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Potential of Collaboration in the Design Process for Better Building Energy Performance

Exploring the role of energy consultants in the early phases using Skanska as a case

Master's Thesis in Design and Construction Project Management

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ABSTRACT

The climate crisis and energy crisis are more prevalent than ever, and both the European Union and Sweden have set goals to try to mitigate this. The construction sector is one of the main contributors to these crises, buildings historically have had a considerably high energy consumption and energy usage in the operational phase has a negative impact on the climate. It has also been proven that the people involved in the design process significantly impact the final building. Energy consultants have further expressed a lack of prioritisation of the energy question in commercial buildings. Therefore, it was relevant to study if earlier involvement of energy through better collaboration could have an impact on the energy performance.

The master thesis aims to optimise the energy performance of buildings through an empirical study focused on the collaboration between developing actors and energy consultants in the design process, with a specific focus on energy consultants. The case study was conducted at Skanska, one of Sweden's largest construction companies with a global presence. The research combines a literature study and an interview study to investigate the design process at Skanska, the roles of various actors involved, and the coordination of energy throughout the design process. The findings reveal diverse perspectives and variations in understanding the same processes based on role and department. The absence of a standardised approach to energy coordination is attributed to unclear roles, differing viewpoints, varying levels of knowledge, economic factors, and habits. As a contribution, this thesis provides guidelines for companies seeking to enhance collaboration and optimise energy performance in buildings.

The guidelines emphasise building relationships and trust through marketing, conducting regular educational energy workshops across departments, involving energy consultants early in brief discussions, add incentives for in-house collaboration, designating a contact person, and standardising internal documents to align energy considerations in new construction.

Keywords: energy, energy performance, design process, collaboration, inter-organisational relationships, climate change, construction sector.

Samarbetspotential i designprocessen för bättre energiprestanda i byggnader

Undersökning av energikonsulters roll i de tidiga faserna med Skanska som fallstudie

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SAMMANFATTNING

Klimatkrisen och energikrisen är mer utbredda än någonsin, och både Europeiska unionen och Sverige har satt upp mål för att försöka mildra detta. Byggsektorn är en av de främsta bidragsgivarna till dessa kriser. Byggnader har historiskt haft en avsevärt hög energiförbrukning, energianvändning och driftsfasen har negativ påverkan på klimatet. Det har också bevisats att de personer som är involverade i designprocessen har en betydande inverkan på den slutliga byggnaden. Energikonsulter har vidare uttryckt bristande prioritering av energifrågan i kommersiella byggnader. Därför var det relevant att undersöka om en tidigare involvering av energi genom bättre samverkan kunde ha en inverkan på energiprestandan.

Examensarbetet syftar till att optimera byggnaders energiprestanda genom en empirisk studie fokuserad på samarbetet mellan de utvecklande aktörerna och energikonsulter i designprocessen, med särskilt fokus på energikonsulter. Fallstudien genomfördes på Skanska, ett av Sveriges största byggföretag med global närvaro. Masteruppsatsen kombinerar en litteraturstudie och en intervjustudie för att undersöka designprocessen på Skanska, olika aktörers roller och samordningen av energi genom hela designprocessen. Resultaten visar på olika perspektiv och variationer i att förstå samma processer baserat på roll och avdelningstillhörighet. Avsaknaden av ett standardiserat tillvägagångssätt för energisamordning tillskrivs oklara roller, olika synsätt, varierande kunskapsnivåer, ekonomiska faktorer och vanor. Den här masteruppsatsen kommer fram till riktlinjer för byggföretag som vill förbättra samarbetet i tidiga skeden och optimera energiprestanda i byggnader.

Riktlinjerna betonar att bygga relationer och förtroende genom marknadsföring, genomföra regelbundna utbildande energiworkshops mellan avdelningar, tidigt involvera energikonsulter för diskussion, lägga till incitament för internt samarbete, utse en kontaktperson och standardisera interna dokument för att anpassa energi i nybyggnation.

Nyckelord: energi, energiprestanda, designprocess, samarbete, inter-organisatoriska relationer, klimatpåverkan, byggbranschen.

Acknowledgements

Our five years at Chalmers University of Technology have come to an end, and the final project of our education was to complete this master thesis. The master thesis was carried out during the spring of 2023 in Gothenburg, Sweden at the master´s program Design and Construction Project Management. Our thesis came from an interest in the environment and energy as well as an inquiry from Skanska.

We would like to convey our sincere gratitude to our three supervisors. Firstly, our academic supervisor at Chalmers, Liane Thuvander who guided us through the whole project. Without her guidance we would not have reached as far as we have. Secondly, to Lisa Lundin, one of the supervisors at Skanska, an expert in sustainability and with a wide network. Thirdly, the second supervisor at Skanska, Charles Chu, an energy expert with much knowledge, it would not have been possible without either of them. We would also like to thank Charlotta Cvach, who has been a mentor to us during the process, her personal network at Skanska has been highly valuable. Furthermore, we would like to address the interviewees who laid the foundation for the whole thesis. Without the insights that they provided this would not have been possible, therefore we want to express our gratitude for their openness and willingness to speak with us. We would also like to thank our opponents, Klara Håkansson and Ida Alexandersson, for their valuable insights, their perspective provided us with reflections helping us move forward. Lastly, we would like to thank everyone we have been in contact with, both at Chalmers and at Skanska. We have treasured the reassurance and support we have received highly, thank you!

Gothenburg, June 2023

Julia Blom and Cornelia Hansson

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Notations

Glossary

Construction document – Bygghandling

Feasibility study - Förstudie

Our way of working - Vårt sätt att arbeta

Program document – Programhandling

Project planning document – Systemhandling

Proposal document - Förslagshandling

Abbreviations

BBR - Boverket´s Building Regulations

CDN – Commercial Development Nordic

EPI - Energy Performance Index

HVAC - Heating, Ventilation and Air-Conditioning

LCC – Life Cycle Cost

PBA - Planning and Building Act

PBO - Plan and Building Ordinance

VSAA - Vårt Sätt Att Arbeta

1. Introduction

Intending to optimise the energy performance of buildings this thesis empirically studies the impact of collaboration between different actors in the design process with focus on energy consultants. This master thesis will study Skanska as a case, one of the largest construction companies in Sweden, acting globally.

The thesis is based on a literature study and an interview study. During the interview study, the design process at Skanska is outlined as well as various actors' roles in the design process. The thesis furthermore develops guidelines for improved collaboration for optimised energy performance in buildings.

The following chapter will give insight to why the studied subject is important, it will give nuance to the problems society faces today. The situation that society is in today in regard to the climate crisis and energy crisis, as well as the current state of energy performance in the operational phase in buildings. The design process and collaboration regarding energy from an energy consultant is also described.

1.1 Background

The world is facing huge challenges in battling climate change, one of the main contributors to climate change is the construction sector, both on a global level and in Sweden. The Swedish construction sector accounts for approximately 20% of the total amount of emitted greenhouse gases in Sweden and (Boverket, 2021c) states that one of the critical environmental factors is energy. The total energy consumption of buildings has increased in recent years (Boverket, 2021c), this has for example created a dependency on district heating and thereby waste, because of the crucial role of waste-to-energy plants in district heating. For sustainability transitions society thus has to lower its need for energy and electricity (Skanska, 2022b). Together with the energy crisis that primarily involves the Russian invasion of Ukraine, rising prices on energy are also a current factor. The demand for more energy efficiency therefore arises (European Commission, 2023). These factors make for an improvement of the energy performances of buildings an issue of high importance.

In October 2022, the council of the European Union released an agreement, stating stricter regulations regarding the energy performance of buildings (European Council, 2022). It is further stated that by 2030 all new buildings must be zero-energy buildings. Since, out of the energy that is consumed in Europe, 40% is accounted for by buildings along its lifecycle. Furthermore, almost 40% of greenhouse gases are directly or indirectly related to energy in both Europe and in Sweden (Reindl, 2020). This makes for more efficient energy use and buildings with better energy performance necessary to work towards, attaining an enhanced sustainable built environment. Skanska, one of the leading construction companies in Sweden and acting in a global context, strives to be at the forefront. In 2015, Skanska set the goal of being climate neutral by the year 2045 along with cutting their impact on the climate with 50% by 2030 (Skanska, 2022d). This goal includes the whole value chain of the production, meaning materials from suppliers and subcontractors, as well as the operation of the buildings.

