



**CHALMERS**  
UNIVERSITY OF TECHNOLOGY



# Use of the environmental assessment method Miljöbyggnad

The application of an environmental classification system

Master's thesis in the Master's Programme Design and Construction Project Management

Milad Rohanimehr



MASTER'S THESIS E2015:125

# Use of the environmental assessment method Miljöbyggnad

- The application of an environmental classification system

Master's Thesis in the Master's programme Design and Construction Project Management

MILAD ROHANIMEHR

Department of Technology Management and Economics  
Division of Service Management  
CHALMERS UNIVERSITY OF TECHNOLOGY  
Göteborg, Sweden E2015:125





# Use of the environmental assessment method Miljöbyggnad

Master's Thesis in the Master's programme Design and Construction Project Management

MILAD ROHANIMEHR

Examensarbete E2015:125 Institutionen för Teknikens Ekonomi och organisation  
Chalmers Tekniska Högskola 2015

Department of Technology Management and Economics  
Division of Service Management

SE-412 96 Göteborg  
Sweden  
Telephone: +46 (0) 31-772 1000

Cover:

Photo: Milad Rohanimehr, 2016-01-08



Use of the environmental assessment method Miljöbyggnad  
- The application of an environmental classification system

Master's Thesis in the Master's programme Design and Construction Project  
Management

MILAD ROHANIMEHR

Department of Technology Management and Economics  
Division of Service Management

## **Abstract**

The global construction industry is intensively becoming conscious to advance sustainable and environmental issues. Environmental classifications systems (ECS) have become more common to apply in order to reduce the environmental footprint for the construction industry. A case study research based on a quantitative questionnaire and qualitative interviews was conducted with a Swedish construction developer, HSB. The case study investigates how employees receive and apply the ECS. The report provides a discussion based on some of the literature within environmental assessment methods, green building, and sustainability in the construction industry. However, the Swedish ECS Miljöbyggnad is a relatively new assessment method, which has severed to certify constructions during 3-4 years. The system has brought several different challenges during the application stage to different construction developers. It is suggested that the assessment of Miljöbyggnad should be reviewed and improved, where also an enhanced focus of assessment of Miljöbyggnad should be emphasized in the pre phase of construction projects. Thereby, the report aims to provide an enhanced knowledge regarding the environmental assessment method, Miljöbyggnad and benefits of sustainable buildings.

Key words: Miljöbyggnad, environmental classification system, environmental assessment methods, sustainability, green building, green marketing, standard



# Content

<b>ABSTRACT .....</b>	<b>1</b>
<b>1. INTRODUCTION .....</b>	<b>5</b>
1.1 AIM AND OBJECTIVE.....	7
1.2 ABBREVIATIONS .....	8
<b>2.FRAME OF REFERENCE.....</b>	<b>9</b>
2.1 SUSTAINABILITY IN THE CONSTRUCTION INDUSTRY .....	9
2.2 GREEN BUILDING AND GREEN MARKETING.....	10
2.3 STANDARDS.....	11
2.4 ECS IN THE CONSTRUCTION INDUSTRY .....	12
<b>3. MILJÖBYGGNAD .....</b>	<b>14</b>
3.1 THE MILJÖBYGGNAD PROCESS FOR NEW AND EXISTING BUILDINGS .....	14
3.2 GENERAL STRUCTURE .....	14
3.3 MILJÖBYGGNAD CERTIFICATION PROCESS .....	20
3.4 ON-GOING DEVELOPMENT OF MILJÖBYGGNAD .....	21
<b>4. METHODOLOGY .....</b>	<b>23</b>
4.1 RESEARCH APPROACH .....	23
4.2 LITERATURE REVIEW .....	23
4.3 CASE STUDY DATA COLLECTION.....	23
4.4 COMMENTS ON LIMITATIONS OF SELECTED APPROACH .....	25
<b>5. THE CASE OF HSB – A SWEDISH BUILDING DEVELOPER.....</b>	<b>27</b>
5.1 HSB .....	27
5.2 HSB SUSTAINABILITY MEASURES.....	27
<b>6. FINDING QUESTIONNAIRE SURVEY .....</b>	<b>29</b>
PART 1 - THE EMPLOYEES’ ENVIRONMENTAL ATTITUDE.....	29
PART 2 - MILJÖBYGGNAD IN HSB .....	29
<b>7. INTERVIEWS .....</b>	<b>32</b>
7.1 MILJÖBYGGNAD IN HSB.....	32
7.2 THE IMPLEMENTATION PROCESS OF MILJÖBYGGNAD IN A CONSTRUCTION.....	34
7.3 THE FUTURE OF MILJÖBYGGNAD AND SUSTAINABILITY IN THE CONSTRUCTION INDUSTRY .....	35
<b>8. DISCUSSION AND CONCLUSION .....</b>	<b>37</b>
8.1 SUSTAINABILITY AND STANDARDS IN THE CONSTRUCTION INDUSTRY .....	37
8.2 THE IMPLEMENTATION OF THE ECS MILJÖBYGGNAD .....	38
8.3 FURTHER IMPROVEMENT AND MARKETING OF MILJÖBYGGNAD .....	39
8.4 CONCLUSION OF THE RESEARCH QUESTIONS.....	41
<b>9. PRACTICAL IMPLICATIONS AND RECOMMENDATIONS ON FURTHER RESEARCH .....</b>	<b>42</b>
<b>REFERENCES.....</b>	<b>43</b>
<b>ATTACHED FILES .....</b>	<b>49</b>
INTERVIEW QUESTION:.....	50
SURVEY QUESTIONS .....	51



# 1. Introduction

*"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (Brundtland, 1987)*

Human mankind has for long time had a negative impact on the environment through high-energy consumption and by adding hazardous waste as a consequence of global development (Brundtland, 1989). The quote above conveys the importance of not venturing the future generation's needs, by reducing and improving the usage of natural resources. Greenhouse gases occur from everyday activities e.g. industrial emissions, electricity and carbon dioxide (CO<sub>2</sub>) emissions from cars (Swedish Environmental Protection Agency, 2015). The European construction industry commits approximately to 40 per cent of the total energy consumption and is a large contributor of CO<sub>2</sub> emissions (Enbri, 2012). In order to affect the substantial use of energy, the Swedish parliament has created a vision to achieve zero net emissions of greenhouse gases by 2050 (Swedish Environmental Protection Agency, 2015). The main objective is to reduce 20 per cent energy use by 2020 and 50 per cent reduction by 2050 in the built environment in comparison to the levels in 1995 (Brown et al., 2012, Thuvander et al., 2012). Furthermore, in order to reach a more sustainable environment in the construction industry, it is also necessary to avoid resource waste of raw materials, water, and energy during the life cycle of constructions (Wahlström et al., 2014).

Requirements and targets established by EU and national governments has during the past two decades put pressure on the construction industry to become aware of advancing green building practices and further reduction of energy consumption (Gluch et al., 2009, Thuvander et al., 2012). Green building practice aims to enhance the social wellbeing and improve environmental issues in the construction industry. Furthermore, it provides sustainable policies, which includes assessment of total consumption of energy, water, land and greenhouse gas emissions (Crawley et al., 2010). There are international and national assessment methods, which serve to manage these frameworks. Using standardized Environmental Management Systems (EMS) and Environmental classification system (ECS) can be an effective approach to stimulate the quality and sustainability thinking of the actors involved in the construction and real estate industry in order to develop sustainable buildings (Ericson & Larsen, 2013, Christin et al., 2004).

Two most common international ECSs are BREEAM (Building Research Establishment Environmental Assessment Method) and LEED (Leadership in Energy and environmental Design), these systems has been used to certify several thousands of buildings all over the world (Thuvander et al., 2012). An ECS developed and based by Swedish norms and requirements is Miljöbyggnad, which serves to certify new and existing buildings (Rosvall, 2014). Miljöbyggnad was first introduced as a certification system in 2011 and is a result of ByggaboDialogen, which had the aim to improve the development of sustainable buildings and the property sector in Sweden (Sweden

Green Building Council, 2014). Miljöbyggnad is managed and operated by the Swedish Green Building Council (SGBC), a non-profit association owned by its members in the construction and real estate industry. The system was developed in collaboration with universities, architects, property owners and engineers. It is based on four assessment areas: energy, indoor environment, building materials and special environmental requirements. The assessment areas include evaluating and rating different indicators, which determine the building's final certification grade *bronze*, *silver* or *gold*. Numerous building developers in Sweden use the ECS to certify their buildings environmentally. During 2015 nearly 300 buildings were Miljöbyggnad certified in Sweden, observing that only 76 were certified during 2013 (Sweden Green Building Council, 2015a). This indicates an increase of Miljöbyggnad certifications in Sweden and has a huge potential to be further developed. Development and use of ECS could gain competitive advantages securing more tenants, higher occupancy rates, increased financial value of buildings, higher rents and increased attractiveness, which could be an incentive to develop an enhanced built environment (Heincke & Olsson, 2012). However, ECS Miljöbyggnad is not statutory for the building developers, which has brought several challenges during assessment of the indicators that are required in a certification process. These challenges will further be discussed in the thesis.



## 1.1 Aim and objective

The objective of this research is to get an overview on how *Miljöbyggnad* is implemented and perceived within a building developer, HSB. *Miljöbyggnad* has been used to certify buildings in Sweden since 2011 and is therefore relatively new for the construction developers. In order to maintain a certificate, several indicators are required to be achieved during the certification process. *Miljöbyggnad* has brought several challenges to the construction developers, therefore the aim of this case study is to investigate and bring forward challenges of the ECS *Miljöbyggnad*.

### The objective is to analyse:

- The employees' attitude towards environmental sustainability in the construction industry:
  - Which are the major difficulties using Miljöbyggnad certification system in order to certify a construction?
  - Why did HSB decide to certify their buildings on the basis of Miljöbyggnad silver and not gold?
  - Why is there less focus on certifying existing buildings?
- Is there any possibility for improvement of Miljöbyggnad both internally and externally in the organization?
  - Which improvements could be made in the system in order to have a better flow through the process?
  - Are there any possibilities for enhanced marketing of Miljöbyggnad to potential customers?
- How is the implementation of Miljöbyggnad carried out?

## 1.2 Abbreviations

<b>HSB:</b>	Housing association
<b>Representative floor:</b>	A representative floor means either the entire building, a few floors of the building or only one floor as its own.
<b>Abidance-room:</b>	In Miljöbyggnad an abidance room is an area “where people are present more than temporarily” which is based on National board of housing in Sweden.
<b>ECS:</b>	Environmental Classification System
<b>EMS:</b>	Environmental Management system
<b>BBR:</b>	BBR is the National Board of Housing in Sweden for building and planning. BBR is valid during construction of new and existing buildings. BBR provides instruction and general guidelines on accessibility, housing design, room height, the operation space, fire protection, hygiene, health and environment, noise, safety regulations during use of the building and energy efficiency.
<b>Miljöbyggnad:</b>	Environmental classification system used in Sweden.
<b>NCC:</b>	Swedish construction company
<b>Skanska:</b>	Swedish construction company

## 2. Frame of reference

*The relevant theories for the study are presented below.*

### 2.1 Sustainability in the construction industry

Sustainability is a large concern for all kind of people and embraces three components: environmental protection, social equity and financial growth, also known as the “triple bottom line” (Stewart & Swan, 2010). The construction industry provides services and production worldwide and constitutes to be the largest employers in many national economies (Tranchard, 2012). The environmental impact caused by the construction industry has for decades been accused, contributing to environmental issues (Ding, 2005). Earlier researches have stated that the construction industry needs to rethink and modify their way of processing constructions in order to assess environmental issues (Gluch, 2005).

Greenhouse gas emissions in Sweden caused by the construction industry, including road and railway construction from only the national production and use of goods were estimated to approximately 13 million tonnes per year during 2008-2011. The property sector is the largest actor contributing to CO<sub>2</sub> emissions, which stands for nearly 60 per cent of the 13 million tonnes of emissions (Boverket, 2014). The Swedish government has developed 16 national environmental objectives as a target to be reached by 2050 (Naturvårdsverket, 2015a). These objectives serve to establish a long-term, efficient and modern environmental policy. Environmental objectives are used as a tool to form a common vision for all actors involved in the construction industry locally, regionally and nationally (Jakubova & Millander, 2012).

