your interest in this survey. It is designed to last less than 15 minutes. Click on "Next" to start! Best regards, and thank you again."

Page 2: Demographics

Q1: What is your gender?

Female	Male
9	21

Q2: What is your age?

18-24	25-34	35-44	45-54	55-64	65 or older
0	10	12	5	3	0

Q3: What is the highest level of school you have completed or the highest degree you have received?

Less than High School Degree	High School Degree	Some university but no degree	Associate Degree	Bachelor Degree	Master Degree	PhD
0	2	3	2	7	15	1

Q4: How long have you been working in the Gröna Skrapan (in months)?

Less than 2	2-6	6-12	12-24	More than 24
1	9	2	3	15

Q5: What is your job title?

Administrator
Business Architect
Business Intelligence Consultant
Category Manager Procurement
Controller
Coordinator
Director
District Purchasing Manager
Environmental Business Manager
Financial Accountant
Group Compensation & Benefits
HVAC Project Engineer
IT Consultant
IT Manager
Key Account Manager
Manager
Manager Project Development
Physiotherapist
Programmer
Project Engineer
Project Manager
Project Manager Sales
Sales
Sales Manager
Senior Account Manager
Senior Technical Consultant
System Developer
Transaction Manager
(Question skipped)

Page 3: Green Building Certification

Q6: How much do you know about Green Buildings?

Nothing at all	A little	A moderate amount	A lot	A great deal	**Rating Average**
5	14	3	6	2	**2,47**

Q7: What Green Building Certification Systems have you heard of?

BREEAM	CASBEE	DGNB	EU Green Building	HQE	LEED	Miljöbyggnad
9	0	1	10	1	13	18

Other (please specify): **CEEQUAL, Green Roads, Green Star, Svanen, Svanen**

Q8: Gröna Skrapan is LEED-certified. How much do you know about LEED?

Nothing at all	A little	A moderate amount	A lot	A great deal	**Rating Average**
17	5	3	4	1	**1,90**

Page 4: Transport

Q9: How frequently do you use public transport to commute to and from your office?

Never	Very rarely	More than twice a month	More than twice a week	Every day	**Rating Average**
3	12	5	3	7	**2,97**

Q10: How satisfied are you with the distance from your office to public transport?

Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied	**Rating Average**
4	10	5	8	2	**2,79**

Q11: To what extent does this distance influence your frequency of use of public transports?

Not at all	To little extent	To some extent	To a moderate extent	To a large extent	**Rating Average**
6	2	11	5	6	**3,10**

Q12: How frequently do you use a bicycle to commute to and from your office?

Never	Very rarely	More than twice a month	More than twice a week	Every day	**Rating Average**
12	7	3	4	4	**2,37**

Q13: How satisfied are you with the means for securing bicycles in and around Gröna Skrapan (bike racks' location, access, bike garage...)?

Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied	**Rating Average**
1	2	16	8	0	**3,15**

Q14: How frequently do you use the means for securing bicycle in or around Gröna Skrapan?

Never	Very rarely	More than twice a month	More than twice a week	Every day	**Rating Average**
12	8	3	2	4	**2,24**

Q15: How satisfied are you with the change/shower facilities of Gröna Skrapan?

Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied	**Rating Average**
1	1	11	6	8	**3,70**

Q16: How frequently do you use these change/shower facilities?

Never	Very rarely	More than twice a month	More than twice a week	Every day	**Rating Average**
13	8	4	3	2	**2,10**

Q17: How satisfied are you with the size of Gröna Skrapan's parking lot?

Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied	**Rating Average**
0	4	14	8	3	**3,34**

Q18: How much does the parking lot size influence your frequency of use of your car?

Not at all	To little extent	To some extent	To a moderate extent	To a large extent	**Rating Average**
21	2	5	0	2	**1,67**

Q19: How important is it for you that the parking lot is underground?

Very Unimportant	Somewhat Unimportant	Neither			**Rating Average**
7	7	9	6	1	**2,57**

Q20: Gröna Skrapan has a contract with the carpool "Sunfleet". How frequently do you use this carpool?