Energy efficiency in the operational phase of buildings is important from a climate perspective. Studies have shown that there is an opportunity to reduce the energy requirement without

significantly increasing the construction process' emissions of greenhouse gases (Larsson et al., 2016). It has also been shown that the construction process's share of the climate impact over the life cycle is higher today than previously assumed. This further highlights the reason to build highly energy efficient buildings to lower the share of energy, to benefit both the climate and the costs over the life cycle.

To reach the goals set by the European Union, that by the year 2030, all new buildings should be zero-emission buildings, energy performance needs to be optimised (European Council, 2022). It is during the early phases of the design process that the foundation for what is built is made and these early phases should encompass energy performance as an important parameter to optimise the building. Therefore, the design process in the construction sector must be efficient from the very beginning. The unsustainable use of energy today is deeply rooted in the way we are building now and have built in the past decades (Gross & Davidson, 2018). Accordingly, a transition towards more sustainable design and system is needed. It is essential to reach the goals set up by both the European Union as well as the internal goals set by companies, for example at Skanska.

According to Reindl (2020), studies have shown that the actors involved in the design process play a crucial role for the energy use in the final product. How the energy questions are addressed in construction processes depends on the people involved in the design process and their enthusiasm and attitude towards energy. Additionally, it is also stated that the energy question is raised in the design process however not all actors have the agency to make a change. Reindl (2020) found a correlation between low agency and high capacity to change in the field of energy as well as an imbalance of agency and capacity to enhance the energy question to get the attention it needs. According to Gross and Davidson (2018) incorporating social studies to the technical aspects of energy might help to manage and reach a more sustainable energy usage. Along with this, Gross and Davidsson also emphasises a greater understanding of the governance strategies and the dynamics of system changes for improved sustainability.

Indications from discussions with energy consultants at Skanska show that they have similar experiences as the statements from Reindl (2020) when it comes to the correlation between low agency and high capacity to change. Skanska's energy consultant's involvement in the design process is perceived as low, especially during the early phases of the process, despite their special competence in energy performance. This thesis therefore explores how energy performance in buildings is managed by energy consultants and if it should be considered at an earlier phase in the design process to build more energy efficient buildings. The thesis further explores the collaboration between energy consultants and developers, to see if the collaboration could work more efficiently and thereby enhance the energy performance.

1.2 Aim

The thesis aims to study how construction companies can achieve better energy performance in their buildings through an improved collaboration of actors in the early design phases with a focus on energy consultants. A further aim is to find gaps in knowledge and areas of improvement to reach better energy performance and lower the environmental footprint caused by energy consumption in buildings during the operational phase. This will be done by mapping

the workflow and prioritisation of energy in the early phases of the design process with Skanska as a case. The intended outcome of this thesis is to, based on the case, formulate general guidelines for the design process to prioritise energy performance and enable more effective energy performance in buildings.

1.3 Research Questions

This chapter presents the selected research questions. The first question is the main question, with the following three being sub-questions of the main question. The sub-questions aim to create an understanding along with helping to answer the main question.

How can the early phases of the design process be adapted to enable better energy performance of buildings?

- How is energy performance prioritised in the early phases of the design process?
- How are the roles and responsibilities regarding energy in a project structured?
- How do the energy consultants collaborate with the other professionals in the design process?

1.4 Scope and Delimitations

The delimitations of the thesis have been set to the Swedish construction sector as well as to the company Skanska regarding the case. Due to the size of the company, limitations have been set to the collaboration between the Commercial Development Nordic Gothenburg (CDN Gothenburg) as the client, Building 2 Gothenburg as the contractor and the energy department as consultants.

In this thesis, the term energy refers to the energy performance of a building, measured during the operational phase, since the focus is on how the design process can be improved to result in more energy efficient buildings. Embodied energy is not included. The definition of energy performance is based on Boverket's (2009) definition of the building's energy use. Stated as the energy that, in normal use, during a normal year needs to be delivered to a building for heating, comfort cooling, domestic hot water and the building's property energy. If another device for heating is installed, its energy use is also included.

The delimitations furthermore include reviewing the collaboration between different actors with different roles in the design process from an energy and energy consultants' perspective. Still, a group of diverse roles involved in the design process affiliated with the field of energy and with the ability to influence energy performance are studied in order to get a broader perspective.

The design process is defined as the process from feasibility study up until production in this thesis. Additionally, the design process has different phases as well as different actors collaborating and working on a project, these include the project developer, project managers, architects, structural engineers, energy engineers and sustainability experts etcetera. However, this thesis will mainly focus on energy engineers, project developers and project managers, who can also be referred to as consultants, clients and contractors.

As the thesis focus on Skanska, certain related delimitations have been made, for instance review of assessment tools and certifications were limited to the ones that are commonly used at Skanska. Furthermore, limitations have been set to new construction and since CDN Gothenburg and Building 2 Gothenburg work with commercial buildings, the thesis has a slight focus on office buildings.

2. Literature Study

In the following chapter, the literature describing the subject matter is presented to apprehend an understanding of the field that the research questions explore. The literature study is divided into the subchapters: energy laws and regulations, building energy performance, environmental certifications, design process, contracts, organisational relationships and change management and continuous improvement.

2.1 Energy Laws and Regulations

The issues regarding building related energy in the European Union (EU) mainly focus on energy efficiency, saving energy and the development/use of renewable energy (Boverket, 2020a). The EU has directives on the energy performance of buildings, modified in 2018, to be able to achieve the goals for 2030 (Infrastrukturdepartementet, 2022). This means that every country in the EU has the responsibility to set up plans to increase the number of zero-energy buildings. Zero-energy buildings are defined as buildings with very high energy efficiency, and the little energy that is needed should, as much as possible, be from renewable sources of energy (European Commission, n.d.). Further, the energy should also be produced locally.

In Sweden, all buildings need to meet certain demands, specified in the Swedish building regulations, Boverket´s Building Regulations (BBR) (Boverket, 2020b). The demands for energy in buildings are further set by the Planning and Building Act (PBA), together with the Plan and Building Ordinance (PBO). The demands for example specify how much energy a building can use there are also for example demands for the technical qualities of buildings in PBA. These are demands that always need to be met when building new constructions, there are other demands during renovations. Further, PBO clarifies the demands for energy and thermal isolation.

2.2 Building Energy Performance

To be able to fulfil building regulations for energy and increase the energy efficiency of buildings, energy performance needs to be evaluated. There are several parameters affecting the energy performance of a building, the most important are, among others, building orientation, plan shape, plan depth, and window-to-wall ratio (Raji et al., 2017). Measuring the energy performance of commercial buildings, such as offices, is generally done by using the Energy Performance Index (EPI) (Panicker et al., 2023). The EPI is calculated using a building's total energy consumption over a year, divided by the total built-up area (kWh/sq.m/year).

2.2.1 Energy Performance Parameters

As previously mentioned, different parameters affect the energy performance, thus also the EPI. In this chapter, the thesis will look further into relative compactness, window-to-wall ratios (WWRs) and the coefficient of heat transmission (U-value).

Firstly, the definition of relative compactness reads as; “the ratio of the area of the external envelope (A) to the volume (V).” (Raji et al., 2017, p. 2), where the external envelope (A) is

the area of the sum of the external wall and roof. Since the improvement of building performance simulation tools, the impact that the form of the building has on energy performance has been widely investigated. Raji et al., (2017) presented a correlation between compact buildings and energy efficient buildings, findings have especially been made in contrasting hot and cold climates.

Moving on to window-to-wall ratios, it is difficult to set a standard value on the most profitable WWRs value in a temperate climate because of the dependency on the quality of the building envelope (Raji et al., 2017). A well performing envelope will reduce the effect the WWRs have on the total energy performance. Despite this, it has been proven that WWRs values lower than 20% negatively affect the total energy performance because of the rising demand for electric lighting in the building. In addition to this, the highest value for the WWRs has been suggested to not exceed 60% because of increasing transmissions through the envelope leading to up to a 10% rise in the total energy consumption.