**Table 1: The 16 national environment objectives (Naturvårdsverket, 2015b)**

1. Reduced climate impact	9. Good-quality groundwater
2. Clean air	10. A balanced marine environment, flourishing coastal areas and archipelagos
3. Natural acidification only	11. Thriving wetlands
4. A non-toxic environment	12. Sustainable forests
5. A protective ozone layer	13. A varied agricultural landscape
6. A safe radiation environment	14. A magnificent mountain landscape
7. Zero eutrophication	15. A good built environment
8. Flourishing lakes and streams	16. A rich diversity of plant and animal life



**Figure 1: Triple bottom line**

Moreover, by incorporating these three factors (figure 1) all involved parties gain a positive benefit (Hubbard, 2006). Environmental protection was, for a long time, seen as expensive to address in the Swedish construction industry (Stenberg & Räisänen, 2006). Traditional construction projects had a sustainable focus on performance, cost and quality production, while focusing less on the use of resources, building materials, environmental issues and a healthy environment for workers wellbeing. A sustainable construction project should include the triple bottom line during the planning, construction and demolition phase, in order to provide a construction that is affordable, available and environmentally emphasised (Aysin, 2008). According to an earlier study, environmental issues in Swedish companies are today obtained as something that “everyone” is responsible for and assess on a regular basis, instead of considering it as a problem. The study also indicated that environmental issues are becoming institutionalized as a strategic part in the organisations (Gluch et al., 2011). Sustainable strategies provide companies to enhance their sustainable competitive advantage by implementing environmental and sustainability issues in a systematic way, where new insights and focus on the core business objectives are made. These objectives include reducing risk and expenses during manufacturing, improving productivity and ability to increase market shares and profit (Willard, 2012).

## **2.2 Green building and green marketing**

During the last decades, consumers, environmental interest in green buildings and influence in sustainable issues has enhanced significantly. A green building defines how to increase its effect on social wellbeing and environmental issues. It serves the purpose to practise different environmental methods in order to consume less water, less energy and improve usage of material considering the material life cycle. Earlier researchers have argued that CO<sub>2</sub> emissions occurred by production of building materials represent 15 per cent of the total emission of a building during 50 years. Remaining 85 per cent is produced by the buildings maintenance emissions. However, in order to achieve to construct sustainable buildings, improved design, operation, site development, transportations and usages of management systems are some of the

factors that is sufficient to include during the construction development (Yudelso, 2008). The major barrier in green building according to several researches is that developing sustainable buildings are expensive (Mellon, 2011, Yudelso, 2008). A survey made by *Public Policy Polling* during 2009 indicated that 59 per cent of the servants considered environmental sustainable products are important during the purchasement of products, where 56 per cent was willing to pay more for environmental friendly products (Public Policy Polling, 2009).

A survey made by (Albinsson et al., 2005) pointed out that potential consumers of residences have an acceptance and incentive to pay more for buildings with lower maintenance costs. In addition, the survey indicated that the reason for low demand of energy-efficient buildings in Sweden is due to lack of knowledge and insufficient marketing among potential consumers.

Green marketing is about developing sustainable services and products, while presenting sustainability performances at the core of the business and marketing practises. Green marketing implement sustainability in companies' activities and creates a balance between a need for profit with an aim to protect the environment (Gordon et al., 2011). In order to achieve these settings, two different approaches can be assessed: defensive and assertive approaches. A defensive approach is applied by organizations, which follow minimum in order to present environmental action in order to avoid consumer rejections. A defensive approach also works as a strategy to copying the competitor's environmental actions by making less than is necessary. These organizations are often tending to apply minimum effort to avoid governmental consequences and penalties (McDaniel & Rylander, 1993).

Moreover, an assertive approach provides to establish a sustainable competitive advantage by performing and applying more than the consumer or the government expect or requires. The sustainable image that is created by an assertive approach, is the basic element for the organization to create a long term planning strategy, with the ability to critically advance for future demands and regulations (McDaniel & Rylander, 1993). Green-marketing approaches serves several benefits, where different consumer researches has shown that minimum differences in the variety of products, can make environmental performances to act as a decision making factor (Christensen, 1995, Gordon et al., 2011). However, Elkington (1994) argues that environmental performances could provide a win-win situation, where the companies are able to form a strategy that profits the company and the environment.

### **2.3 Standards**

The modern world is rapidly advancing trough innovations and technology, where environmental indicators point out the construction industry to be one of the heaviest contributors for environmental waste (Rawshan & Chamhuri, 2009). International goals have been taken to improve the sustainability in the world where international coordination standards, various of management tools and classifications systems are required to point the construction industry in right direction (Choen & Goulding, 2008). Many of the international construction companies uses various of specific standards, such as the International Organization for Standardization (ISO), which is

the world's largest developer of voluntary international standards (ISO Central, Secretariat, 2012). ISO provides society, business and governments with practical tools for economic, environmental and societal sustainable development (ISO Central, Secretariat, 2010).

The purpose of implementing ISO standards in the construction industry is to improve management control, customer service, better usage of resources, communication, better coordination of work, functions and enhanced environmental protection (Murat, 2008, Hiyassat, 2000). ISO standard related to sustainability in the construction industry are ISO 14001 (Environmental management), ISO 9001 (Quality management) and ISO 26000 (Social management).

According to Brunsson et al. (2002) standards can be explained as pieces of general advice, which is voluntary and offered to large quantities of potential adopters. There are two types of actors, which standards are aimed at, individuals and organizations. Standards consist of different methods that advice how those who adopt them can achieve desirable qualities of products, marketing and improved activity of processes. Different actors all over the world practice these standards with the aim to accomplish specific goals. Standards are regulated processes, which generate collaboration, coordination and directives. These can be seen as rules, which have the ability to convey what the adopter should do in certain situations. When these rules apply to a major quantity of adopters, the adopters will provide to behave in similar ways, which create uniformity among people and organizations (Brunsson et al., 2002).

## **2.4 ECS in the construction industry**

Environmental assessment method is a tool that guides environmental aspects in different processes such as planning, production, waste handling and future development improvements. It was initially introduced as a concept within the electronics industry in Japan during 1980 (Söderman, 2006). Environmental classification systems are used to identify and regulate sustainable issues during design and construction of buildings. An environmental certification system assesses a real estate or a building's environmental impact. It provides a systematic approach, which displays the property developers' environmental impact. In order to achieve a certification for a building, a third party review is required to be performed. This implies that an independent specialist reviews documents regarding the construction of the building. Where a certificate and plaque is issued and corresponds to the rating of the building e.g. Green Building Councils (Ericson & Larsen, 2013, Yudelson, 2008).

The demand to contribute to a more sustainable and eco-friendly environment in the construction industry is growing rapidly, due to the request from stakeholders and real estate investors (SGBC, 2015). The global community is becoming more viable to reduce and improve the environmental impact. ECS is an incentive that encourages the property owners and developers to invest in these systems, not only to meet governmental regulations and regulatory requirements, but also by presenting a label of environmental performances for the constructions. Demand for improved environmental quality has resulted in that several researchers and specialists' argues

that innovation within environmental development creates a competitive advantage (Cole, 2005, Gluch et al., 2009).

There are several different international and national certification-assessing tools, which serves the construction industry to provide a more sustainable environment. The first environmental classification system BREEAM was introduced in Great Britain in the early 1990s. Most common ECS used internationally is BREEAM and LEED (Thuvander et al., 2012). BREEAM and LEED are in content very different to the Swedish system, Miljöbyggnad. Miljöbyggnad is a relatively new established system on the market. It serves to evaluate the finished building based on three different rating levels: *bronze*, *silver* and *gold*. Different researches have shown that ECS provide environmental protection as well as improved environmental reputation in the industry and cost savings, by being involved in the movement of reducing environmental impact (Shen, 2002).

According to a study from 2012, there was no greater demand to certify residential buildings in Sweden, except for certification of commercial buildings (Yakhyaeva & Johansson, 2012). However, the implementation and development of environmental classifications systems has progressed rapidly. The majority of building developers in Sweden has, since 2012, chosen to certify all their new residential building according to the ECS Miljöbyggnad *silver*. ECSs provides to deal with the constructions more complicated environmental issues e.g. chemical substances, radon, moisture, solar heating, indoor climate for the tenants and the overall energy consumption in order to reduce and improve these factors (SP Technical Research Institute of Sweden, 2015). Previous researches have shown that focus on environmental innovations has improved the quality of constructions as well as building developers position and enhancement of the relationships between involved actors during the construction processes (Bossink, 2004).

### 3. Miljöbyggnad

#### 3.1 The Miljöbyggnad process for new and existing buildings

Miljöbyggnad is a result of a dialogue project called Building, Living and Property Management, which were introduced in 1998. The project was a collaboration between Swedish government and actors in the property and building sector, with the purpose to improve the development of sustainable buildings and the built environment in Sweden (Ericson & Larsen, 2013). Moreover, the project stressed to create a voluntary assessment method for environmental classification of buildings in the Swedish construction industry (Malmqvist et al., 2011).

Miljöbyggnad is a Swedish initiative to encourage development and use of environmental certifications. The system is managed and administrated by Sweden Green Building Council (SGBC), which is a full member of the World Green Building Council. SGBC is a non-profit organization accessible to all companies and organizations in the construction and property sector, with the objective to develop and influence sustainability in the construction industry. Miljöbyggnad approaches as an assessment method, in order to evaluate and assess potential performances in order to reduce environmental impacts and reach environmental objective goals, set by the government (Miljöbyggnad, 2014, Malmqvist et al., 2011).

Miljöbyggnad assess a constructions quality and performance in four areas: *energy, indoor environment, building materials* and *special environmental requirements*. These assessments serves the purpose to improve total energy use of a building, enhance indoor-climate and reduce usage of building materials containing hazardous substances. The last mentioned area applies in case constructions have their own water supply and waste water system (Miljöbyggnad, 2014, Malmqvist et al., 2011).

#### 3.2 General structure

In order to calculate concerned indicators in Miljöbyggnad free software's are available on SGBCs website. The software's can be downloaded in order to support and confirm that the rating criterion in Miljöbyggnad is achieved for issued construction.

Each area in Miljöbyggnad is divided into different aspects, were the aspects are divided into a several indicators. There are 16 indicators where indicators 1- 15 are used to assess new production and indicators 1- 13 and 16 are used for evaluation of existing buildings (table 2). Approximately all indicators have different requirements that have to be approved in order to reach a certification (see attached appendix 1).



**Table 2: Different Indicators, aspects and areas that are included during assessment of Miljöbyggnad**

Indicators	Aspects	Areas
Energy use	Energy use	Energy
Heat power demand	Power demand	
Solar heating load		
Type of energy	Type of energy	
Environment noise	Environmental noise	Indoor environment
Radon gas	Air quality	
Ventilation standard		
Nitrogen dioxide		
Moister resistance	Moisture	
Thermal climate during winter	Thermal climate	
Thermal climate during summer		
Daylight	Daylight	
Legionella	Legionella	
Documentation of building materials	Documentation of building materials	Materials and chemicals
Phasing out dangerous substances	Phasing out dangerous substances	
Removal of dangerous substances	Removal of dangerous substances	

Miljöbyggnad provides four different rating levels, which a construction can be certified through: *Rated*, *Bronze*, *Silver* and *Gold*. The rating level *Rated* provides information that the building is inspected but the requirements for a Miljöbyggnad certification is not achieved (Heincke & Olsson, 2012). *Rated* can only be used to assess existing buildings if governmental building regulations are fulfilled. *Bronze* level basically corresponds to the level of demands, e.g. National board of housing (BBR), work environment, radiation safety authority and public health authority requires. A *bronze* certification confirms that the constructions features and technical solutions are qualified according to BBRs demands, with a third party assessment, but is seen as a low level of ambition for newly produced buildings (Sweden Green Building Council, 2015b).

To achieve *silver* rating, improved and higher requirements than governmental building regulations are necessary to be applied. By example, the *energy usage* has to be at least 75 per cent or less for the *silver* level and 65 per cent for the *gold* level of the national requirements (Table 3). These requirements only apply for constructions, which do not use heated using electricity. For electrically heated constructions, the *energy use* requirements change to 5 and 10 per cent (Sweden Green Building Council, 2015b, Heincke & Olsson, 2012).

**Table 3: Example on different assessment criteria's, regarding different level of grades**

Indicators:	Bronze	Silver	Gold
Energy use	BBR	75% of BBR	65% of BBR
Solar heating	< 38 W/m <sup>2</sup>	< 29 W/m <sup>2</sup>	< 18 W/m <sup>2</sup>
Radon level	≤ 200 Bq/m <sup>3</sup>	≤ 100 Bq/m <sup>3</sup>	≤ 50 Bq/m <sup>3</sup>

*Gold* level is the highest rating level to accomplish. To attain this rating none of the indicators are allowed to be rated *bronze* or lower. The *gold* certification also requires a questionnaire survey being answered by the tenants/users of the building. At least 80 per cent of the questionnaire responses regarding ventilation standard, moisture, environmental noise, thermal climate during winter and summer and daylight has to be answered “acceptable”, “good” or “very good” in order to reach gold.

To reach a final rating for a building, a specific rating assessment is applied in Miljöbyggnad. Some of the indicators assess the building as whole, while others are examined at room level (Table 5). Miljöbyggnad also serves to assess different indicators which are not regulatory required but vital in order to improve the quality of the building, indoor environment and provide lower energy usage (Sweden Green Building Council, 2015b).