Never	Very rarely	More than twice a month	More than twice a week	Every day	**Rating Average**
25	2	2	1	0	**1,30**

Q21: How satisfied are you with the carpool (accessibility, parking spots, ease of use etc.)?

Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied	**Rating Average**
0	0	22	3	1	**3,19**

Q22: Charging possibilities for electric vehicles are available in Gröna Skrapan. How frequently do you use electric vehicle-recharging stations?

Never	Very rarely	More than twice a month	More than twice a week	Every day	**Rating Average**
30	0	0	0	0	**1,00**

Q23: How satisfied are you with the electric vehicle-recharging stations?

Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied	**Rating Average**
0	0	25	0	0	**3,00**

Q24: How much do these stations influence your frequency of use of electric cars?

Not at all	To little extent	To some extent	To a moderate extent	To a large extent	**Rating Average**
25	0	2	0	0	**1,15**

Q25: Gröna Skrapan has video conferencing facilities for meetings. Most of companies also have their own video conferencing rooms. How frequently do you use the video conference facilities?

	Never	Very rarely	Now and then	> twice a week	Every day	**Rating Average**
of your company?	3	3	16	6	2	**3,03**
of Gröna Skrapan?	15	9	6	0	0	**1,70**

Q26: How satisfied are you with the video conferencing facilities?

	Very Dissatisfied	Dis-satisfied	Neither	Satisfied	Very Satisfied	**Rating Average**
of your company?	0	0	7	19	4	**3,90**
of Gröna Skrapan?	0	1	18	8	1	**3,32**

Page 5: The Site

Q27: How important is to for you that the building you work in is located in a developed area where infrastructures already exist (e.g. office buildings, transport facilities, shops, restaurants...)? [29 answers]

Very unimportant	Somewhat unimportant	Neither	Somewhat Important	Very Important	**Rating Average**
0	0	2	19	8	**4,21**

Q28: How satisfied are you with the location of the building regarding the development density of its surrounding (other buildings, restaurants, etc.)?

Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied	**Rating Average**
0	0	4	21	5	**4,03**

Q29: How much does the location of the building influence the planning of your day (lunch at restaurant, leisure activities before/after work etc.)?

Not at all	To little extent	To some extent	To a moderate extent	To a large extent	**Rating Average**
1	5	10	11	3	**3,33**

Q30: How satisfied are you with the amount of natural/vegetation area on the building's site?

Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied	**Rating Average**
3	5	11	10	1	**3,03**

Q31: How important is it to you that the roof of Gröna Skrapan is vegetated (green roof)? [29 answers]

Very unimportant	Somewhat unimportant	Neither	Somewhat Important	Very Important	**Rating Average**
6	5	7	10	1	**2,83**

Page 6: Water Use and Management

Q32: Gröna Skrapan has many technologies implemented to reduce water consumption. How satisfied are you with:

Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied	**Rating Average**
The technologies used for water management, such as low-flow taps and toilets?					
0	0	9	19	2	**3,77**
The drought tolerant plant species used on the roof and site landscaping, which avoid the need for landscape irrigation?					
0	0	13	15	2	**3,63**

Page 7: Indoor Environmental Quality

Q33: How satisfied are you with the followings?

Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied	**Rating Average**
Avoidance of exposure of non-smokers to tobacco smoke? [29 answers]					
1	1	4	9	14	**4,17**
The air change effectiveness, i.e. the amount and quality of fresh air?					
2	4	5	13	6	**3,57**
Your ability to control your individual comfort conditions? [29 answers]					
3	6	9	8	3	**3,07**
Your thermal comfort?					
2	6	7	11	4	**3,30**
Your access to daylight from your office space?					
0	5	4	9	12	**3,93**
Your line of sight to vision glazing from your office space?					
0	4	3	8	15	**4,13**

Q34: How important is it for you that Gröna Skrapan has:

Very unimportant	Somewhat unimportant	Neither	Somewhat Important	Very Important	**Rating Average**
A permanent CO2 monitoring system [29 answers]					
0	3	6	13	7	**3,83**
A permanent entry systems that capture hazardous chemicals [29 answers]					
0	2	3	14	10	**4,10**