Lastly, the coefficient of heat transmission, the U-value, affects the thermal insulation of the exterior walls, thereby affecting the energy performance (Ounis et al., 2022). Ounis et al. (2022) researched the most suitable general U-value by reviewing 100 European cities. Moreover, a wall with medium-high mass was the most suitable for Europe. The cold continental climate, represented by warm summers with low demands of cooling, is recommended to have walls with a low U-value. However, Ounis et al. (2022) emphasised that a local analysis is of high importance to find the optimal solution for the specific location.

2.2.2 Building Shape and Orientation

Already early in the design process, it is important to evaluate and analyse the shape and orientation of the building. It is described by Dervishi and Baçi (2023) that it cannot only reduce energy consumption but also that it minimises the building's environmental footprint. This ties together with the local analysis of the U-value, a local analysis of the orientation regarding shading, sunlight and daylight is also essential (Sofias et al., 2023). The orientation plays a huge part in how much shading, sunlight and daylight the building receives, which thereafter affects how much cooling and warming is necessary. Furthermore, too little daylight makes artificial light sources a more common necessity. The shading and daylight in the building are calculated with computer software, with as much data as possible to get the most accurate calculations. The orientation and building shape can make a huge difference for the end product, subsequently, the early phases of the design process are hugely important to identify vulnerabilities.

2.2.3 HVAC and Internal Gains

The heating, ventilation and air-conditioning (HVAC) of a building can have a huge impact on the energy performance (Lu et al., 2023). Overheating, overcooling or heating unoccupied areas for instance can quickly become problematic and cause unnecessary energy consumption (Chen et al., 2023). Since HVAC systems are so important regarding energy efficiency, having an effective HVAC system can substantially reduce the use of energy (Lu et al., 2023). Approximately 30% of energy savings can be achieved in office buildings, while still having an adequate level of thermal comfort for its occupants. The authors continue to describe how

31% was the average energy savings number when using more efficient HVAC systems, despite different climate zones, internal gains and operational use. Another article, written by Franco et al. (2023), describes how through HVAC optimisation of temperature in offices up to 60% of energy can be saved. Along with, up to 50% saved energy through having occupant controls. As the authors write, there are good HVAC control systems, these should receive more endorsement.

Internal gains entail different electrical appliances, but also occupants, and they are the prime movers of how much energy is consumed in a building (Franco et al., 2023). However, the internal gains also influence the temperature and concentration of pollutants for example, which further is contained by the HVAC system. Therefore, what kind of operational use and the internal gains have a huge impact on what the definitive energy is.

2.3 Environmental Certifications

Using certifications is a common way to demonstrate that buildings have reached certain environmental goals, both for marketing purposes and to achieve specific standards. Certifications have historically been a big contributor to moving the construction sector forward. There are many certification systems on the market, frequently used systems in Sweden are LEED, Miljöbyggnad, BREEAM, NollCO_2 and Green Building (Chu & Lundin, internal communication, 17 January, 2023; Sweden Green Building Council, 2023).

LEED was developed in the 1990s in the US by the Green Building Council and it aims to implement and measure sustainable design, construction and operation (Sweden Green Building Council, 2023e). There are different LEED systems adapted to for instance commercial buildings and even urban areas. LEED certifications review factors such as water, waste, carbon and energy, however, it does not only target specific factors, but it has a more holistic approach (U.S. Green Building Council, 2023).

Miljöbyggnad (Environmental Building) is a Swedish certification system that reviews a building's environmental performance (Sweden Green Building Council, 2023f). During the certification process, it is reviewed by a third party where 16 indicators are analysed. An important detail of the certification is that a follow-up is made on the building after three years. Regarding energy, an observation is made so that the building does not use too much energy and so that an adequate amount of heating energy is in the building, further also the electricity and heating need to be supplied from environmentally safe sources. Adding a dimension, there are three different levels of Miljöbyggnad, bronze, silver and gold. The most used level is silver, which implies that a building is reasonably above what is legally required.

BREEAM is a certification system that was developed in the UK for new buildings (Sweden Green Building Council, 2023a). It has been used since 1990 and it is one of the most outspread certification systems in Europe. The certification includes many different factors with energy usage, choice of material and project management being three of them. In Sweden BREEAM is handled by the Sweden Green Building Council, it is called BREEAM-SE and adapted to Swedish laws and regulations while at the same time making buildings comparable internationally. The certification system is furthermore based on a point system, where every factor can give points and the total amount of points determine what grade the building receives.

The certification NollCO_2 (or zero carbon dioxide) aims to be at the forefront regarding climate impact (Sweden Green Building Council, 2023c). The certification sets up limits for greenhouse gases both during the production and the operational phase. The climate impact that is left is then balanced out by taking other measures for the climate, to get it to net zero climate impact. Because of this the certification indirectly regards energy usage.

Green Building is a certification with a focus on energy, both already existing buildings and new buildings (Sweden Green Building Council, 2023d). The demand for new buildings is for the energy performance to correspond to energy class B, meaning 25% better energy performance than what Boverket demands.

2.4 Design Process

The design process at a construction company aims to create a product, a building. The design process consists of several phases, the feasibility study, the project phase and the project planning phase based on what is stated by Boverket (2021d). The phases are described and discussed in the following sections.

2.4.1 Feasibility Study

In the feasibility study many parameters for business opportunities are examined. For example, interesting plots to be considered, what needs to exist for the property and which building is most optimal to build (Boverket, 2021a). Furthermore, all the land's technical and legal prerequisites are examined along with the governing documents. Additionally, the existing knowledge is considered, and experts should be invited so gaps can be identified. Furthermore, goals should be formulated to provide support for the future, and these should be supplemented with supporting investigations. The evaluations make up a good foundation for an assessment of the opportunities and risks a business opportunity hold. By working in a structured way, all perspectives should be included, future risks are minimised, and the project can move on to the next phase.

2.4.2 Project Phase

In the project phase, the goals and requirements for the construction work and the building are specified further based on the overall goals formulated in the feasibility study (Boverket, 2021b). This could end up in operational goals, providing support for the continued work. To be able to do this the investigations completed in the feasibility study, more detailed investigations could be needed as the goals and requirements become more concrete. These goals and requirements are stated and described in the program documents. The program document is a resume of all the prerequisites specific to the project and forms the base for further determination and planning of the project (Boverket, 2023a). The program document consists of everything from idea sketches to building documents. The program documents consist of the broad decisions made about the building, for example location, the overall design and some technical details. The prerequisites need to be set for the continued planning to work. In the proposal documents, there are more details than the program documents. In addition to this, the client decides in this phase which type of contract should be used for the project.

2.4.3 Project Planning Phase

During the project planning phase, the work with design, shape and inquest continues. Alternative sketches and solutions are produced and compared. The project planning document contributes to a common view of the project's constructability including HVAC and the modelling of the project (Boverket, 2023). All the technical consultants are processing their documentation. Moreover, system planning is done, where various documents, e.g., building drawings, construction drawings and HVAC drawings, are coordinated to meet the requirements of the PBA as well as the client/developer. An important step to ensure smooth construction later in the process. Also, usually applying for a building permit is done during the project planning phase. In preparation for the start notification, the detailed planning is done along with the preparation of several technical documents e.g., construction documents. Boverket (2023) states that the construction documents are the executing documents that the construction of the building will be based on. In addition, the documents are also the basis for material purchases that first are planned and then brought to action.

2.5 Contracts

The collaboration during the design process can vary depending on what type of contract is used because the contract form can determine when in the process the contractor gets involved. Increasing the use of turnkey contracts and partnering is indispensable if further improvements are of interest, but partnering for example can be complex (Eriksson, 2010b; J. Larsson et al., 2014). The contract forms turnkey contract, general contract as well as partnering will be described in the following chapter since these are the most commonly used contracts and collaboration forms.