**Table 4: Illustrate, which indicators that is and not directly linked to regulatory requirements (Miljöbyggnad manual, 2014)**

<b>Indicators</b>	<b>Legal requirements for new and existing buildings</b>
Energy use	Lacking regulatory requirements
Heat power demand	Lacking regulatory requirements
Solar heating load	Lacking regulatory requirements
Type of energy	Lacking regulatory requirements
Environment noise	Governmental demand
Radon gas	Governmental demand
Ventilation standard	Governmental demand on mandatory ventilation inspection
Nitrogen dioxide	Lacking regulatory requirements
Moisture resistance	Existing regulations and recommendations
Thermal climate during winter	Existing regulations and recommendations
Thermal climate during summer	Existing regulations and recommendations
Daylight	Existing regulations and recommendations
Legionella	Existing regulations and recommendations
Documentation of building materials	Lacking regulatory requirements
Phasing out dangerous substances	Lacking regulatory requirements
Removal of dangerous substances	Legal requirements

The rating assessment in Miljöbyggnad are divided as follow:

1. From rating at room level to indicator level
2. From indicator level to aspect level
3. From aspect level to area level
4. From area level to building level

**Table 5: The assessment of the indicators in Miljöbyggnad, at room and building level (Miljöbyggnad, manual 2014)**

Room-level	Indicators	Building-level
	Energy use	←←←←←
	Heat power demand	←←←←←
→→→→→	Solar heating load	
	Type of energy	←←←←←
→→→→→	Environmental noise	
	Radon gas	←←←←←
	Ventilation standard	←←←←←
	Nitrogen dioxide	←←←←←
	Moister resistance	←←←←←
→→→→→	Thermal climate during winter	
→→→→→	Thermal climate during summer	
→→→→→	Daylight	
	Legionella	←←←←←
	Documentation of building materials	←←←←←
	Phasing out dangerous substances	←←←←←
	Removal of dangerous substance	←←←←←

### 1. From rating at room level to indicator level

For new production of buildings, the assessment of indicators on room level is Indicator 3, 5, 10, 11 and 12. The fundamental requirement of Miljöbyggnad is that the buildings most critical elements should adjust the level of rating.

The rating aggregation at room level is determined by selecting the most representative floor of the building to evaluate, which is an area “where people are present more than temporarily”. In order attain the rating at room level, an assessment of each room area is executed and graded. The indicator grade is then assessed on the basis of the worst room grade, which could be advanced by one grade if at least half of the estimated room areas have a higher rating (Table 6 and 7) (Sweden Green Building Council, 2015b). Moreover, it is also essential that no larger area than 20 per cent of apartments *Atemp* is evaluated, since the assessed impact of the worst room would otherwise decrease. *Atemp* is the internal surface of the floor, attic and the basement, which is heated to more than 10 ° C in the building, were the buildings specific energy usage is determined and calculated upon (Boverket, 2014).

Table 6

Room grade	Evaluated room area, ex 1	Indication grade
BRONZE	23 m <sup>2</sup>	
SILVER	10 m <sup>2</sup>	SILVER
GOLD	15 m <sup>2</sup>	

Table 7

Room grade	Evaluated room area, ex 2	Indication grade
BRONZE	23 m <sup>2</sup>	BRONZE
SILVER	10 m <sup>2</sup>	
GOLD	7 m <sup>2</sup>	

**Table 6 & 7:** The worst room rating determines the indicator grade, which may be increased one grade if at least half of the estimated room areas have a higher grade.

## 2. From indicator level to aspect level

In this stage the aspect grade is determined on the basis of the lowest indicator rate. In table 8 the aspect rating is rated *silver*, although one of the indicators is rated *gold*.

Table 8: Example on the assessment of rating from indicators to aspects

Indicators		Aspects	
Radon gas	SILVER	Air-quality	SILVER
Ventilation standard	SILVER		
Nitrogen dioxide	GOLD		

## 3. From aspect level to area level

During this process the lowest aspect rate determines the area rate. The area rate is permitted to advance one level if at least half of the other aspect ratings have a higher rate (Table 9). The aspect rating process perform a important part during assessment of the building, this is due to the fact that it is easier to reach a higher level of grade by adding other aspect rates.

**Table 9: Example on assessment of rating on indicator, aspects and area level**

Indicators		Aspects		Area			
Radon gas	SILVER	Air-quality	SILVER	Indoor Environment	SILVER		
Ventilation standard	SILVER						
Nitrogen dioxide	GOLD						
Moisture resistance	BRONZE	Mositer	BRONZE				
Thermal climate during winter	GOLD	Thermal climate	GOLD				
Thermal climate during summer	GOLD						
Daylight	SILVER	Daylight	SILVER				
Legionella	GOLD	Legionella	GOLD				

#### 4. From area level to building level

This stage is the most important part for the property owner, where the final grade for the building is determined, which is assessed on the basis of the lowest area grade (Table 10) (Sweden Green Building Council, 2015b).

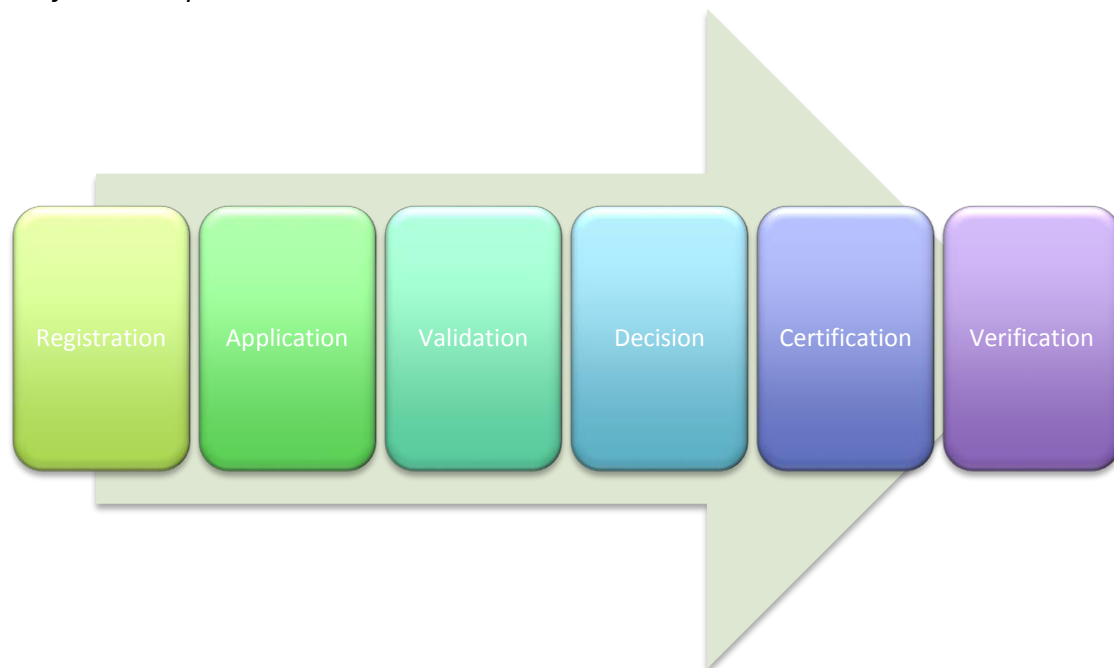
**Table 10: Illustration on the assessment of the final rating of the building**

Indicators		Aspects		Areas		Building			
Energy use	GOLD	Energy use	GOLD	Energy	GOLD	SILVER			
Heat power demand	GOLD	Power demand	SILVER						
Solar heating load	SILVER	Type of energy	GOLD						
Type of energy	GOLD								
Environment noise	SILVER	Environmental noise	SILVER	Indoor environment	SILVER				
Radon gas	SILVER	Air quality	SILVER						
Ventilation standard	SILVER								
Nitrogen dioxide	GOLD								
Moister resistance	BRONZE	Moisture	BRONZE						
Thermal climate during winter	GOLD	Thermal climate	GOLD						
Thermal climate during summer	GOLD								
Daylight	SILVER	Daylight	SILVER						
Legionella	GOLD	Legionella	GOLD						
Documentation of building materials	SILVER	Documentation of building materials	SILVER	Materials and chemicals	GOLD				
Phasing out dangerous substances	GOLD	Phasing out dangerous substances	GOLD						

The Miljöbyggnad grading tool is essential during the aggregation process, which assists to illustrate how planning and assessment of different parts of a construction process could conduct to reach less environmental impact to the property owners, project managers and consultants.

### 3.3 Miljöbyggnad certification process

*This section will briefly illustrate by figure 2 and description how the Miljöbyggnad certification is processed.*



**Figure 2: The process on assessment of the different parts, during a certification**

#### **Registration**

In order to certify a construction, first it demands to be registered. During the first step issued construction is registered at (SGBC) where the registration date determines which version of the manual is needed and which clarifications are required to accomplish a certification. The present manual at the time the building is registered is used as decision assessment criteria, which the registration will be determined upon.

#### **Application**

The application for Miljöbyggnad certification has to be received within three years after the date of registration, where a required registration fee also has to be paid in order to assess the issued registration. The application consists of completed forms which is collected from SGBCs website. The applications should be sent in digitally to SGBC were submitted forms also has to be attached with documents that confirm the accuracy of information and the applicant's proposed rating for each indicator for the building. Furthermore a specific administrator at SGBC controls that formal requirements are fulfilled and the inspector of the construction is non-bias (conflict of interest) for the required inspection. The application is then sent for a validation and an inspection fee has to be paid.

#### **Validation/ Decision**

The application is examined by independent specialists from SGBC, where specific documents and forms are compared with existing assessment criteria's. The assessment of each indicator rating, including comments from the inspector is documented in an assessment report, which the applicant will have access to. The

applicants demanded rating could be failed due to faults in property or because of insufficient information of the building. In such case the inspector can also with the technical council consider a lower rating if the requirements are not accomplished. The technical council is involved in the certification process by sample basis to check the examination, and, if necessary, to interpret and clarify the assessment criteria. In addition the inspection takes place in confidentiality and all communication between the inspector and applicants will be through an administrator. In case the inspection fails the applicant has to send in required improvements within three months in order to not stop the inspection process. The required re-inspection can then take up to three weeks.

### **Certification**

Short after the Certification Council approves the application, a certification and a plaque, which can be installed in the building, are received to the property owner. The certificate is preliminary valid in 10 years, until the final result has been verified for the completed building.

### **Verification**

Newly produced or refurbished constructions has to be verified within two years, but cannot be verified earlier than one year after the building has been taken in use. During verification of the construction, execution and functions is compared with preliminary documentations. Furthermore a new verification report is then submitted for review and must be approved by the inspector and the Certification Council. During the first year newly produced or refurbished buildings in operation has the opportunity to upgrade their indicator ratings, which in such case is reported to the verification report. After an authorized verification the construction is issued a final certificate, which upon a verification fee has to be paid.

## **3.4 On-going development of Miljöbyggnad**

*This section will give a brief description of an on-going review of Miljöbyggnad*

New governmental demands and development has been established during the years Miljöbyggnad has been operating which affect the indicators in Miljöbyggnad. When construction regulation and requirements change, SGBC update their manual versions so required indicators in the system accomplishes to the governmental requirements.

During 2015 SGBC arranged several workshops to investigate what different participants considered about Miljöbyggnad and which improvements that could be established for an updated manual of Miljöbyggnad. The served purpose of the workshops was to collect users' experiences and opinions about Miljöbyggnad as an environmental assessment method. Different private property owners, architects, contractors, energy companies, consultants, politicians, material manufacturers and different actors in the construction industry participated during the workshops.

Common point of view from the participants during the workshops was that Miljöbyggnad is a valuable assessment method to use. It contributes to reach national environmental goals and function as an advancement of knowledge in the

construction industry. As well as the assessment method is efficient for improvements of buildings. During the time of writing the case study a revision of the existing Miljöbyggnad manual 2.2 to 3.0 is being performed. Miljöbyggnad 3.0 will be processed in collaboration with different actors from the industry, academia and governmental agencies. One of the major aims with the new manual is further improvement of new indicators and demands so that additional investments to use the ECS Miljöbyggnad will be profitable for both the environment and property owners (Sweden Green Building Council, 2015b).



## **4. METHODOLOGY**

### **4.1 Research Approach**

This report is based on a case study of a building developer HSB. The case study is based on a qualitative and a quantitative approach, semi-structured interviews and a questionnaire survey. The research has examined if there is a possibility to enhance marketing of Miljöbyggnad and how different employees point of view is on Miljöbyggnad and which challenges it has during different certification processes. Moreover, combining interviews and a questionnaire in the case study provided an enhanced understanding of Miljöbyggnad. It enabled to compare how wide spread the knowledge of Miljöbyggnad is and if the difficulties and challenges are the same in the different regions in Sweden.