Q35: **Over certain concentrations, Volatile Organic Compound (VOC) and formaldehyde resins can cause allergies, irritations, respiratory problems and other health effects). In Gröna Skrapan, how important is it to you that:**

Very unimportant	Somewhat unimportant	Neither	Somewhat Important	Very Important	**Rating Average**
All adhesives have a limited amount of VOC?					
1	0	7	14	8	**3,93**
All paint and coatings have a limited amount of VOC?					
1	0	7	14	8	**3,93**
All carpets and rugs have a limited amount of VOC?					
1	0	7	14	8	**3,93**
All composite wood or agri-fiber products have no added formaldehyde resins?					
1	0	7	13	9	**3,97**

Q36: **During construction, many chemicals and particles are emitted in the building. How important is it to you that an Indoor Air Quality Management plan has been developed and implemented during construction and pre-occupancy?**

Very unimportant	Somewhat unimportant	Neither	Somewhat Important	Very Important	**Rating Average**
0	0	7	8	15	**4,27**

Page 8: Energy & Atmosphere

Q37: **How satisfied are you with the following means to reduce energy use in the building?**

Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied	**Rating Average**
Light sensors [29 answers]					
1	2	1	23	2	**3,79**
Insulation [29 answers]					
0	0	7	19	3	**3,86**
Windows with integrated sunshade [29 answers]					
0	1	3	14	11	**4,21**
Ventilation and heat recovery system [29 answers]					
1	6	3	13	6	**3,59**

Q38: **How satisfied are you, overall, with the energy management system of the building? [29 answers]**

Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied	**Rating Average**
1	1	4	22	1	**3,72**

Q39: **How satisfied are you with the absence of window handle in Gröna Skrapan? [29 answers]**

Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied	**Rating Average**
0	5	6	17	1	**3,48**

Page 9: Materials & Resources

Q40: How satisfied are you with the area for separation/collection/storage of recyclable material? [27 answers]

Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied	Rating Average
1	1	12	10	3	**3,48**

Q41: How frequently do you use this area? [27 answers]

Never	Very rarely	> twice a month	> twice a week	Every day	Rating Average
7	9	6	4	1	**2,37**

Q42: At least 20% of the materials in the building have been manufactured regionally. How satisfied are you, overall, with the materials of the building?

Very Dissatisfied	Dissatisfied	Neither	Satisfied	Very Satisfied	Rating Average
0	0	4	21	3	**3,96**

Q43: How important is it to you that:

Very unimportant	Somewhat unimportant	Neither	Somewhat Important	Very Important	Rating Average
At least 1% of the material is a reused material coming from other projects? [28 answers]					
0	0	7	14	7	**4,00**
Building products incorporate recycled content material? [28 answers]					
0	0	5	13	10	**4,18**
At least 50% of wood-based material in the building is environmentally certified? [28 answers]					
0	0	7	9	12	**4,18**

Q44: How important is it to you that waste from construction, demolition and land clearing is recycled and/or salvaged for further use?

Very unimportant	Somewhat unimportant	Neither	Somewhat Important	Very Important	Rating Average
0	0	4	10	13	**4,33**

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Q45: Before construction, the site of the future building has to be chosen and treated. How important are the following actions to you? ** brownfield site = land previously used, that may be contaminated, but has the potential to be reused once it is cleaned up*

Very unimportant	Somewhat unimportant	Neither	Somewhat Important	Very Important	Rating Average
No development on inappropriate site (e.g. prime agricultural land, habitat for threatened species) [24 answers]					
0	1	9	10	4	**3,71**
Development on a brownfield site* [23 answers]					
0	1	7	12	3	**3,74**
Provide a remediation of the brownfield site* [23 answers]					
0	0	7	12	4	**3,87**
Prevention of sedimentation of storm water [23 answers]					
0	0	11	9	3	**3,65**

Q46: **During construction, the site has to be treated as well. How important are the following actions to you?**