2.5.1 Turnkey Contract

In the article written by Borg and Lind (2014), it is described that a turnkey contract can be labelled with different names, such as an integrated contract or a design-build contract. However, in this text, the phrase turnkey contract will be used. During a project where a turnkey contract is used, the authors describe how the responsibility for the detailed plan lies with the contractor, as opposed to the client. Compiling the different definitions of a turnkey contract, it can be described as when a client hires a contractor who further is responsible for both the design and the construction phase. Further, the contractor has the option to hire subcontractors during the construction phase. Alternatively, one more step can be added, the client can hire an engineering construction manager who then has the authority to hire a design and construction manager, who further are responsible for the construction phase. The turnkey contract can in addition include maintenance and operation as well, this is decided by the owner. This type of contract is common for more complex projects.

2.5.2 General Contract

According to Borg and Lind (2014), a general contract can also be defined as a design-bid-build contract or as a traditional contract. This type of contract usually has a process where a

client hires a designer who prepares the necessary documents. This is then followed by a bidding process where a contractor is chosen. When the contractor is hired, they have the responsibility for the construction process, including the option to hire subcontractors. The client is the one with both control but also risk since the contractor is limited to only the construction phase. The authors further describe how compared to a turnkey contract; a general contract allows for less freedom for the client. However, they also highlight that the distinction between a turnkey contract and a general contract can be quite hard to define.

2.5.3 Partnering

Partnering is complex and can have different definitions, however, what is common throughout the definitions is that trust and mutual understanding are essential (Nyström et al., 2005). The authors continue by describing that since partnering is so varied, it is not possible to conclude in one definition. Partnering is also not a form of contract, however, it heavily influences the collaboration between client and contractor (Borg & Lind, 2014). Partnering is essentially a way to work more closely together, which enables the project to adapt to changes throughout. It can furthermore be adapted to different kinds of contracts, though for example, general contracts can be an obstacle for partnering (Eriksson, 2010). Partnering works best when the parties have joint objectives, use collaborative tools such as workshops and teambuilding as well as have continuous and structured meetings (Eriksson, 2010a; Nyström, 2005). Since partnering is most beneficial for big complex projects with high uncertainty, cooperation is of utmost importance.

2.6 Organisational Relationships

Relationships within a company are highly connected to its performance, therefore inter-organisational relationships, trust, and the difference between internal and external consultants are explored in this chapter.

2.6.1 Inter-Organisational Relationships

According to Khouja et al. (2021), highly accomplished projects are heavily dependent on collaborative inter-organisational relationships (IORs). Moreover, the structure of the construction sector as a temporary industry makes it a huge challenge to handle. Khouja et al. (2021) states that one problem is the awareness of what working together really means, what is needed to establish and maintain IORs. Additionally, the adaptability of settled collaboration relationships might restrict projects because of the limitations of modifications to the specific project setting. Despite this, the expected positive outcomes of the IORs are often the driving forces for the firms. Khouja et al. (2021) stated that lower costs are the most wanted result of the IORs. Followed by an increase in value-creating activities, decreased risks, and social outcomes such as improved communication and higher trust among both persons and organisations. Further, Huemer (2004) states that as an industry, relationships between people are the most essential. How employees interact and cooperate affects the process and workflow. Therefore, good relations are of high importance, and this comes from trust. Huemer (2004) describes how predictability and familiarity present stability which can build trust. However, the construction sector is a project-based industry, with momentary financial plans, which

makes for different professionals to be more uncooperative and cautious towards each other. Based on the very specific attributes of the construction sector, trust and relationships are even more fundamental. Lastly, Khouja et al. (2021) stated that IORs also have the potential to enhance understanding and competencies, shared organisational knowledge and add value because of the interconnections.

2.6.2 Trust

Building trust between different actors can be done through various ways, an activity that Huemer (2004) highlights is socialising. Actors who are collaborating need to get to know each other to try new things and progress, the trust itself becomes a resource. Socialising also makes it easier for actors to understand each other, which is another important factor in inter-organisational relationships. It is important to focus on the internal relationships of an organisation, sometimes the external relationships receive all the focus, and this can lead to poor collaboration (Ekanayake et al., 2017).

2.6.3 Internal vs. External Consultants

The difference between internal and external consultants is described in the article by Sturdy and Wright (2011) as having different perspectives on the organisation. The internal consultant has an overview of the company and can more easily identify knowledge gaps. They also have a higher social capital as well as a network within the company. However, having an external network and using external consultants was also highlighted as important, as this allows for sharing experiences. External consultants are also of high value when a company is too busy or does not have the resources themselves. According to Sturdy and Wright (2011) it is believed that a combination is beneficial, both internal and external consultants, this provides both insight from within the company and also external expertise. Making it distinct for a specific company, with a lot of collaboration.

2.6.4 Collaboration

In practice, there are a lot of technical challenges affecting energy performance that are relatively easy to change (Gram-Hanssen & Georg, 2017). However, along the phases in the design process, there are people involved who have different professions as well as backgrounds. They have different perspectives and thereby also different intentions with the project. Studies have shown that good collaboration between actors within the construction process, from idea to finished product, can make a significant difference on the product (Shi et al., 2019; Van Der Leer et al., 2022). Despite this, studies have not shown what this collaboration should look like and where in the process the collaboration is lacking and should be improved. Since the final energy performance of a building relies on the decisions made in the design process (Palm & Reindl, 2016). While the design process completely depends on the social relationships between the participating professionals. Moreover, energy efficiency is heavily dependent on individual skills and abilities like being able to debate, compromise and understand. Furthermore, personal knowledge and competence, established working methods, behaviour and ability to collaborate decide the way energy is discussed during the design

process. Additionally, it is stated by Bögel et al. (2019) that collaboration and having a collaborative approach is a fundamental factor for good accomplishments.

2.6.5 Communication

The basic definition of communication can be described as the exchange of information, it can likewise include the exchange of ideas and skills within a company (Safapour et al., 2019). Communication is crucial in the construction sector, without it, projects can become delayed and out of budget (Pamidimukkala et al., 2022). Without effective communication the design process can become disorganised, resulting in un-called-for work, delays and an increasing number of challenges. The authors continue to describe how numerous studies have pointed out that how actors at a company communicate can influence workplace culture. They also highlight how this is important at any company but in particular at construction companies. During construction projects, numerous actors and professions are involved, meaning that there are extensive amounts of factors to consider (Pamidimukkala et al., 2022; Safapour et al., 2019). Therefore, if one reviews projects that have succeeded, they have good communication in common. The authors further explain that many factors can affect the level of communication at a construction company, for example, financial resources and transparency of aims and objectives.

Furthermore, the process of a project depends on the communication and when the communication is not working, the process can be held back, and the process flow is halted (Safapour et al., 2019). Within companies there are different kinds of communication, these are referred to by the authors as formal and informal communication. Formal communication can be described as more official communication, while informal is the communication that occurs between the company's official business. Communication can also be distinguished as upward, downward and horizontal communication. Upward and downward refers to the communication that takes place between employees and leaders, usually within a department, whilst horizontal communication can be for instance between partners.

As previously mentioned, the quality of the communication is key for a construction project. Moreover, Safapour et al. (2019) describe that this is highlighted by both research and people from the field. Communication can affect cost, schedule as well as the engagement of the people involved, three crucial factors in a project. Therefore, having a good project management team is of utmost importance, since they so heavily can influence the internal communication.

2.8 Change Management and Continuous Improvement

Previous research states that it is important for companies to successfully handle change management to be able to sustain its position and on the market in today's rapidly changing industry (Todnem By, 2005). Moreover, when implementing change in an organisation, the occurrence of difficulties is common. There can be different reasons for these difficulties, however they include factors such as peoples' backgrounds and interests. For smooth transitions, Todnem By (2005), states that good change management is needed, and this is a skill that all leaders need in order to be successful. The author further writes that change management often comes as a reaction and not as a proactive measure. It was also described in

the article written by Sturdy and Wright (2011) that being active or passive, other words for being reactive or proactive, does not necessarily determine if the set-out goals are achieved.