### **4.2 Literature Review**

A literature study is necessary to perform in order to be familiarized with the area that is aimed to investigate (Hartman, 2004). The literature review process secondary data, while primary data is included only in the case study. Primary data is gathered data, aimed for the specific study, while secondary relates to analyse existing data, which has been developed with different purpose in contrast to the actual case study (Björklund & Paulsson, 2012). Secondary data analyse existing literature, which could be examined as articles, reports, books and different websites. The literature review in this report includes to process literature studies of environmental issues in the construction industry and Environmental Classification Systems for developing environmental performances. Specific documents from Swedish Green Building council have been collected in order to understand, describe and illustrate how the certification process of Miljöbyggnad is performed.

The literature study was executed by reading different research reports, articles and academic books that cover the subject of this study. It has been important to search for relevant information in international journals to find what other experts have found in the same research area. The material has been collected through different references: Google scholar, Tandfonline, Rightslink, Chalmers and Gothenburg University libraries and the Chalmers library database, which includes access Science, Britannica online, Scopus and Web of Science etc. The following keywords and phrases has been used in order to find relevant material: "Miljöbyggnad", "BREEAM", "LEED", " environmental classification system", "green building", "Standards in the construction industry", "sustainability in the construction industry", " environmental buildings" and other phrases within the research area.

### **4.3 Case study data collection**

Case study is a regularly used qualitative research method (Johansson, 2003). This case study was performed in collaboration with HSB Mölndal. The collaboration was of great importance to accomplish major parts of this case study, such as creating a necessary platform for the questionnaire, case study and the interviews conducted. A deep investigation of the case was created, by sending out a survey in HSB and conducting six interviews.

### ***Questionnaire survey***

A questionnaire survey was created to get a picture of how employees perceive the ECS Miljöbyggnad and how it affects their thinking towards sustainability. The survey for this case study was developed to perceive an overall perspective of the difficulties and challenges the employees have using Miljöbyggnad. The survey was conducted through Google Form, which is a program on Google's website that enables to create questionnaires in an organized structure. The questions in the survey were created through discussions and feedback with my supervisors at Chalmers and HSB.

Furthermore, the survey was conducted by means of a questionnaire sent by email to 40 different employees, working with environmental issues in all different regions in HSB. The survey consists of two sections, where the first section concerns to find the employees' attitude towards thinking eco-friendly and how environmental questions are perceived in HSB. The second part comprehends to collect information about difficulties and challenges with Miljöbyggnad and how sustainability is perceived at HSB.

Main questions of the survey were the following:

- Which/what indicators do you think is most difficult to deal with?
- Which/what indicators do you think contributes most deviation?
- Which/what indicators do you think is most expensive to operate?

The questionnaire was divided in two sections where the first section includes questions on a more general basis, while the second section focused on specific question about Miljöbyggnad. Thus in order to answer these questions some form of experience with ECS Miljöbyggnad was required. The first part of the survey had a 55 per cent response-rate, while the second part had a 48 per cent response-rate due to criteria of the questions.

The survey was statistically analysed by a summarized document, which Google form present from the received answers. The questions were written and sent out in Swedish (see appendix 4).

### ***Interviews***

According to Merriam (1994) qualitative researches focus on understanding how different individuals identify situations. A qualitative approach was chosen to be suitable for the aim and purpose of this research. One of the motives with the case study was to examine how Miljöbyggnad are applied in projects and what challenges and difficulties there are in order to certify a building. The interviews were conducted to collect more information on how Miljöbyggnad is used and which difficulties the system have brought to HSB, both practical and theoretically.

Interviews were an effective way to collect information and gave a better understanding on where the problems occur and where the challenges lay in ECS

Miljöbyggnad for the building developers. The persons that were interviewed had personal experiences, of working with Miljöbyggnad.

There was a general focus on four main questions during the interviews:

- Which/what are the most challenging indicators during a Miljöbyggnad Certification?
- Which/what indicators are most critical to improve? Regarding costs and work process
- What challenges have Miljöbyggnad brought to the organization?
- Why is there a less focus to certify existing buildings?

A total of 6 persons were interviewed: two project managers at HSB, one energy consultant and environmental coordinator at HSB, one consultant working with Miljöbyggnad at Swedish Green Building Council and one external consultant at a construction company working with certification of Miljöbyggnad for different building developers. The individuals are anonymous and mentioned in general by their work title in the case study. The interviews were made on a semi-structured basis in order to allow the respondents to answer more freely (see Appendix 2). All the interviews were conducted in Swedish through meetings at the interviewee's offices or by telephone. In order to reduce the risk of missing anything during the conversations, all the discussions were recorded, which enable a more accurate interpretation. Transcribing interviews are an explanatory process for the researcher, which enable to create and enhance the understanding of the data during the process of converting audio to text according to Kvale & Brinkmann (2009). The interviews resulted in great data collection, where the length of the interviews varied between 45- 60 minutes. All the interviews were transcribed and a summary of all interviews is presented in the finding chapter of the case study. The interviews provided a solid basis to strengthen and draw conclusions concerning the aim of the case study.

#### **4.4 Comments on limitations of selected approach**

The author has no earlier experiences of the construction industry besides theory and practises that has been gained during the studies as civil engineer. The research was made alone, therefore, the amount of interviews and target group of the questionnaire were organized to be large enough to make a sound analysis of the collected data. However, the case study only focuses on one building developer, which can be seen as a limitation. All the data that has been collected during the research process, has been critically analysed based on the similarity and dissimilarity of the interviews and questionnaire responses, which could be found in the appendix chapter. It is important to notice that there is always some uncertainty among the collected and analysed data. The interviewees and respondents have different perspectives due to different backgrounds and work position. Therefore, a critical analysis is of major importance. The organized question for the interviews and the questionnaire could have resulted to be conducted different, if the audience of the

questionnaires were larger and other employees were interviewed. Further it is important to consider the validity of the case study. Validity assesses to measure if the research results are reliable and if the purpose of the research has been fulfilled (Golafshani, 2003, Roberts et al., 2006). In order to minimize the risk of misunderstanding, all the interviews were recorded in order to be accurately analysed. Other material that has been collected during interviews, HSB and SGBC has a high reliability, due to that the material can be address to the authors and those who has published the material.

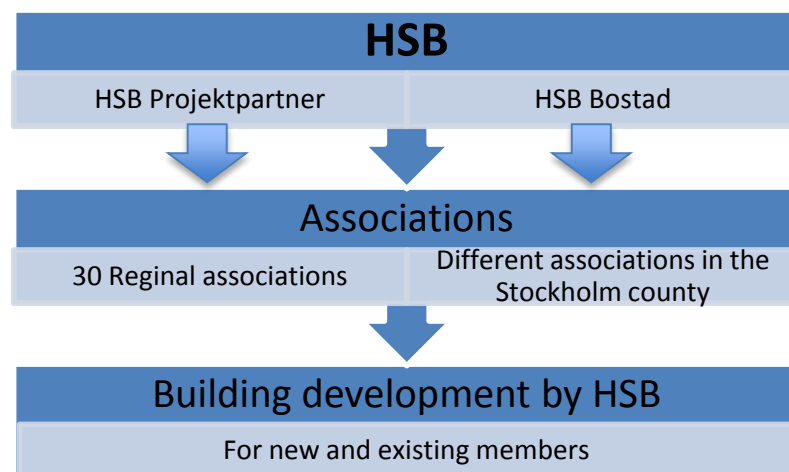
## 5. The case of HSB – A Swedish building developer

This chapter will give a brief review of the HSB organisation.

### 5.1 HSB

HSB was established 1923 with the main objective to develop housings that provide good quality, improved space possibilities, higher standard for their members and affordable housings for large population groups (HSB, 2015b). HSB is today a cooperative housing association owned by its 560 000 members, which functions at a national, regional and local level. HSB represent 30 regional cooperative associations and have 3900 cooperative local housing associations as members. HSB manages 335 000 real estates with a total market value of 612 billion SEK (HSB, 2015c).

HSB Housing Association also owns two companies, HSB Bostad and HSB Projektpartner. These are two business corporations with focus to develop buildings for both new and existing members (HSB Riksförbund, 2014). HSB Projektpartner is owned by 30 regional associations and operates all over Sweden, while HSB Bostad is owned and operated by different associations in the Stockholm County. The aim for these two companies is to provide services such as project management, project and production finance, interior design, marketing, sales, market analysis and legal services (HSB projektpartner, 2015).



**Figure 3:** Illustration of HSB Projektpartner and HSB Bostad

### 5.2 HSB sustainability measures

HSB has a strong commitment to the environment and has a focus to develop and maintain sustainable living standards. HSB has a cooperative goal to reduce their CO2 emission with 50 per cent until 2023 in comparison to their levels of emissions during 2008. In December 2013, board members of HSB Projektpartner and HSB Bostad decided to certify all their new constructions according to the ECS Miljöbyggnad Silver. The motive behind the implementation of ECS is to construct buildings that are environmental friendly with low energy usage, improved indoor climate and improved materials (HSB Riksförbund, 2014).

There is also a huge focus to improve future households where HSB has created an innovation project, called HSB Living LAB in Gothenburg. The aim of the project is to

enhance the quality of both present and future buildings for a more sustainable lifestyle. The project is a collaboration between HSB, Chalmers University of Technology, NASA, Johanneberg Science Park and several other actors in the construction industry. HSB living lab is planned to involve a four-storey building with major parts that are detachable. The building will provide an exhibition section for offices, residential section offering homes, meeting rooms and a showroom for research results etc. The building is constructed with removable internal and external parts with objective to test different materials of interest. However, short and long-term research will be executed, during a ten-year time, where students will be living in the research buildings, while on-going research projects will occur at the same time. HSB Living Lab will provide a new forward thinking and innovation approach to sustainable living. The purpose of HSB Living Lab is to implement the improved solutions and materials, which is provided from the researches in existing and future homes and buildings (HSB, 2015a).

Furthermore HSB has during 2014 collaborated with the government and several actors on the market with an aim to increase energy-efficiency, reduce the housing sectors carbon footprint and also further develop a non-toxic environment.

HSB is also a member in Swedish Green Building Council with the purpose to follow industrial developments and be further involved in the developing process of Miljöbyggnad (HSB Riksförbund, 2014).

## 6. Finding questionnaire survey

Data presented in this section are based on responses from the questionnaire. The total response rate of the survey was 55 per cent. 22 employees answered the first section of the survey, while 19 responses were collected in the second part due to a demand to know what Miljöbyggnad is in order to answer that part.

### Part 1 - The employees' environmental attitude

In this section, different questions about how employees behave in their work life was investigated, in order to get a perspective on how their practices affect their eco-friendly behaviour, following questions were asked:

- **To what extent do you agree with the following question:** You switch off the lights, turn off the computer screen or close the window when you leave the office for at least 30 minutes?
- **To what extent do you agree with the following questions:** You take into account to choose environmentally friendly and energy efficient products when purchasing goods?

Regarding the employees' eco-friendly behaviour in their offices, they continuously try to consider reducing their energy usage during work time. In addition, 86 per cent of the surveyed answered that they frequently choose to purchase products that are environmentally friendly. The same quantity was also convinced that there are things that they could organize in their daily work in order to prevent climate changes. Of those surveyed, 64 per cent were willing to be informed or educated in order to reduce their climate impact.

These indicate that several of the employees' regard sustainable thinking as important during their daily work. In order to develop and reach environmental targets that the organization has set, environmental acceptance and practise on basis is vital for HSB.

### Part 2 - Miljöbyggnad in HSB

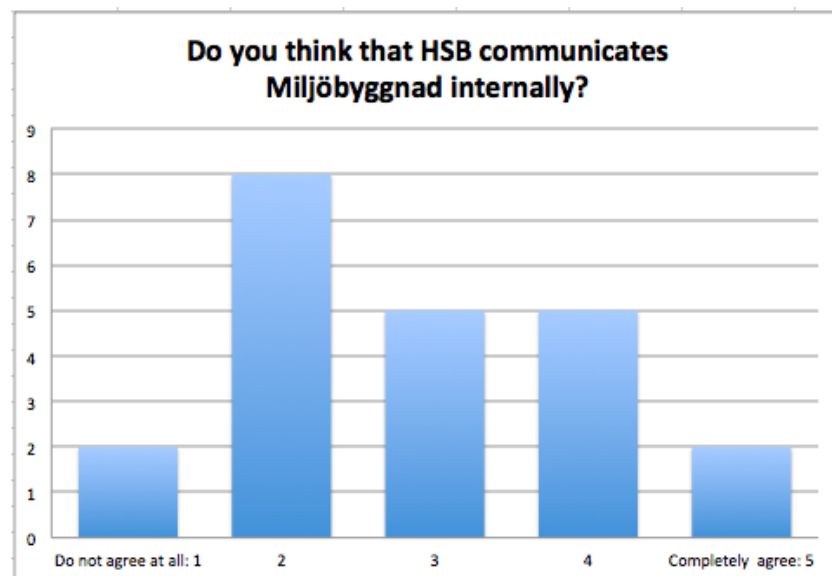
In order to answer the questions in section 2, the respondents were required to sustain knowledge or have an education in Miljöbyggnad. Assessing the second part, 63 per cent of the surveyed were educated in Miljöbyggnad certification. Three different open questions about the indicators in Miljöbyggnad was formed in order to analyse what the employees think about the different indicators:

- Which/what indicators do you think is most difficult to deal with?
- Which/what indicators do you think contributes to most deviation?
- Which/what indicators do you think is most expensive to operate?