Very unimportant	Somewhat unimportant	Neither	Somewhat Important	Very Important	Rating Average
Reduction of the development footprint [24 answers]					
0	0	4	14	6	**4,08**
Reduction of contaminant by treatment systems [24 answers]					
0	0	4	13	7	**4,13**
Prevention of loss of soil by storm water runoff and wind erosion [24 answers]					
0	1	6	13	4	**3,83**

Q47: **CFC, HCFCs and H alones are substances responsible for ozone depletion. How important is it to you that there are:**

Very unimportant	Somewhat unimportant	Neither	Somewhat Important	Very Important	Rating Average
No CFC-based refrigerants are used in the building? [23 answers]					
0	0	4	3	11	**4,30**
No HCFC's or H alones are used in refrigeration equipment nor in fire suppression-systems? [23 answers]					
0	0	5	7	11	**4,26**

Q48: **How important is it to you that:**

Very unimportant	Somewhat unimportant	Neither	Somewhat Important	Very Important	Rating Average
The energy-use is recorded and compared with the energy-use estimated during the design? [23 answers]					
0	0	2	11	10	**4,35**
There is a 2-years contract to purchase power generated from renewable resources? [24 answers]					
0	0	4	14	6	**4,08**
Some percentage of the total energy cost is from on-site renewable energies? [23 answers]					
0	0	2	15	6	**4,17**
Tenants can sub-meter their energy and water consumption? [24 answers]					
0	**0**	**7**	**8**	**9**	**4,08**
Regional sustainability issues have been addressed when the building has been designed and constructed? [23 answers]					
0	1	2	13	7	**4,13**
Fundamental best practice commissioning procedures are implemented in the building? [24 answers]					
0	0	2	13	9	**4,29**

Annex 4.B: User Experience survey – correspondence between question numbers of the survey, indicators, green building elements and related-credits, together with the survey mean value for each question.

Annex 4 - Table 1

Question number	Indicator Number	Green Building Element	Question on	Related-credit	Rate
9	UA 1	Public transport	Frequency	SSc4.1	2,97
10	US 1		Satisfaction		2,79
11	UA 2		Influence		3,1
12	UA 3	Cycling	Frequency	SSc4.2	2,37
13	US 2	Means to secure bikes	Satisfaction		3,15
14	UA 4		Frequency		2,24
15	US 3	Change/shower facilities	Satisfaction		3,7
16	UA 5		Frequency		2,1
17	US 4	Size of the parking lot	Satisfaction	SSc4.4	3,34
18	UA 6		Influence		1,67
19	UN 1	Parking underground	Need	SSc7.1	2,57
20	UA 7	Carpool	Frequency	SSc4.4	1,3
21	US 5		Satisfaction		3,19
22	UA 8	Electric vehicle recharging station	Frequency	SSc4.3	1
23	US 6		Satisfaction		3
24	UA 9		Influence		1,15
25.1	UA 10	Conference facilities in offices	Frequency	Not LEED	3,03
25.2	UA 11	Conference facilities of the building	Frequency		1,7
26.1	US 7	Conference facilities in office	Satisfaction		3,9
26.2	US 8	Conference facilities of the building	Satisfaction		3,32
27	UN 2	Site located in a developed area	Need	SSc2	4,21
28	US 9		Satisfaction		4,03
29	UA 12		Influence		3,33
30	US 10	Amount of vegetation	Satisfaction	SSc5.1	3,03
31	UN 3	Green Roof	Need	SSc7.2	2,83
32.1	US 11	Low flow taps & toilets	Satisfaction	WEc2-c3	3,77
32.2	US 12	Adapted plant species on the roof	Satisfaction	WEc1	3,63
33.1	US 13	No exposure to tobacco smoke	Satisfaction	IEQp2	4,17
33.2	US 14	Amount and quality of fresh air	Satisfaction	IEDc2	3,57
33.3	US 15	Ability to control comfort conditions	Satisfaction	IEQc6	3,07
33.4	US 16	Thermal comfort	Satisfaction	IEQc7	3,3
33.5	US 17	Access to daylight	Satisfaction	IEQc8.1	3,93
33.6	US 18	Line of sight to vision glazing	Satisfaction	IEQc8.2	4,13
34.1	UN 4	Permanent CO_2 monitoring system	Need	IEQc1	3,83
34.2	UN 5	Permanent entry systems that captures hazardous chemicals	Need	IEQc5	4,1
35.1	UN 6	Limited amount of VOC in adhesives	Need	IEQc4.1	3,93
35.2	UN 7	Limited amount of VOC in Paint and coatings	Need	IEQc4.2	3,93
35.3	UN 8	Limited amount of VOC in Carpets and rugs	Need	IEQc4.3	3,93
35.4	UN 9	No urea formaldehyde in wood products	Need	IEQc4.4	3,97
36	UN 10	IAQ management	Need	IEDc3	4,27
37.1	US 19	Light sensors	Satisfaction	Eac.1	3,79
37.2	US 20	Insulation	Satisfaction		3,86
37.3	US 21	Windows with integrated sunshade	Satisfaction		4,21