Additionally, there are levels of change that can occur within organisations, and bigger changes have according to Todnem By (2005) been easier to adapt to. Bigger changes seem to achieve less confusion, while smaller achieve more confusion and can be harder to adapt to. The authors further write about four different levels of change, these include fine-tuning, incremental adjustment, modular transformation as well as corporate transformation. This thesis focuses on the smaller changes, thus fine-tuning. Fine-tuning entails that both the individual and the group aligns with and works towards the goals of the organisation. Accordingly, the fine-tuning change process implies refining the processes and methods that are already in place, as well as further establishing already set roles, it does not imply any profound change.

With this in mind, one of the most important factors regarding change management is collaboration, this is where a boundary spanner enters (Bögel et al., 2019). The Boundary spanner has knowledge of multiple parts of an organisation, which makes this actor significant for bridging gaps. This actor can also understand the different professionals and that they all have their own interests. Hence, the boundary spanner is critical in the collaboration of a project when different professionals with different backgrounds are collaborating. The boundary spanner is furthermore most beneficial on an individual level as opposed to on a bigger organisational level, since it is the personal relationships that matter and could tear the whole project (Ekanayake et al., 2017).

3. Case: Skanska

The construction company Skanska was used to analyse the current collaboration between energy consultants, developing units and the contractor (consultant, client and contractor). This section will present the organisational structure along with how Skanska is working as a company today.

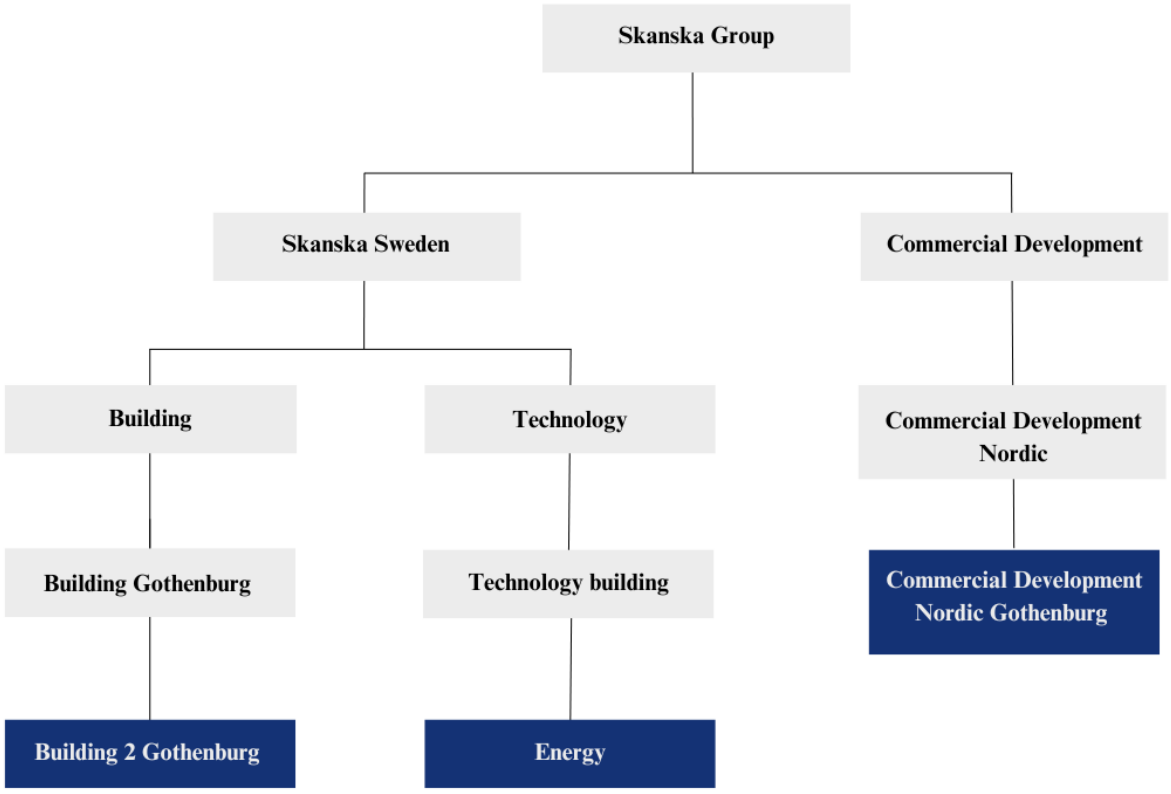
3.1 The Organisation

Skanska Group is one of the world's largest development and construction companies, operating across several selected markets in Europe and in the United States (Skanska, 2023a). Skanska's global experience along with their local expertise and economic assets makes the opportunity to develop and build some of the most complex projects in the world (Skanska, 2023b). Moreover, grand commercial projects require deep understanding and a close collaboration. Skanska is present in most of the value chain, from project development and construction to property investments (Skanska, 2023b). Considering that Skanska is a big company, most of the needed professions and skills can be found in-house, such as project managers, architects, structural engineers, and energy engineers.

The corporate group is based on local business units, strengthened by the brand and financial strength and the group-wide expertise (Skanska, 2023c). Skanska Sweden is one of the local business units of the Skanska Group. Moreover, Skanska Sweden is divided into three business areas Building, Civil and Industrial solutions (Skanska, 2023d). Furthermore, the different areas are divided into different regions, Building Gothenburg being one of the building regions. The studied region, Building Gothenburg is divided into four districts, two residential districts and two commercial districts, where Building 2 Gothenburg is one of them (Skanska, internal communication, 6 February, 2023). Besides these business areas several support functions are available as a part of Skanska Sweden, one of them being technology with a group focusing on buildings, Technology building. Furthermore, the subgroup, energy, is a part of technology building. This thesis studies how one of the commercial districts, Building 2 Gothenburg, are collaboration with the subgroup energy. In addition to this another part of the Skanska group, Commercial Development is also studied. As they, Commercial Development Nordic Gothenburg, are the ones starting up projects and early in the design process setting the requirements for the studied building region and the energy consultants (Chu & Lundin, internal communication, 17 January, 2023). Presented in figure 1 is a simplified illustration of the organisational structure of the studied parts of Skanska, to easier understand how and why it is functioning the way it is today.