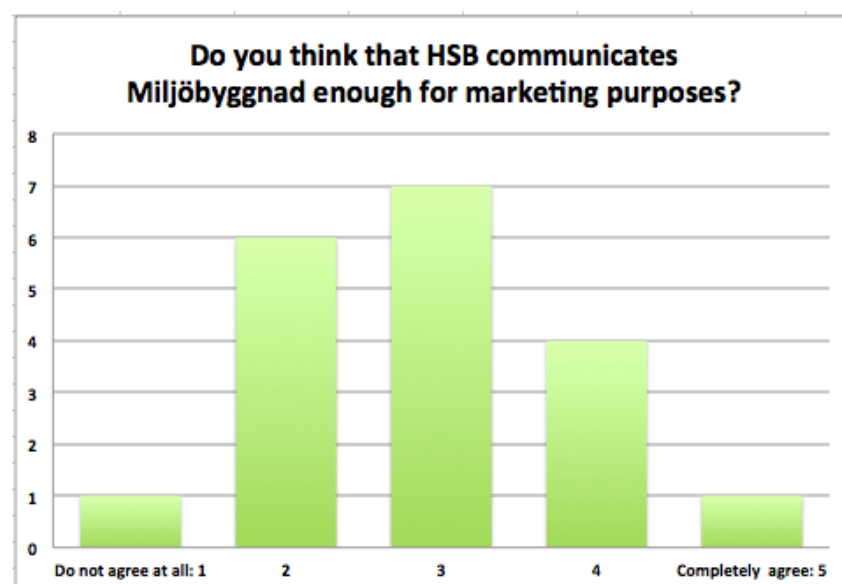
The answers from these questions presented that indicators *daylight*, *environmental noise*, *solar heating* and *energy use* are the most challenging indicators to work with. The same indicators were also seen as difficulty to deal with during the conducted

interviews. This indicates that there may be an overall challenge to apply indicators in major parts of the association, which HSB should assess to evaluate and improve.

Two questions comprehend what employees think about how HSB communicates Miljöbyggnad internally in the organization respectively externally for marketing purpose.



**Figure 4:** The questions were based to be answered in a scale of 1-5 where 1 are not at all, and 5 is completely (figure 4 and 5).

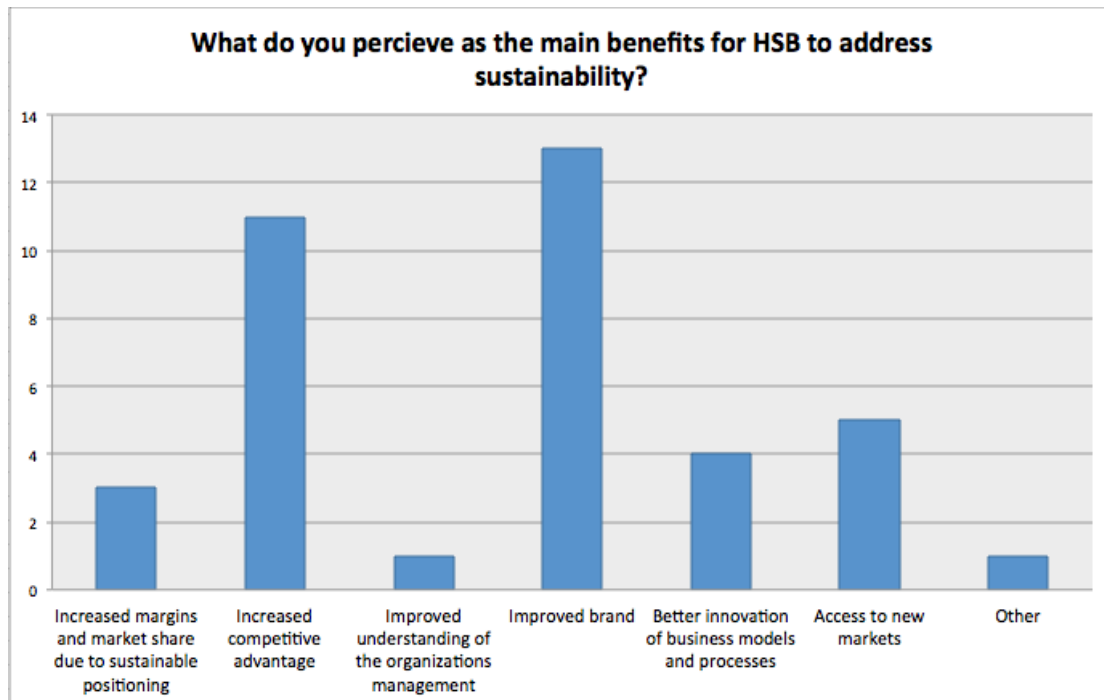


**Figure 5:** This figure illustrates in which scale the employees consider that HSB Inform Miljöbyggnad for marketing purpose.

As shown in figure 4 and 5, majority of the collected responses indicate that the employees believe that there is a possibility to further improve internal communication among different associations and also enhance marketing of Miljöbyggnad to potential costumers.



The last question of the questionnaire survey investigated what different employees regarded as benefits for HSB to addressing sustainability.



**Figure 6: Shows what the employees' consider as benefit of addressing sustainability**

The respondents were able to choose between two of six different alternatives. This option was enabled because sustainability presents a large field of different actions, which could be found as difficult for the respondents to only address the benefits to one answer. Of those surveyed, 13 individuals believed that *improved brand* is a clear benefit followed by *increased competitive advantage* which scored 11 answers by addressing sustainability in the construction industry. *Increased margins and market share*, *access to new markets* and *improved understanding of the organizations management* were also obtained as valuable for the organization by observed sustainability in the business.

## 7. Interviews

### 7.1 Miljöbyggnad in HSB

Environmental certification systems have developed to be an important tool, essential to be included through the whole construction life cycle. This is mostly due to the demands and regulatory from stakeholders, government and building developers. According to the interviewees, BREEAM and LEED are more suitable for large building developers such as NCC and Skanska, especially considering that these firms operate internationally and build commercial buildings. Commercial buildings tend to have international buyers and tenants, which makes BREEAM and LEED to be more suitable systems to use. The environmental coordinator at HSB argued that HSB only operates in Sweden where Miljöbyggnad is modified according to Swedish norms and regulations. That makes Miljöbyggnad the best adaptable certification system to use.

Moreover, common view during the interviews was that Miljöbyggnad is easy to interpret. It basically focus on the building and works as a checklist. It enables those who apply the system to focus on 15 different indicators that are vital in order to certify a building. In addition, some of the indicators rated in Miljöbyggnad are already legislative demands from different authority's and municipalities, making it even easier to adapt. According to one of the interviewed project managers, Miljöbyggnad enables all involved actors in a project to be aware of environmental issues around a project. By having one system to follow, Miljöbyggnad assist the project managers to exactly know how it functions, understand what they are working towards and have a clear vision on the final outcome. Furthermore, the project manager at HSB argued that due to different opinions in an organization, environmental directives could otherwise be complicated to enforce. Each one of the interviewed persons specified that Miljöbyggnad is useful and easy to use during building developments.

According to the environmental coordinator at HSB, HSBs board of directors has decided that all newly produced buildings within HSB must be certified with Miljöbyggnad Silver. On the question why HSB do not choose to certify their buildings with the gold rating, the project managers at HSB described that certifying according to gold rating, will require stricter regulatory demands for the indicators. These requirements entail additional expensive products and services such as more energy efficient windows with improved U-value, additional consultation hours and improved choice of material. All mentioned factors are required in order to improve the environmental noise and energy usage inside the residence. The project manager also argued that the final rating of the building is decided upon a survey, which the tenants have to respond to. The survey evaluates the tenants' answers on how they receive the indoor climate and several other parameters one year after they have settled in the new residence.

There is uncertainties related to this tenant evaluation, one project manager at HSB state:

“You can never be sure what response the survey will provide,  
because different individuals have different opinions”

The quote highlights that despite the amount of money and effort that the organization put on a project it is not sure they will reach the gold rating demand. Thus, the construction developer can never be certain on the final outcome of the rating due to the received responses from the survey.

However, some of the interviewees argued that it is important to observe the competitive situation on the market. Silver is the most common choice of level for building developers using Miljöbyggnad. If HSB choose to certify their buildings according to the gold rating, the residences will end up to be more expensive for the potential buyers. The price competition between the companies could result in less sold residences for HSB while competitive building developers would sell more residences due to lower prices.

One of the project managers at HSB explained that a payoff-calculation is made for each project where Miljöbyggnad is included. The payoff-calculation shows the time it takes before the investment of ECS is perceived. According to the environmental coordinator at HSB, the additional cost by using ECS Miljöbyggnad could approximately be estimated to 100-150 000 SEK for the total building. Furthermore, dependent on the size of the building, the certification cost could end up being more expensive.

Aside from certification of new buildings, a main question during the interviews was, *why HSB do not certify existing buildings*. Several of the interviews claimed that HSB has developed an assistance service that could be used by different housing associations in order to certify existing buildings. The environmental coordinator stated that many associations have already made the main controls, which are mandatory to be assessed during a certification process. Some of the main controls are ventilation, radon and thermal controls. Since majority of the associations have no aim to sell the buildings, they are less willing to reclaim the additional cost that is incurred. Examples of additional costs during the certification could be exchange of material, removing hazardous material containing PCB, inventory of material etc.

During the interviews, added value of Miljöbyggnad inside and outside the organisation was discussed. The interviewed employees at HSB argued that Miljöbyggnad should be better informed between different associations. By constantly discussing and informing the employees about Miljöbyggnad in annual presentations and newsletter could improve the added value.

One of the project managers stated that Miljöbyggnad is well known in the construction industry but less branded in society and among consumers of residences. Several of the interviewers argued that by applying Miljöbyggnad *silver* and not only assess the building according to BBRs regulatory demands, an added value is created for the construction developers. It enables building developers to construct in a standardized and environmental friendly way. The building developers are then able to receive a quality assurance, which is executed by a third party and is beneficial for the tenants. Additional values for the tenants by implementing Miljöbyggnad *silver* or

*gold* instead of bronze or only BBRs demands, are sustainable residences with enhanced *air quality* and *internal climate*, improved *daylight*, reduced *noise*, lower *maintenance costs* and lower *energy usage*. These benefits are something that potential consumers value during investment of residences, which are important to be presented and marketed to potential consumers according to the consultant at SGBC.

However, all of the interviewed employees at HSB argued that there is a lot of potential to improve marketing of Miljöbyggnad. Additional marketing and effort should be put to communicate Miljöbyggnad to potential buyers. The consultant at SGBC clarified that SGBC is a non-profit organization and lacks money to invest in any marketing. In addition, the consultant also specified that majority of those who apply Miljöbyggnad have worked hard to find solutions for the problems that have occurred for some of the indicators in the projects. Building developers, which apply Miljöbyggnad, have to enhance the marketing of Miljöbyggnad in order to establish the brand in the society as well as informing the tenants the benefit Miljöbyggnad provide in comparison to non-certified buildings.

## **7.2 The implementation process of Miljöbyggnad in a construction**

During the interviews different questions were asked regarding how HSB applies Miljöbyggnad in their projects. According to several interviews, an environmental classification plan is implemented in each project. All necessary requirement and readjustment is listed for all indicators in the classification plan in order to reach Miljöbyggnad *silver*. Furthermore, environmental meetings are pre planned in the planning stage in order to inform and assess involved actors in how to certify and follow the indicators during the building process. HSB ensure to follow all the indicators in their construction process on the basis that there are consultants that manage to estimate preliminary energy, light and other necessary calculations. The calculations is then reported to the project manager or the environmental coordinator, which are responsible to implement and manage them in the pre planning phase and through the whole project to ensure that all legal demands and requirements are achieved. Failing one single indicator can risk the final rating of the construction completely and be difficult to readjust later in the project. The environmental coordinator argued that, therefore it is important to critically calculate and evaluate the demands that are required for the different indicators.