37.4	US 22	Ventilation and heat recovery system	Satisfaction		3,59
38	US 23	Energy management system of building	Satisfaction	EAc3	3,72
39	US 24	No window handles	Satisfaction	Not LEED	3,48
40	US 25	Recycling area	Satisfaction	MRp1	3,48
41	UA 13		Frequency		2,37
42	US 26	Regionally manufactured material	Satisfaction	MRc5	3,96
43.1	UN 11	Reused material from other projects	Need	MRc3	4
43.2	UN 12	Recycled content of material	Need	MRc4	4,18
43.3	UN 13	50% of wood environmentally certified	Need	MRc6	4,18
44	UN 14	Waste from construction recycled or salvaged	Need	MRc2	4,33
45.1	UN 15	No development on inappropriate site	Need	SSc1	3,71
45.2	UN 16	Development on a brownfield site	Need	SSc3	3,74
45.4	UN 17	Prevention of sedimentation of storm water	Need	SSp1	3,65
46.1	UN 18	Reduction of the development footprint	Need	SSc5.2	4,08
46.2	UN 19	Reduction of contaminant by treatment systems	Need	SSc6.2	4,13
47.1	UN 20	No CFC-based refrigerants	Need	EAp3	4,3
47.2	UN 21	No HCFC's or H alones	Need	EAc4	4,26
48.1	UN 22	Recording and comparison of energy-use	Need	EAc5.1	4,35
48.2	UN 23	2-years contract for renewable resources	Need	EAc6	4,08
48.3	UN 24	On-site renewable energies	Need	EAc2	4,17
48.4	UN 25	Tenant sub-metering of energy and water consumption	Need	EAc5.2	4,08
48.5	UN 26	Focus on regional sustainability issues	Need	IDc1	4,13
48.6	UN 27	Implementation of fundamental best practice commissioning procedures	Need	EAp1	4,29

Annex 4.C: User Experience survey – correspondence between indicator numbers and green building elements.

Annex 4 - Table 2 Correspondence between users frequency of use indicator and green building elements, and classification of the indicators between Direct (UA_D) or Indirect (UA_I) indicator.

UA	Green Building Element	UA_D	UA_I
UA1	Public transport	✓	
UA2	Public transport		✓
UA3	Cycling	✓	
UA4	Means to secure bikes	✓	
UA5	Change/shower facilities	✓	
UA6	Size of the parking lot		✓
UA7	Carpool	✓	
UA8	Electric vehicle recharging station	✓	
UA9	Electric vehicle recharging station		✓
UA10	Conference facilities in offices	✓	
UA11	Conference facilities of the building	✓	
UA12	Site located in a developed area		✓
UA13	Recycling area	✓	

Annex 4 - Table 3 Correspondence between users' satisfaction indicators and green building elements