Figure 1

Simplified organisational chart of Skanska



Comment: The studied departments are marked in blue

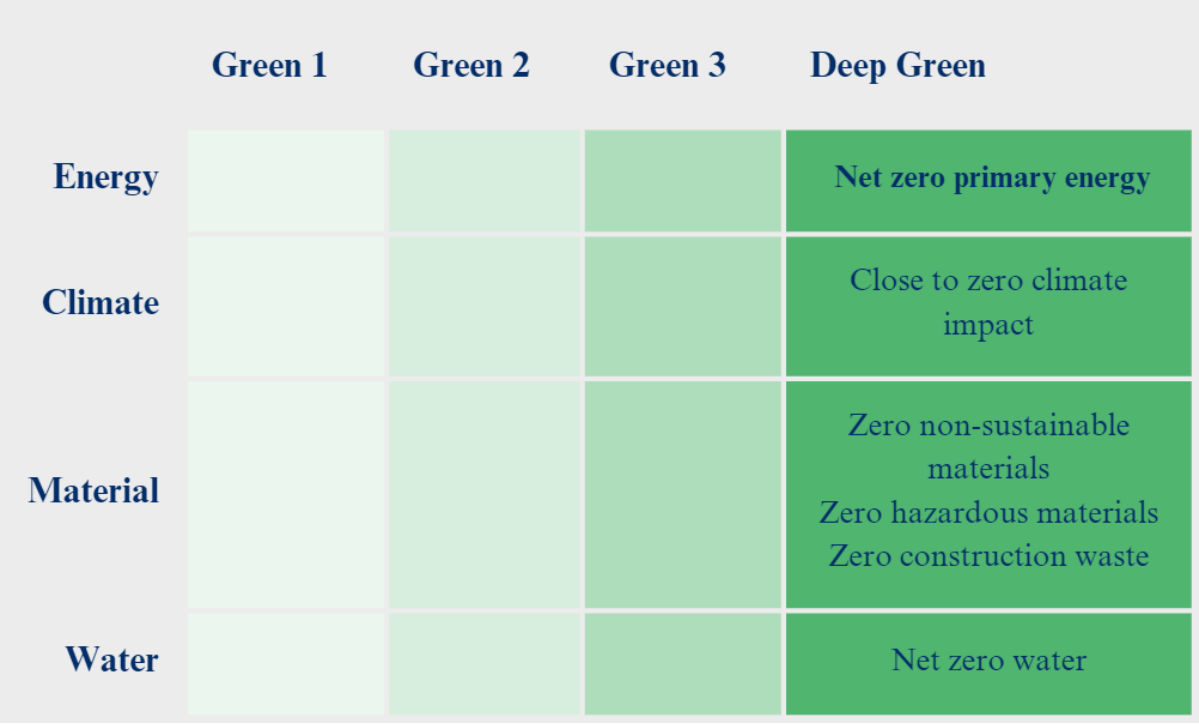
3.2 Skanska Sweden and Sustainability

Skanska (2023) states that sustainability is a fundamental part of the business. Aiming to be at the forefront of developing sustainable products, such as green office buildings (Skanska, 2022a). Therefore, Skanska Sweden often uses environmental certifications such as LEED, NollC02, BREEAM and Miljöbyggnad, as well as their internally developed Green Chart to achieve and ensure this. Further, 90% of what is built and developed by Skanska Sweden is sustainable built, according to their internal model, the Green Chart. The Green Chart consists of higher demands than the laws and regulations, and their sustainability work is still developing (Skanska, 2023). However, in this thesis a simplified version of the green chart is illustrated due to it being a strictly internal model, this simplified version is for external use, see figure 2.

The Green Chart includes different environmental aspects, climate, material, water and energy (Skanska, internal communication, 11 May, 2022). The Green Chart is furthermore divided into different shades of green, with the deep green being the best for the environment. Regarding the energy category on the Green Chart, it states that to be able to reach deep green, energy must be net zero primary energy. For a building to reach deep green, three out of six boxes on the deep green level need to be fulfilled. With the energy box being ticked as a requirement for heated houses, the rest of the boxes only need to be on level two (Skanska, internal communication, 15 December, 2022).

Figure 2

Simplified illustration of Skanska´s Green Chart



The foundation of Skanska Sweden's sustainability work is stated in the management strategies "Vårt sätt att arbeta" (VSAA) integrates quality, ecological sustainability and working environment (Skanska, 2022c). The greatest possibilities to affect and transform as a construction and developing company have been identified. These have shaped into measurable goals that continuously are followed up. As well as internal routines to ensure that both internal and external goals, laws, regulations and requirements are achieved.

3.3 Design Process at Skanska

The design process at Skanska follows the typical design process as described in chapter 2.4, see figure 3 for an illustration of the design process. In this chapter some specifics about the design process at Skanska will be described, their methods can be found in their internal documents called "Vårt sätt att arbeta" (VSAA). In the internal documents the workflow can be followed, and guides are available for employees. This gives the employees at Skanska an established process to follow and a somewhat standardised way to work, however it is still a project-based industry, meaning that every new project is unique, and every individual has a way of working as well.

Figure 3

Skanska's design process and related documents

The design process is divided into phases with different requirements in the different phases. The first phase of the design process is the feasibility study followed by the program phase, proposal phase, project planning phase and last but not least construction phase. For each phase specific documents are prepared.

In the feasibility study many parameters for the business opportunity are examined. For example, what needs exists for the property, which product is most optimal to build. Along with potential customers and tenants should be identified. Furthermore, Skanska have some specific points that must be taken into account in this phase. This includes prerequisites for deep green in Skanska's Green Chart (figure 2), environmental certification and energy performance (Skanska, internal communication, 16 April, 2023).

According to standards stated in internal documents (15 December 2022) the energy calculation must be produced in the project planning document and then continuously be updated. Details about energy calculations and safety margins can be found in the management strategies “Vårt sätt att arbeta” (VSAA). The calculation of energy balance and how energy monitoring must be done in accordance with Skanska Technology's routines in VSAA.

3.4 Energy Consultant at Skanska

The energy department at Skanska are Skanska Sweden's own consultants (see organisation chart in figure 1), they only work internally, however they invoice like any other consultant on the market (Chu, internal communication, 3 May, 2023). The energy department furthermore has many competence areas, these include energy performance, daylight, solar panels, thermal climate and follow ups. There is much more that goes into the work around energy than solely the energy performance. Accordingly, Raji et al. (2017) states that building orientation, plan shape, plan depth, and window-to-wall ratio are the most important factors impacting the energy performance. Parameters affecting several roles from different point of views. Therefore, collaboration between the involved professions is crucial to achieve the best possible solution. Skanska's ambition is to enter a project as early as possible. To enable smart solutions for construction processes, materials and technology. A solution that is better for the environment can also mean a lower total cost.

At Skanska, energy is considered a critical risk (Skanska, internal communication, 26 April, 2017). Therefore, an early review is mandatory for projects with the goal of having energy requirements of less than 75% of BBR, projects with energy fines or projects with demands of certifications with the highest degree in Miljöbyggnad, LEED and BREEM. Apart from these

demands there is no set process for how to work with the energy question in the design process except for the energy calculations at Skanska. It is a decision made by the project manager, the one with the overall responsible of the project and thereby the energy, to decide when to consider energy (Chu, internal communication, 24 January, 2023).

3.5 Building 2 Gothenburg

Building 2 Gothenburg is one of the commercial building units at Skanska, see figure 1. The business unit operates in the entire Gothenburg region, with a concentration on the city of Gothenburg and its peripheral municipalities (Skanska, internal communication, 31 Mars, 2023). In the coming years, Gothenburg faces major challenges to meet the need for new offices, premises and community services. Requiring long-term and sustainable solutions. The ambition of Building 2 Gothenburg is to be a social developer and to actively contribute to the development of a sustainable Gothenburg. This is done by participating in the social debate and striving to work closely with the customers in long-term relationships. The organisation consists of project managers, production managers, project engineers, production engineers, supervisors and skilled workers.

3.6 Commercial Development Nordic Gothenburg

Commercial Development is a separate part of the Skanska Group, see figure 1. Commercial Development is divided into different geographical groups, Commercial Development Nordic (CDN) being one of them. CDN is involved throughout the value chain initiating, developing, investing and property management in commercial properties. Offices and logistics are their two most important products. With a focus of green and efficient offices and properties. CDN works with long-term processes, it is not uncommon for a project to last between five to ten years, from idea to finished building. CDN has offices in Gothenburg, Stockholm, Malmö, Copenhagen, Oslo and Helsinki, this thesis focuses on Commercial Development Nordic Gothenburg.

Many of CDNs projects are self-financed, giving the flexibility and freedom of making impactful decisions, desired improvements and the possibility of making necessary changes quickly benefiting both the clients as well as the overall project. CDN states on their website that they can build a nearly limitless high-level of quality on the most attractive land because of this. Internally it has been decided that all self-developed commercial buildings at least should be certifies with LEED gold (Skanska, 2022c).

4. Methodology

The thesis is based on a qualitative, semi-structured interview study complemented by a literature study. Skanska was used as a case and actors at Skanska were interviewed to determine their roles and the factors in the design process that affect energy performance. The focus was on the early phases of the projects. During the whole process the authors of the thesis were in close collaboration with Skanska and two supervisors guided the process. The supervisors at Skanska included an energy engineer as well as a sustainability expert, along with a district manager as a mentor. The master thesis had an abductive reasoning approach since observations in the case and interviews led to an expansion to the literature study and vice versa. Based on the case Skanska and findings from the interview study along with the literature study, general guidelines were formulated.