The *daylight* and *solar heating* indicator combined with the *energy* indicator has during all interviews been mentioned to be the most challenging indicators in Miljöbyggnad. The energy consultant at HSB clarified that it is difficult to manage how to obtain the right amount of sun and natural light and at the same time avoiding higher temperature in the building. Another indicator that is related to the *daylight* and *solar heating* is the energy usage in the buildings. Reduced energy usage during heating of the buildings requires in most cases more insulation in the walls, which is expensive but provides a lower energy usage in long-term. Several of the interviewees stated that involvement of the architects in the planning phase of the projects perform a vital part during an environmental certification process. The *daylight* indicator is one of the most time demanding parameters to work with and it is dependent on other

calculations at the beginning of the project. The architects' selection of material and sketching of the building has to comply with the different indicators. By involving the architect in an early stage, calculations and constant controls can be organized in order to comprehend if the daylight requirements are achieved for the building. An early involvement of the architect also provides reduce possibilities of unnecessary work, costs and failing to certify the building.

The environmental coordinator at HSB in Gothenburg explained that majority of the project managers in the different regions in Sweden are responsible to control and implement Miljöbyggnad in their projects. HSB Gothenburg uses an environmental coordinator, which works between the architects, project managers and other involved actors in order to control that all requirements and demands for Miljöbyggnad is achieved during the project. Furthermore, the environmental coordinator argued that monitoring different environmental actions and issues requires a lot of process and time during the projects. Therefore, it is important that other regions try to employ someone, in order to have somebody responsible to follow up Miljöbyggnad through the entire building process in future projects. Less focus on environmental actions and indicators could result failed rating for the building. The environmental coordinator exemplified this issue by mentioning that HSB has failed to certify two buildings due to lack of observation and focus on the *daylight* indicator. Moreover, the different interviewees stated that Miljöbyggnad has only been operated to certify buildings during 4 years and that it takes time to process and evaluate how to improve the system. The interviewees considered that the quantity of indicators in Miljöbyggnad should remain the same as it is today, in order to not make it more complex. It was also seen critical, that further improvements and exchange of the indicators are made in order to advance sustainability in the construction industry.

### **7.3 The future of Miljöbyggnad and sustainability in the construction industry**

BBR's building demands and requirement always applies during new production and refurbishment of buildings. In order to receive a valid building permit, an inspection of BBRs requirements including the daylight parameter has to be controlled and approved by the municipalities housing and urban development offices. One of the interviewed consultants, argued that lack of critical inspection for the *daylight* indicator while approving building permits, has resulted that the *daylight* parameter has become more complex to manage. A consultant at SGBC specified that municipalities have to make more critical and precise controls upon BBRs demands in order to avoid unnecessary complications in the future. In addition, if the municipalities execute more accurate controls, the *bronze* rating in Miljöbyggnad would end up losing its purpose. That is because it only complies to BBRs demands with an added third party assessment on the basis to attain a quality assurance for the building.

Moreover, future improvements and development of sustainability and Miljöbyggnad in the construction industry was discussed during the different interviews. The majority argued that Miljöbyggnad sets no requirements on how the building

developers manage energy usage and transports to and from the construction sites during building processes. Furthermore some of the interviewees argued that it is important to improve the efficiency of the energy usage for already existing buildings. One of the interviewed consultants stated that in order to reach the zero net emission goal the government has set, it is essential to improve the energy usage of old buildings, which approximately consume twice the amount energy than newly produced buildings. The consultant also mentioned that analysing a buildings life cycle, indicates that between 80 and 90 per cent of the buildings energy consumption is merged during its using stage. The majority of the interviewers saw it important to further develop and improve the energy usage of existing buildings in order to reduce the environmental footprint.

One of the project managers claimed that due to international purchases of building materials, HSB as well as other industry actors are source of large amounts of pollution. These materials are often shipped to Sweden and then further transported by trucks to the construction site. The project manager illustrated that it requires approximately 100 trucks to freight the construction frames loaded on one boat. In many cases these cargoes are transported through major parts of Sweden in order to be delivered, which entails to large amount of carbon emissions. Numerous of the interviewers considered it important to improve and combine the transports of construction materials from the manufacturers and other transportations from the construction sites in future projects.

Several of the interviewers argued that Miljöbyggnad should include evaluating how waste on the construction site, transports and energy usage of construction machines is during the entire building process. The consultant at SGBC stated that since Miljöbyggnad has become an important tool for the industry, SGBC find it important to involve the different actors in the construction industry to provide feedback and suggestions for the new Miljöbyggnad manual 3.0. By involve actors will be a part of the development of the system and possibly pay more attention to environmental issues in the future.

Moreover, according to the consultant at SGBC, environmental issues are easier to adapt in the construction industry in the present, in contrast to two decades ago. Many of the interviewers argued that new ideas take time to process within the construction industry, making it slow to change. Several of the project managers found it important to have environmental meetings with those who apply Miljöbyggnad in the future, to share the knowledge and experience that has been perceived from the different projects. All the interviewees argued that they thought more buildings would be certified trough Miljöbyggnad in the future. In addition they also argued that Miljöbyggnad has the potential to be further developed and play an important part in the industry, and possibly become an industrial standard in Sweden.

## 8. Discussion and conclusion

The main finding that is presented in the previous chapter creates a basis for discussion.

### 8.1 Sustainability and standards in the construction industry

Perhaps one of the main reasons for enhanced sustainable performances by the building developers are due to stricter governmental demands. The Swedish government has 16 objectives in order to reach a long-term sustainable development. This is in line to that HSB has established different environmental goals in the organization.

Due to the structure of the construction industry, environmental innovation has for decades been challenging to be implemented. According to Gluch et.al (2005) and Cole (2005), the construction industry has to rethink and modify their way of processing constructions in order to decrease their environmental negative impact. Construction developers have to implement sustainable strategies into their businesses, to be able to reach objectives and requirements set by the government.

To accomplish long-term environmental developments, several of the interviewees argued that there is a link between innovation and the employees environmental behaviour in the organizations. This could be interrelated to the questionnaire, where 86 per cent responded that they attempt to apply environmental friendly approaches during their daily work life, which seems promising for the organizations environmental development. In addition one of the project managers at HSB stated that the research area *HSB Living Lab* is an innovative exploit made by HSB, which are hoped to create and contribute to new thinking, learning and implementation of materials and solutions in order to further develop sustainable buildings.

Thus, HSB Living Lab is a promising concept with an incentive that inform new and complex solutions about environmental building performances to potential investors, clients, tenants and others. The research may also provide that new constructions are certified according to Miljöbyggnad gold. In addition, it may also contribute to educate and enhance the knowledge of sustainable solutions and actions internally in the organization. This could be linked to the questionnaire survey from the case study, where several of the employees' have a wish to be further informed and educated from an environmental perspective.

Moreover, the industry has taken a new turn, where sustainable strategies and processes are applied on a regular basis in the construction companies (Gluch et al., 2011). The frame of reference in the thesis presented that building developers address environmental actions in order to decrease the industries environmental impact. Environmental actions provide to create sustainable constructions, which combine social equity, economic growth and environmental protection, also called as *triple bottom line*. Aysin (2008) and Hubbard (2006) argue that by adopting sustainable strategies, *triple bottom line* benefits could be created for the building developers and potential tenants. These benefits provide residents with improved quality and lower maintenance costs. In addition, these benefits also enforce their employees' to

minimize their organizations ecological footprint.

However, by implementing Miljöbyggnad, all involved actors are informed and aware of which specific environmental goals that need to be reached, where assessment of environmental issues is executed in a systematic way. Miljöbyggnad can be applied as a standard, since it is not statutory for the organizations and is also a method, which regulate potential adopters to achieve improved quality or activity of a process.

## **8.2 The implementation of the ECS Miljöbyggnad**

Johansson and Yakhyeva (2012) state that the demand to use ECS systems for houses and apartment, before 2012, was relatively low in Sweden. Implementation of new systems can take time for organizations, where the ECS Miljöbyggnad has only been adopted to certify constructions in HSB during 3-4 years. After interviewing different project managers, consultants and the environmental coordinator, it can be concluded that Miljöbyggnad *silver* has issued several problems and challenges during the years the system has been used.

The responses from the interviewees and the questionnaire specified that especially the indicators *solar heating*, *energy usage* and *daylight* are the most *cost* and *time* demanding indicators to apply. It was claimed that mentioned indicators above has in earlier projects, due to the challenges of applying them in the construction, failed the level of rate the construction has aimed for. Analysis and experiences from earlier projects has indicated that it is of major importance that all indicators are carefully assessed, calculated and analyzed in the pre- planning phase. Early involvement of actors and continuously follow up during the project is essential. The interviewers suggested that an overall review of the Miljöbyggnad manual should be performed, where new approaches on how to improve the challenging indicators are evaluated. However, from an environmental perspective, it was claimed during the interviews that the project managers have a huge-responsibility during building projects where the assessment and application of Miljöbyggnad could be compromised due to lack of time and monitoring the different indicators. The environmental coordinator thought that the application of Miljöbyggnad should be assigned to a specific employee, which has a main focus to assess the environmental issues and constantly follow up the indicators during the construction process. One possible suggestion by analyzing the results is to educate additional employees in the different regions, which could serve to assist each other and be responsible to assess and apply the specific indicators in different projects. Thereby, the benefits are that new solutions, knowledge and specific responsibility areas are created, which could constantly be exchanged. In addition, it also reinforces to inform and educate the employees internally in the organization, as well as it reduces additional expenses for external consultants in long term.

Even if HSB has created a Miljöbyggnad certification assistance service for existing building, there is no main demand and focus today from different HSB associations to apply Miljöbyggnad in existing buildings. The service assesses the buildings



environmental issues and to apply necessary environmental actions. However primary reason for low interest to certify existing buildings by the associations are the added expenses, which are created by the certification and that possible demolitions and reconstructions for replacement of hazardous material is required. As mentioned earlier the ECS Miljöbyggnad is relatively new for the building developer HSB, ongoing improvements and evaluation of the challenges Miljöbyggnad silver have caused is under progress. By the fact that HSB has already established a service, which provides to certify existing buildings, indicates the building developer effort to advance their environmental actions in the organization. A possible recommendation is to apply the certificate on a few experimental buildings, which could demonstrate the benefits of a certification and positively raise the demand for certification of existing buildings.

### **8.3 Further improvement and marketing of Miljöbyggnad**

HSB like many other construction developers has during the last years been attentive that implementation of ECS is necessary in order to fulfill governmental and consumer requirements. They have since 2013 chosen to certify all their new construction with Miljöbyggnad silver, as similar to many other construction developers in Sweden. As presented earlier in the thesis, Miljöbyggnad can be assessed on three different levels *bronze*, *silver* and *gold*. *Bronze* is at the same line as governmental requirements, but with an added quality assurance, where the *gold* level serves to implement higher requirements than Miljöbyggnad *silver*. Using the terminology from McDaniel and Rylander (1993), Miljöbyggnad *silver* is an assertive approach since it is not legally demanded from the government and also *complies* to apply more than the government and potential consumers requires.

It was claimed during the interviews that Miljöbyggnad *gold* demands stricter requirements in contrast to Miljöbyggnad *silver*. For example a gold rating requires a questionnaire, which needs to be assessed by the tenants to determine the final rating of the construction. Further the systems assess 65 per cent lower *energy usage* than national requirements, lower *heating power*, lower *solar heating* and improved *noise protection in contrast to the silver rating, which has lower regulatory demands*. These demands require improved systems and material such as ventilation systems, more energy efficient windows with lower u-values and insulation in the walls. Furthermore, the assessment of a gold rating demand specialized expertise, which requires recruiting consultants by cause of lack of internal expertise in the organization. One of the project managers argued that since production of buildings is dependent on the variation of demand on the market, it more flexible and affordable to employ external consultant when it is required.

According to several interviewees the gold rating substantially increase total costs of the building, which are also argued to be a major barrier during development of sustainable buildings (Mellon, 2011, Yudelson, 2008). To estimate the time it takes before the investment of the certification is received, one of the project managers at HSB stated that before every new construction project, a pay-off calculation is executed. Moreover, the certification cost is calculated on the total cost of the construction and not for each house or apartment. One suggestion could be to

calculate the certification cost per square meter or for each apartment. This method could be beneficial, since it may increase the possibility to implement a gold certification, where the expenses are divided on the basis of the size of constructed residences. In addition, it will also increase the standard of the construction simultaneously as it make the building more environmental friendly.

Several of the interviewers claimed that it is important to observe the price competition between the different building developers on the market. If the competitors charge lower prices for their residences, some investors may not be willing to pay more for a certified residence. These arguments reinforce that it is vital to communicate and market the benefits the certificate adds to potential investors, as well as the employees' in the organization. According to Levitt (1983) "the purpose of a business is to create and keep a customer", this statement implies that marketing plays a vital role to identify and meet the costumers' demands (Jones et al, 2008). Communication is today seen as a method to influence and maintain relationships, create values and common goals and also form a socially constructed reality (Heide et al., 2012). Hoogervorst (2004) argues that organisational performances are in major determined by the employees' behaviour. This could be compared to the answers and response collected from the interviewers and the questionnaire survey from the case study. The majority considered a possibility to improve the marketing of Miljöbyggnad, which could enhance to inform and clarify the received benefit the implementation of Miljöbyggnad creates for potential investors.