US	Green Building element
US1	Public transport
US2	Means to secure bikes
US3	Change/shower facilities
US4	Size of the parking lot
US5	Carpool
US6	Electric vehicle recharging station
US7	Conference facilities in offices
US8	Conference facilities of the building
US9	Site located in a developed area
US10	Amount of vegetation
US11	Low flow taps & toilets
US12	Adapted plant species on the roof
US13	No exposure to tobacco smoke
US14	Amount and quality of fresh air
US15	Ability to control comfort conditions
US16	Thermal comfort
US17	Access to daylight
US18	Line of sight to vision glazing
US19	Light sensors
US20	Insulation
US21	Windows with integrated sunshade
US22	Ventilation and heat recovery system
US23	Energy management system of building
US24	No window handles
US25	Recycling area
US26	Regionally manufactured material

Annex 4 - Table 4 Correspondence between users' need indicators and green building elements

UN	Green Building element
UN1	Parking underground
UN2	Site located in a developed area
UN3	Green Roof
UN4	Permanent CO_2 monitoring system
UN5	Permanent entry systems that captures hazardous chemicals
UN6	Limited amount of VOC in adhesives
UN7	Limited amount of VOC in paint and coatings
UN7	Limited amount of VOC in carpets & rugs
UN8	No urea formaldehyde in wood products
UN9	IAQ management
UN10	Reused material from other projects
UN11	Recycled content of material
UN12	50% of wood environmentally certified
UN13	Waste from construction recycled or salvaged
UN14	No development on inappropriate site
UN15	Development on a brownfield site
UN16	Prevention of sedimentation of storm water
UN18	Reduction of the development footprint
UN19	Reduction of contaminant by treatment systems
UN20	No CFC-based refrigerants
UN21	No HCFC's or H alones
UN22	Recording and comparison of energy-use
UN23	2-years contract for renewable resources
UN24	On-site renewable energies
UN25	Tenant sub-metering of energy and water consumption
UN26	Focus on regional sustainability issues
UN27	Implementation of fundamental best practice commissioning procedures

Addendum

Comic strip

There's a battle outside and it's ragin'

Scenario: Maud Lanau
Drawing: Wouzit
2014

The comic strip presented on the cover is a short version of the one presented on the next page, titled *There's a battle outside, and it's ragin* [‡].

It has been drawn by Wouzit in Toulouse, France, in June 2014, based on a scenario from Maud Lanau.

The first frame depicts the raising awareness of society concerning the issues caused by anthropogenic climate change. As a response, companies of all kind are making efforts to meet the demands of the public and thus are willing to integrate sustainable solutions in their business. One of these solutions is to work in an environmentally friendly workplace. Such a way of thinking is depicted by the second frame, where tenants (i.e. persons who rent an office) hear the public demands and conclude that they need a environment-friendly workplace. Since the tenants ask for a green workplace to satisfy their potential clients, they also want a proof of the sustainability of their office.

On the third frame, the future owners of a future building hear the demands of the tenants and conclude that they need to construct green buildings, and to get a proof of it.

The fourth frame depicts the construction companies who hear the demands of the potential buyers and thus future owners of their project, and thus conclude that they need to use an green building certification system.

The fifth frame shows how much time, money and documentation needs to be supplied by the construction company to get their building environmentally certified. The sixth frame depicts the construction company finally getting their certificate.

On the seventh frame, the construction company shows the certificate to the owner of the building. In turn, owners show it to the future tenants who agree to rent office space in the building (eigth frame).

The last frame depicts the company renting an office space in the building: the company's sustainability report written – obviously including the fact that their office space is located in a certified green building, the company's dirigeants are satisfied and want to focus on their core business. Unfortunately, in some cases, such business is closely related to unsustainable practices, such as digging oil, as pictured on the board behind the dirigeant.

The comic is an attempt to depict two of the main conclusions of the present report:

- The (Swedish) construction industry needs to switch its focus back on actual efficient sustainable work: environmental certification schemes should be a tool, not a goal.
- Tenants see green building as a good way to give their company a sustainable profile.

[‡] «*There's a battle outside and it's ragin'*» is a quote from Bob Dylan's song «The Times They Are A-Changin'», released as the title track of his (third) album in 1964.

there's a battle outside and it's ragin'