4.1 Literature Study

A literature study was chosen to acquire knowledge and insight from previous studies along with acknowledging gaps. The literature study was the starting point of the thesis and formed an academic foundation for the case as well as the interview study. It broadened the viewpoint in the field of energy and the design process. Further, the literature study was carried out in several cycles, and it grew over time along with new findings from the interview and case study. Digital databases such as Chalmers Library, Google Scholar and Scopus were used to find relevant literature. In addition to this Chalmers physical library was used for printed literature. The main advantage of a computer analysis is that large amounts of text can be processed in a consistent manner (Boréus & Bergström, 2018). To be able to do this a coding frame of search words was used to find articles suitable for the research. The words that were used are: *change management, climate change, collaboration, communication, construction contracts, construction industry and/or construction sector, design process, energy, energy performance, inter-organisational relationships and partnering.* Additionally, some articles were provided by the supervisor at Chalmers.

4.2 Case

The thesis has been based on a case of a single organisation, Skanska. The case focused on the inter-organisational relations and collaboration between the energy department and developing units at Skanska. More precisely, Skanska Commercial Development Nordic and one of the commercial building departments of Skanska Gothenburg were studied. Furthermore, the different interview respondents were part of different projects which were studied to be able to identify similarities and differences between different projects design processes. Most projects were commercial office buildings in the early phases of the design process However, the projects were in various phases, which enabled a broader view of the design phases but still facilitated general conclusions. An instrumental case study that used the results of the case to receive insights that formed the foundation to the general guidelines presented in the results of the thesis.

4.2.1 Document Study

A document study was used to study internal documents from Skanska to broaden the understanding of the current state of the company. This was a way to objectively study the structures and processes at the company at the time of the study. Document studies provide the opportunity to create knowledge about, for example, the organisations structure at a general level (Persson, 2017). Studied documents include governing documents, historical documents, educational documentation and other written material. In these studies, one main goal was to gain knowledge about the content of what is being documented and for what purpose it is being documented.

4.3 Interview Study

Qualitative research can provide convincing descriptions of the qualitative human world (Bell et al., 2022). Moreover, qualitative interviews provide well-founded knowledge of conversational reality. The interview study in this thesis was semi-structured. Further, the interviews were also the principal basis for the results. Because of the studied subject in the thesis, the interviewees personal professional experiences were important to explore. That is what is called an interpreting interview study and according to Hallin and Helin (2018) it is a suitable method when trying to understand the reality of the interviewees.

During the process of choosing the interviewees, conversations with the supervisors and the mentor were held in order to find the most relevant interviewees. All the interviewees associated with the design process were based in Gothenburg, since they all belong to the department Building 2 Gothenburg and Commercial Development Nordic Gothenburg. While the energy engineers work on a national level. Therefore, their offices are in Gothenburg, Malmö as well as Stockholm, meaning, their projects can be based anywhere in Sweden. Further, the energy engineers make up the energy department at the technology department, and they are 21 in total as of the spring of 2023. Out of the 21, 6 have been interviewed in this study.

All of the 19 interviewees in the three different departments come with a variety of backgrounds, experience, interest and age, details presented in table 1. The interviewees include for example actors with many years of experience at Skanska and newcomers, as well as project managers with backgrounds in other disciplines. Some of the experiences that the interviewees held were for example heating, ventilation, structural engineering, machine engineering, production, carpentry and calculation.

The interview study used three sets of interview templates consisting of 14-16 questions, grouped into different categories. The interviews were conducted in Swedish, since all respondents and the authors were Swedish, see appendix A-C for interview templates. Three different templates were used due to that three categories of actors were interviewed, consultant, contractor and client. All the interviews started wide with open questions, following the semi-structured interview technique with different follow up questions based on their individual answers (Alvehus, 2019). The interview commenced with questions about the interviewees background as well as sustainability, moving forward to more specific questions about the process and energy.

The interviews were conducted during a period of seven weeks, about six weeks into the thesis process. During the first six weeks, pre-interviews were held in order to gain some knowledge about the company and the basics about how the company works, to lay a foundation in order to write the interview templates. Moreover, these pre-interviews were not transcribed. While, during the interviews, an automated transcription program was used alongside comprehensive notes taken during the interviews, to ensure accurate capture of the interview. This approach facilitated the subsequent analysis of the data. Following the interviews, the notes taken during each session were systematically categorised into distinct themes, enabling subsequent clustering of the themes across all interviews. This systematic process facilitated the identification of recurring patterns as well as diverging arguments that are presented in the results. Several quotes from the interviews are displayed in the results, however since the interviews were held in Swedish, the translation was made by the authors of the thesis and may have caused minor alterations.

Table 1

The interview respondents

Interviewee	**Department at Skanska**	**Experience (years)**	**Skanska (years)**
Energy 1	Technology - Energy	30-35	10-15
Energy 2	Technology - Energy	10-15	5-10
Energy 3	Technology - Energy	5-10	5-10
Energy 4	Technology - Energy	5-10	5-10
Energy 5	Technology - Energy	10-15	5-10
Energy 6	Technology - Energy	0-5	0-5
Architect	Technology - Architecture	10-20	5-10
Structural engineer	Technology - Structural Engineering	35-40	35-40
Client 1	Commercial Development Nordic Gothenburg	25-30	15-20
Client 2	Commercial Development Nordic Gothenburg	10-20	10-20
Client 3	Commercial Development Nordic Gothenburg	5-10	5-10
Client 4	Commercial Development Nordic Gothenburg	40-45	40-45
Client 5	Commercial Development Nordic Gothenburg	35-40	35-40
Client 6	Commercial Development Nordic Gothenburg	5-10	5-10
Contractor 1	Building 2 Gothenburg	35-40	35-40
Contractor 2	Building 2 Gothenburg	20-30	10-20
Contractor 3	Building 2 Gothenburg	10-15	0-5
Contractor 4	Building 2 Gothenburg	10-15	10-15
Contractor 5	Building 2 Gothenburg	30-35	30-35

Comment: The table describes the interview respondents place of work within Skanska Group along with experience both in the construction sector and at Skanska Group

4.4 Ethical Considerations

The thesis, and the interview study in particular, includes actors from different departments of one company. These actors also have diverging opinions, therefore the interviewees were made anonymous to not interfere with any future collaborations between them. It was also important to uphold the integrity of both the individuals and Skanska. Their specific roles were also not mentioned, only their department, in order to keep them anonymous since certain roles are unique. Regarding the internal documents that were used in this study, to ensure that anything under confidentiality was not disclosed, an accountable person at Skanska read the thesis before publication. However, the thesis does not rely on the internal documents, since general conclusions had to be made.

4.5 Reflections on the Chosen Methodology

A case with one single company was used in this master thesis. The intended outcome of this thesis was to formulate general guidelines for any company. However, using a case has been criticised for not being appropriate when generalising. On the contrary, Flyvbjerg (2001, 2006) argues for the opposite, typical patterns together with correlation among substances and things can be detected in a case. Equally, the selected interviewees were not supposed to represent the whole population in any exact way (Bell et al., 2022). The results of an interview study are supposed to be used as a base to form generalisations. In addition to this, the document study was conducted to study the structures and the processes Skanska from a more objective perspective. It can also be noted that as one of the biggest construction companies there were many available documents. Furthermore, due to the time limitation, the selection of documents was chosen with great consideration. The literature study was moreover formed as a support to the case and gave it validity (Reindl, 2020). As a result, general guidelines could be supported and based on the theories presented in the literature study.

The results from the interview study were mainly based on the reflections and notes from the interviews. These interpretations may seem ambiguous. However, during the whole interview study both authors of this thesis were present, this enabled one to be the main interviewer and one to take notes during the interview. Followed by reflections and complementary notes after the interview from the authors. This was what made out the basis for the results, however all of the interviews were recorded and transcribed to enable the authors to look back clear up uncertainties. The reason that the interviews were not manually transcribed was due to the large number of held interviews along with how well the automatic transcribing tool on Microsoft teams works.

The respondents were diverse and quite numerous, however, adding more interviews would have allowed for a greater variety of respondents. By including a larger sample size, more accurate conclusions could be drawn. As the answers provided by the respondents varied significantly depending on their individual experiences as well as their role and place of belonging. This broader range of perspectives could enhance the validity and generalisability of the findings, leading to a more comprehensive understanding of the topic.

5. Results: Interview Study

The following chapter contains the results from the interview study, themes were identified so that answers could be grouped together. The themes include energy integration in the design process, prioritisation, agency, economy, internal vs. external energy consultants, relationships and communication as well as potential improvements.