In addition, the responses collected from the questionnaire survey indicated that the benefits advanced by HSB addressing sustainability could create *increased competitive advantage* as well as *improved brand*. Thus, the *gold* and *silver* certification does not only contribute to sustainable buildings, but also lower the maintenance cost for the residents and house owners. Albinsson et al., (2005) claims that potential investors have an incentive to pay more for apartments or houses, which are environmental friendly and has, lower maintenance expenses. Gordon et al. (2011) and Christensen (1995) claim that improved marketing of Miljöbyggnad serves to implement sustainability in the construction developer activities, while creating a balance to protect the environment and be profitable at the same time. The latter is something that HSB should evaluate as a marketing strategy, where environmental friendly products can act as a decision making factor from an investment view for potential customers.

Moreover, the different interviewees were extremely critical to the questionnaire, which is demand to be answered by the tenants, for determination of a Miljöbyggnad *gold rating*. It was argued that if additional work, costs and time will end up being irretrievable from a cost perspective for the building developer. The demand of questionnaire is one of the reasons why many constructions developers have chosen to not certify according to the *gold certification*.

It would be interesting to evaluate certify according to *gold* in contrast to *silver* in a narrower analysis. In order to perform this analyse, precise documentation of additional material, added costs and workload is required to be documented during

the entire construction process. In addition it is also interesting to evaluate how effective it would be if HSB chose to educate additional employees in HSB with Miljöbyggnad instead of hiring external consultants.

## **8.4 Conclusion of the research questions**

*This part will give brief answers on the research questions of this report.*

### ***1. Which are the major difficulties, using the Miljöbyggnad certification system, in order to certify a construction?***

Based on the findings of the case study, the major challenges in Miljöbyggnad are to assess the different indicators as well as having a constant focus on the environmental actions during the entire building process.

### ***2. Why did HSB decide to certify their buildings on the basis of Miljöbyggnad silver and not gold?***

Miljöbyggnad *gold* is a more expensive certification assessment to apply. The building developers are also critical to the questionnaire, which is included to be answered by the tenants. Moreover, HSB has no incentive to take the risks, necessary to invest for gold certification in the present.

### ***3. Why is there less focus on certifying existing buildings?***

In the present, none of the different housing associations in HSB are willing to reclaim the cost that is incurred by the Miljöbyggnad certification.

### ***4. Is there any possibility for improvement of Miljöbyggnad both internally and externally in the organization and from a marketing purpose?***

Enhanced education and information of Miljöbyggnad internally in the organization could be a possible action by HSB, as well as improving the marketing to potential costumers by addressing benefits Miljöbyggnad certification contributes.

### ***5. Which improvements could be made in the system in order to have a better flow through the process?***

One possible suggestion is to employ someone, who follow up Miljöbyggnad through the entire building process and is directly in contact to assist the different actors involved in the project.

## **9. Practical implications and recommendations on further research**

This report explores the implementation process of an environmental certification system Miljöbyggnad, used by the building developer HSB. In order to improve the process of Miljöbyggnad, following suggestions are given:

### ***Management of construction waste on site***

Other environmental classification systems as BREEAM, LEED include assessing the waste and energy usage of material on the construction sites. It is important that further development of Miljöbyggnad includes assessing how to effectively manage waste, recycling, energy-usage transports and emissions during initial constructions. However this should be implemented by assessing how the waste and transports has been managed during the whole construction process, which affects the final rating of the building.

### ***Usage and transports of material***

It was claimed during the interviews that numerous of construction developers, purchase large quantities of construction material from other countries, which is transported to the construction sites in Sweden. Miljöbyggnad should serve to assess efficiency of transports and domestic purchasing of material in order to reduce the impact of carbon emissions as well as supporting national manufactures.

### ***Certification and improvement of existing buildings***

Improvement and certification of existing buildings are important, since some of the existing constructions contain hazardous material and consume at least twice the amount energy in contrast to new apartments and houses. This should be demanded by the government in order to improve the environmental footprint of existing constructions.

### ***Marketing of Miljöbyggnad***

Enhanced marketing of Miljöbyggnad is essential, which informs the benefits the certification adds, as well as it shows that the organization is environmental active, to potential investors and actors. However, a strong marketing policy could attract and increase the willingness to pay more for an environmental classified construction since it also reduce the maintenance costs and energy-usage. Added marketing of Miljöbyggnad could also increase find potential investor willing to pay more for an environmental classified building and increase the possibilities to implement more advanced certification systems as for example Miljöbyggnad gold.

## References

- Albinsson, M., Allgurén, A., Eak, H., and Wijk, S. (2005) *Marknadens intresse för energieffektiva småhus*. Gothenburg: NCC Construction Sverige AB. [Rapport] NCC Teknik.
- Aysin, S. (2008) *How Can the Construction Industry Contribute to Sustainable Development? A Conceptual Framework*. *Sustainable development*, 17(2009), 161-173
- Björklund, M., Paulsson, U. (2012) *Seminarieboken : att skriva, presentera och opponera*, 2:1th Edn. Lund: Studentlitteratur AB.
- Bossink, B. (2004) Managing drivers of innovation in construction networks. *Construction Engineering and Management*, 130(3), 337-45.
- Boverket., (2014) *Miljöpåverkan från bygg- och fastighetssektorn 2014*. Karlskrona: Boverket. (Report: 2014:23)
- Boverket. (2015) *Bygg & renovera energieffektivt*. Karlskrona: Available at: <http://goo.gl/kPPebq> [Accessed 12 November 2015].
- Brown, N., Malmqvist, T., Bai, W., and Molinari, M. (2012) Sustainability assesment of renovation packages for increased energy efficiency for multi-family buildings in Sweden. *Building and envrionment*, 61(1),140-48.
- Brundtland, G.H. (1987) Our Common Future-Call for Action. *Environmental Conservation*, 14(04), 291-94.
- Brundtland, G.H. (1989) Global change and Our Common Future. *Environment: Science and Policy for Sustainable Development*, 31(5), 16-20, 40-43.
- Brunsson, N., Jacobsson, B. (2002) *A world of standards*. 2th Edn. New York: Oxford Univeristy Press.
- Choen, E., Goulding, J. (2008) Building and Construction Classification Systems. *Architectural engineering and design management*, 4(3), 206-20.
- Christensen, P.D. (1995) The environment: It's not time to relax. *The McKinsey quarterly*, 4(4), 146-54.
- Christin, G., Fetsko, M., and Hendrickson, C. (2004) Environmental Management Systems and ISO 14001 Certification for Construction Firms. *Construction enginnering and management*, 130(3), 330-36.
- Cole, R. (2000) Building environmental assessment methods: assessing construction practices. *Construction Management and Economics*, 18(8), 949-57.

- Cole, R. (2005) Building environmental assessment methods: redefining intentions and roles. *Building research & information*, 33(5), 455-67.
- Crawley, D., Geissier, S., Lindsey, G., and Todd, J. (2010) Comparative assessment of environmental performance tools and the role of the Green Building Challenge. *Building research & information*, 29(5), pp.324-35.
- Delegationen för hållbara städer ( 2015) *Delegationen för hållbara städer*. Available at: <http://goo.gl/QYbN9w> [Accessed 30 September 2015].
- Ding, G. (2005) Sustainable construction- The role of environmental assessment tools. *Envrionmental management*, 86(2008), 451-64.
- Elkington, J. (1994) Towards the Sustainable Corporation: Win -Win Business Strategies for Sustainable Development. *California Management Review*, 36(2). 90-100.
- Enbri (2012), Boosting Energy Efficiency in Construction, Building Up workshop [Online] Available at: <http://goo.gl/hxCorl> [Accessed 08 September 2015].
- Ericson, J. & Larsen, K., 2013. *Utveckling av Miljöbyggnad, En analys av åtgärdsalternativ*. Lund: Lunds Tekniska Högskola. Examensarbete inom Institutionen för Bygg- och miljöteknologi.
- Gluch, P. (2005) *Building Green - Perspective on Environmental Managment in Construction*. Gothenburg: Chalmers Reproservice
- Gluch, P., Baumann, H., Gustafsson, M., and Thuvander, L. (2011) *Miljöbarometern- 12 års miljöarbete i bygg- och fastighetssektorn. vad har hänt och vart är vi på väg?* [Report] Gothenburg: Chalmers Reproservice
- Gluch, P., Gustafsson, M., and Thuvander, L. (2009) An absorptive capacity model for green innovation and performance in the construction industry. *Construction Management and Economics*, 27(5), 451-64.
- Golafshani, N. (2003) Understanding Reliability and Validity in Qualitative Research. *The Qualitative Report*, 8(4), 597-607.
- Gordon, R., Carrigan, M., and Hastings, G. (2011). A framework for sustainable marketing. *Marketing theory*, 11(2),143-63.
- Hartman, J. (2004) *Vetenskapligt tänkande, från kunskapsteori till metodteori*. 2th Edn. Lund: Studentlitteratur.
- Heide, M., Johansson, C., and Simonsson, C. (2012) *Kommunikation i organisationer*. 2th Edn. Malmö: Liber

Heincke, C., Olsson, D. (2012) *Simply Green: A quik guide to environmental and enegy certification systems for sustainable buildings*. Gothenburg: [Report] Swegon Air Academy.

Hertwich, E.G. (2008) Consumption and the Rebound Effect: An Industrial Ecology Perspective. *Industrial Ecology*, 9(1-2), 85-98.

Hiyassat, M. (2000) Applying the ISO standards to a construction company: a case study. *Construction Engineering and Management*, 18(4), 275-80.

Hoogervorst, J. (2004) Implicit communication in organisations: The impact of culture, structure and management practices on employee behaviour. *Managerial Psychology* 19(3), 288-311.

HSB Bostad, (2015) *HSB Bostad bygger i Stockholm*. [Online] Available at: <http://goo.gl/xdHlZK> [Accessed 11 June 2015].

HSB projektpartner, ( 2015) *HSB Projektpartner bygger i övriga landet*. [Online] Available at: <http://goo.gl/YIPMou> [Accessed 11 June 2015].

HSB Riksförbund, 2014. *HSB Hållbarhetsredovisning 2014*. [Report] Stockholm: HSB Riskförbund.

HSB, 2015a. *HSB Living Lab*. [Online] Available at: <http://goo.gl/CvLQCr> [Accessed 13 November 2015].

HSB, 2015b. *HSB- en lång historia av nya idéer*. [Online] Available at: <http://goo.gl/OLtjKx> [Accessed 11 June 2015].

HSB, 2015c. *Så här fungerar HSB*. [Online] Available at: <http://goo.gl/oH829Q> [Accessed 11 June 2015].

Hubbard, G. (2006) Measuring Organizational Performance: Beyond the Triple Bottom Line. *Business strategy and the Envrioment*, 18(3),177-91.

ISO Central Secretariat (2010) *ISO 14001 Environmental Management Systems. An easy-to-use checklist for small business*. [Online] Genève: Available at: <http://goo.gl/v6uFN2> [Accessed 11 October 2015].

Jakubova, E., Millander, J. (2012) *En jämförelse mellan miljöklassningssystem för befintliga byggnader*. Gothenburg: Chalmers tekniska högskola. (Examensarbete inom högskoleingenjörsprogrammet Byggingenjör.

Johansson, R. (2003) *Case Study Methodology*. [Report] Stockholm: KTH Royal Institute of Technology.

- Jones, P., Clarke-Hill, C., Comfort, D., and Hillier, D. (2008) Marketing and sustainability. *Marketing intelligence & planning*, 26(2), 123-30.
- Khalfan, M.M.A., 2006. *Managing sustainability within construction projects*. Thesis. Manchester: University of Salford University of Salford Greater Manchester.
- Klimatsmart, 2013. *Klimatsmart*. [Online] Available at: <http://goo.gl/beyG7y> [Accessed 11 June 2015].
- Kvale, S., and Brinkmann, S. (2009) *Den kvalitativa forskningsintervjun*. 2th Edn. Lund: Studentlitteratur
- Levitt, T. (1983) *The Marketing Imagination*. 1th Edn. New York: Collier Macmillan Publishers.
- Murat, A. (2008) The benefits associated with ISO 14001 certification for construction firms: Turkish case. *Cleaner Production*, 17(5), 559-69.
- Malmqvist, T., Glaumann, M., Svenfelt, Å., and Carlson, P. (2011) A Swedish environmental rating tool for buildings. *Water & Environment Systems*, 36(4), 1893–99.
- McDaniel, S.W., and Rylander, D.H. (1993) Strategic green marketing. *Consumer Marketing*, 10(3), 4-10.
- Mellon, R. (2011) *Barriers to effective climate change adaption in the built environment*. [Research]. Sydney: Green building council Australia.
- Merriam, S.B. (1994) *Fallstudien som forskningsmetod*. 1st ed. Lund: Studentlitteratur.
- Miljöbyggnad, 2014. *Sweden Green Building Council*. [Online] Sweden Green Building Council Available at: <https://goo.gl/hP6IEG> [Accessed 08 September 2015].
- Naturvårdsverket, 2015a. *Reduced Climate Impact*. [Online] Available at: <http://goo.gl/ADSrie> [Accessed 09 September 2015].
- Naturvårdsverket, 2015b. *Sveriges Miljömål*. [Online] Available at: <http://goo.gl/2hzt90> [Accessed 27 October 2015].
- Newman, I., and Benz, C. (1998) *Qualitative-Quantitative Research Methodology: Exploring the Interactive Continuum*. 1st ed. Illinois: Southern Illinois University Press.
- Ousipov, R. (2014) *Miljöcertifieringssystemet miljöbyggnad i produktionen*. Uppsala: Uppsala Universitet. Examensarbete Institutionen för teknikvetenskaper, Tillämpad mekanik, Byggteknik



Public Policy Polling, 2009. *Public Policy Polling*. [Online] (1) Available at: <https://goo.gl/43yhtV> [Accessed 29 October 2015].

Pearce, P.D. (2003) *The social and Economic Value of Construction: the construction industry's Contribution to Sustainable Development*. New Construction Research and Strategy Panel. [Report]. London: nCRISP.

Rawshan, B., and Chamhuri, S. (2009) Attitude and behavioral factors in waste management in the construction industry of Malaysia. *Resources conservation and recycling* 53(2009), 321-28.

Roberts, P., Priest, H., and Traynor, M. (2006) Reliability and validity in research. *Nursing standard*, 20(44), 41-45.

Rosvall, M. (2014) *Bedömning av byggnadsmaterial inom miljöcertifiering för byggnader*. Uppsala: Uppsala Universitet. Examensarbete inom Institutionen för teknikvetenskaper, Tillämpad mekanik, Byggteknik.

SCB, 2014. *Miljöskyddskostnader*. [Online] Available at: <http://goo.gl/XXgw4D> [Accessed 03 September 2015].

Secretariat, ISO, 2012. *ISO & Construction, from traditional foundations to innovative technologies*. [Online] Genève: ISO Central Secretariat (1) Available at: <http://goo.gl/Yu446A> [Accessed 11 October 2015].

SGBC, 2015. *Akutellt i Miljöbyggnad*. [Online] Available at: <https://goo.gl/SejKDy> [Accessed 03 September 2015].

Shen, L. (2002) Implementation of environmental management in the Hong Kong construction industry. *Project Management*, 20(7), 535-43.

SP Technical Research Institute of Sweden, 2015. *Envrionmental classification of buildings*. [Online] Available at: <http://goo.gl/PNAqF8> [Accessed 05 September 2015].

Stenberg, A.C, and Räisänen, C. (2006) The Social Construction of 'Green Building' in the Swedish Context. *Envrionmental Policy & Planning*, 8(1),.67-85

Stewart, R., and Swan, W. (2010) *Sustainability Reporting*. Manchester: University of Salford Construction Innovation. Report in centre for business and sustainability.

Sweden Green Building Council, 2014. *About us*. [Online] Available at: <https://goo.gl/fCR5T9> [Accessed 03 September 2015].

Sweden Green Building Council, 2015a. *Vad är ett Green Building Council?*. [Online] Available at: <https://goo.gl/cT4P58> [Accessed 07 September 2015].

Sweden Green Building Council, 2015b. *Miljöbyggnad Manual 2.2*. [Online] Available at: <https://goo.gl/uCQvp7> [Accessed 08 September 2015].

Söderman, M., 2006. *Environmental Management in the Construction Industry - A Comparative Analysis of Skanska's Environmental Risk Assessment*. Uppsala. Uppsala: Sveriges Lantbruksuniversitet Uppsala. Theses: Faculty of Natural Resources and Agriculture Sciences.

Thuvander, L., Femenías, P., Mjörnell, K. & Meiling, P., 2012. Unveiling the Process of Sustainable Renovation. *Sustainability*, 4(6), pp.188-1213.

Tranchard, S. (2012) *ISO standards- State of the art for the construction industry*. [Online] Available at: <http://goo.gl/4zNQwC> [Accessed 15 July 2015].

Trost, J. (2007) *Enkätboken*. 3th Edn. Uppsala: Studentlitteratur.

Yakhyaeva, N., and Johansson, D. (2012) *Varför miljöcertifiera byggnader?* Stockholm: [Report] KTH Byggt teknik och Ekonomi.

Yudelson, J. (2008) *Marketing Green Building Services- Strategies for success*. 1st Edn. Oxford: Architectural Press

Wahlström, Å., and Catharina, W. (2015) *Användarna om nästa version av Miljöbyggnad*. Gothenburg: Swedish Green Building Council. [Rapport] Swedish Green Building Council.

Wahlström, M., Järnström, H., and Erlandsson, M. (2014) *Environmentally Sustainable Construction Products and Materials-Assessment of release*. Oslo.[Report] Nordic Innovation.

Willard, B. (2012) *The New Sustainability Advantage- Seven Business Case Benefits of a Triple Bottom Line*. Gabriola Island: New society publishers.

## Attached files

### *Demand and requirements for the 15 indicators in Miljöbyggnad*

Issue	Indicator	BRONZE	SILVER	GOLD	Explanation
Energy	Bought energy	<SBC	≤ 0,75*SBC	≤ 0,65* SBC	SBC = Swedish Building Code
	Heating power requirem.	≤ 60 W/m <sup>2</sup> HA	≤ 40 W/m <sup>2</sup> HA	≤ 25 W/m <sup>2</sup> HA	HA = Heated Area
	Solar heat load	≤ 48 W/m <sup>2</sup> FA	≤ 43 W/m <sup>2</sup> FA	≤ 32 W/m <sup>2</sup> FA	FA = Floor Area
	Fraction of energy carriers	< 50% Cat 4	>10% Cat1 or >50% Cat2 and < 25% Cat 4	>20% Cat1 or >50% Cat2 and < 20% Cat 5	Cat 1 = Renewable recurrent Cat 2= Biofuels Cat 4 = Else (fossile, nuclear,...)
Indoor environment	Noise protection	≥ Sound Class C	≥ 50% of the parameters Class B	≥ Sound Class B. ≥ 80% of users satisfied	Classes according Sw. Standard 25268
	Radon content	101-200 Bq/m <sup>3</sup>	51-100 Bq/m <sup>3</sup>	≤50 Bq/m <sup>3</sup>	
	Ventilation rates	≥7l/s,pers + 0,35 l/m <sup>2</sup> FA	+ VAV in rooms with varying load	+ VAV in all populated rooms. ≥ 80% of users satisfied	VAV = Variable Air Volume
	N <sub>2</sub> O to indoor air (from traffic)	> 40 µg/m <sup>3</sup> or unknown	≤ 40 µg/m <sup>3</sup>	≤ 20 µg/m <sup>3</sup> or > 250m to road with > 10 000 veh./day	veh.= vehicles
	Moisture prevention	Moisture proof design according to BBR 6:5	+ Moisture proof design according to Bygga F	+ A certified moisture expert	BBR = Swedish Building Code Bygga F= specific method for moisture proof design
	Thermal climate winter	PPD ≤ 20%	PPD ≤ 15%	PPD ≤ 10% + ≥ 80% of users satisfied	PPD = Predicted Percentage Dissatisfied
	Thermal climate summer	same	same	same	
	Daylight	DF > 1,0%	DF ≥ 1,2 %	DF ≥ 1,2 % + ≥ 80% of users satisfied	DF = Daylaght Factor
	Legionella	≥ 60°C in HWS. Demands on hot water pipes.	+ SWI is applied.	+ thermometers on all WWC-loops	HWS= Hot Water Store. SWI = Secure Water Installation (spec. insustry rules) WWC = Warm Water Circulation.
Material & chemicals	Documentation of materials	LB on building products	+ LB is digital	+ LB with amount and place for each prod.	LB = Log Book with product type, name, producer, year and content of substances
	Absence of hazardous substances (in design-ated builing parts)	No information	Some POS above content limits occur and are listed	POS above content limits do not occur in LB	POS = Phase Out Substances according to Swedish Chemicals Agency.

**Interview question:**

*These are some of the interview questions formed for the first interview. After the first interview, specific questions were posed to each interviewee based on the responses received from the former interviews.*

Name? Age? Education?

Have you any education in Miljöbyggnad Certification?

How applicable do you think Miljöbyggnad Certification is, in order to achieve sustainable environment/buildings?

What are the reasons for choosing to use Miljöbyggnad Certification in HSB?

Why didn't HSB choose to certify their building through other Environmental certification systems? Example BREEAM or LEEDS

How does a Miljöbyggnad Certification affect a new project in comparison to a non-certified?

Which indicators are most critical to improve? Regarding costs and work process.

Which/what are the most challenging indicators during a Miljöbyggnad Certification?

Miljöbyggnad Certification is for the moment only applied in new building. Why is there less focus to certify existing buildings?

What challenges have Miljöbyggnad brought to HSB?

What is the perceived value of Miljöbyggnad certification for HSB and the tenants?

How do you think the communication of Miljöbyggnad is carried out, both internally and externally in the HSB organization?

Could there be any improvements of communicating of Miljöbyggnad in the organization? If yes, how should it be executed?

How do you think the requirements and demand for Miljöbyggnad Certification will look like in the future?

What is your thoughts and believes in the extensive focus to improve the construction industries environmental impact for a more sustainable environment?

## Survey questions

### Miljöbyggnad inom HSB

I samband med ett examensarbete på Chalmers tekniska högskola görs denna enkätundersökning för att få en bättre bild av hur hållbar utveckling inom byggbranschen uppfattas samt kommuniceras hos de anställda inom HSB. Vi vore tacksamma ifall du tar ca 5 minuter av din tid och fyller i enkäten.

Kön

Välj ▼

Hur gammal är du?

Välj ▼

Vilken HSB region jobbar du inom?

Välj ▼

Vad har du för bostadstyp ?

Välj ▼

Hur oroad är du för konsekvenserna av klimatförändringarna i världen?

	1	2	3	4	5	
Inte alls	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremt

I vilken utsträckning instämmer du i följande påstående: Det finns saker jag kan göra i mitt arbete för att motverka klimatförändringar?

	1	2	3	4	5	
Instämmer inte alls	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Instämmer helt

Skulle du vilja bli informerad om möjliga åtgärder för att minska din klimatpåverkan ?

- ☐ Ja
- ☐ Nej

I vilken utsträckning instämmer du i följande frågor:

	Aldrig	Sällan	Ofta	Ej relevant
Släcker lampor när jag lämnar kontoret under minst 30 min?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Stänger av dataskärmen när jag lämnar kontoret under minst 30 min?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tar hänsyn till att välja miljövänliga samt energisnåla produkter vid inköp av varor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Åker bil till jobbet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Åker kollektivt till jobbet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Går eller cyklar till jobbet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Anser du att HSB kan vara mer aktiva med att informera dig som anställd att vara miljömedveten?

	1	2	3	4	5	
Instämmer inte alls	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Instämmer helt

HSB är medlem i Swedish Green Buildings Council som är en ideell förening med fokus på att utveckla och påverka miljö- och hållbarhetsarbetet i byggbranschen. HSBs medlemskap har till syfte att följa med branschutvecklingen samt att vara med och utveckla certifieringssystemet Miljöbyggnad som används för att åstadkomma miljömässigt hållbara byggnader.

Känner du till Miljöbyggnad Certifiering?

- ☐ Ja
- ☐ Nej

För dig som har känner till eller arbetar med Miljöbyggnad.

**Har du blivit utbildad inom Miljöbyggnad Certifiering?**

- ☐ Ja
- ☐ Nej

**Vet du varför HSB väljer att Miljöcertifiera sina byggnader?**

- ☐ Ja
- ☐ Nej

**Vilka indikatorer tycker du är svårast att handskas med?**

Ditt svar

---

**Vilka indikatorer tycker du ger flest avvikelser?**

Ditt svar

---

**Vilka indikatorer anser du vara mest kostnadsdrivande?**

Ditt svar

---

Anser du att HSB kommunicerar Miljöbyggnad internt inom organisationen?

	1	2	3	4	5	
Instämmer inte alls	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Instämmer helt

Anser du att HSB kommunicerar Miljöbyggnad tillräckligt i marknadsföringssyfte?

	1	2	3	4	5	
Instämmer inte alls	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Instämmer helt

Vilka är de största fördelarna för HSB att bemöta hållbarhet inom byggbranschen?

- ☐ Tillgång till nya marknader
- ☐ Bättre innovation av affärsmodell och processer
- ☐ Förbättrad varumärke
- ☐ Förbättrad uppfattning om bolagets ledning
- ☐ Ökad konkurrensfördel
- ☐ Ökade marginaler eller marknadsandel på grund av hållbarhetspositionering
- ☐ Övrigt: \_\_\_\_\_

SKICKA