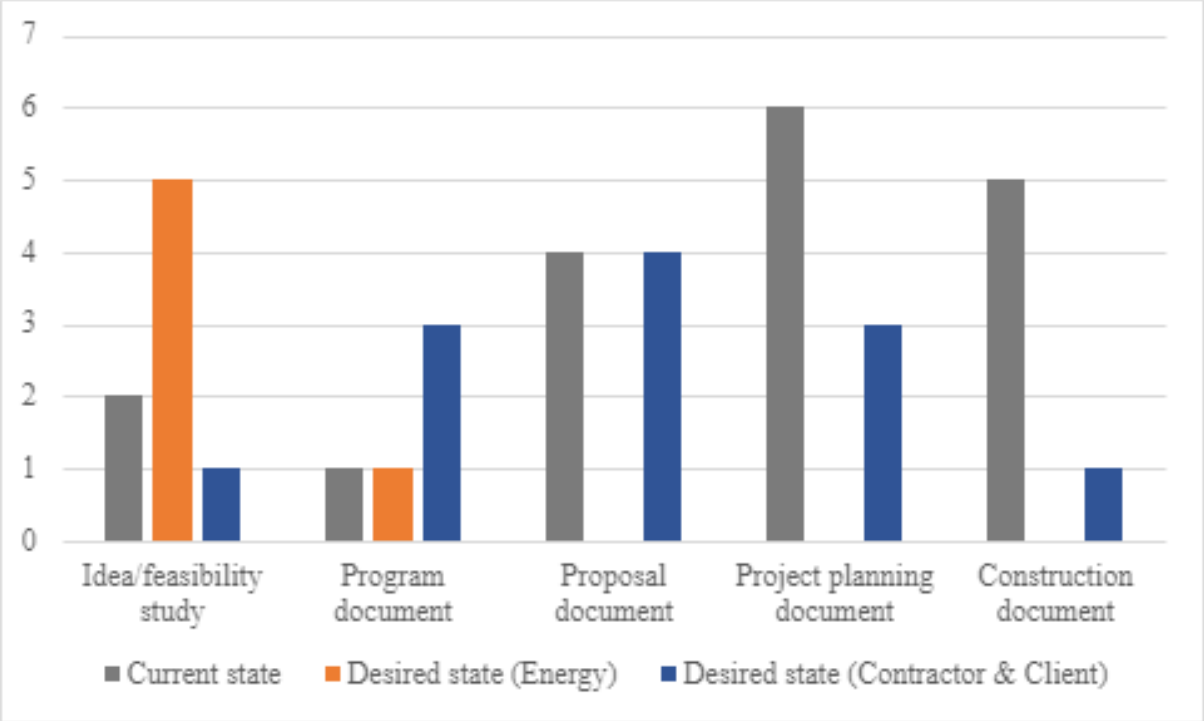
5.1 Energy Integration in the Design Process

The respondents gave varying answers when asked about when energy is considered in the design process, as seen in figure 4. All of the energy respondents, the Structural engineer and Client 6 pointed out the importance of considering energy early in the process. It is very hard to achieve something if connected too late in a project. Then the idea is already set, often along with a specific certification without considering the energy demands. Energy 5 added that if energy is considered as late as in the building document phase there is not much to do. Everything is set, and the energy consultant cannot make a difference for the energy performance. Only deliver the calculations without the possibility to make extensive improvements.

It varies a lot when energy is considered according to Contractor 4. Moreover, the respondent sees the possibilities and advocates for energy to be regarded early, the respondent further states that the involvement of energy is "Very different. When it is our own projects, then I advocate that you enter as early as possible with the energy model, and if we enter early, you can benefit from it through the process" (2023). Accordingly, when using a model, an early indication of how the energy will perform can be made based on the geometry of the building. Furthermore, the façade or windows can be reviewed from an energy point of view. Contractor 4 continues with that this is done quite early today, energy is considered from these points from the system document phase. On the other hand, Client 2 explains that they historically have not worked much with energy until getting to the construction document phase, with a few exceptions starting in the system document phase, but relatively far into the process. Contractor 5 agrees that energy mostly is considered in the construction document phase, if it is not a very complex project, then it might be considered from the program document phase.

Figure 4

The interview respondents view of energy involvement in the design process



Comment. In this figure the structural engineer and architect are counted in the same category as the contractor and client.

5.2 Prioritisation

The prioritisation of energy during the design process is described by Energy 2, 3 and Client 6 to vary depending on the project. Energy 4 further describes how energy is prioritised more and more through the projects, however mostly because they have to according to stricter regulations. Energy 6 describe how the prioritisation affects the work as “if you come in late, it will be difficult and a lot of frustration, and they are not as open to listening” (2023). Moreover, there is a willingness to minimise the operational costs, since CDN Gothenburg is moving forward going to start owning buildings, an important trigger. This has made energy a more prioritised question since Skanska will more directly be affected by the high energy prices for example. This argument is furthermore something that the majority of the interviewees agreed upon. The energy crisis and the high energy prices was highlighted by Contractor 3 as an important factor. The respondent described how if they started a project today, energy would be higher on the agenda in order to optimise its performance. Contractor 2 also highlights the internal tool, the Green Chart, figure 2, as a part in the prioritisation of energy. They further describe how the deep green goals are only implemented in special projects. Adding to that, Contractor 1 describes that energy and climate issues are a priority but, in the end, it depends on if the client is willing to pay.

However, discussions are held to decide what Skanska wants to do regardless, in order to stay on the forefront. From the perspective of Skanska's Internal Clients, CDN Gothenburg, Client 1 describes energy as a fundamental question. An essential question if the company wants to

survive over time. Client 5 and 3 also describe energy as an important factor especially from a climate perspective. Client 5 further highlights that much has happened in the last 3-5 years, and their projects have cycles that span over multiple years. This can make projects that started 5 years ago look outdated compared to the demands of today.

Many of the respondents (Contractor 1, 4, Client 1, 2, 5, 6, Energy 4, 5) highlighted the correlation between the prioritisation and the demands from clients and certifications. When working with a project with high demands from both clients and certifications energy is needed to be considered earlier in order to meet the demands. This can be the factor needed to challenge the usual working method and new great solutions might get explored. On the other hand, many of the respondents also pointed out that a change to a climate neutral construction sector also have made the focus shift. From energy efficiency to materials and greenhouse gas emissions since we historically have been able to manage energy performance quite easily but in relation to the relatively low demands. In addition, green energy recourses in Sweden make a low climate footprint regarding energy. It should be noted that the demands for energy have increased but the focus has shifted anyway. Requiring good solutions, not compensation for bad ones as Client 5 stated. In addition, Energy 1 also stated that when reviewing the environmental footprint of energy "the best kWh is the one not used" (2023).

5.3 Agency

Client 1 stated that the key to a successful project is that the different actors have clear roles and that there is an understanding between them. To this Contractor 2 adds that "a client has more agency than they are aware of" (2023). While Contractor 4 highlights that as a client "CDN Gothenburg is good at taking responsibility" (2023). Regarding energy, it is important that someone owns the question, if the company wants to reach its goals, as Energy 2 describes, there needs to be a "spider in the web", an energy coordinator who can make sure that the goals are reached.

When the clients were asked about if they employ an energy coordinator in their projects, many of them did not know what was meant by this. Further, several respondents mentioned that they do employ an energy coordinator, however as the interviews progressed it became clear that this could have several meanings. What they meant by energy coordinator was often actually an installation coordinator instead, who is a part of the contractor department.

Moving on to whether the contractors utilise an energy coordinator, the response was a bit varied as well. Contractor 4 describes it as energy coordination needs to be made but it does not necessarily need to be done by one specific person. Today the company has people who do the calculations but not someone who directly coordinates. Contractor 2 and 3 describe that they do not always use an energy coordinator, it can depend on the project and the specific projects demands, and it can sometimes be the installation coordinator who receives the responsibility for energy.

It is the project manager who has the final responsibility, and if an energy consultant is hired as an energy coordinator, they can still only come with recommendations. This was expressed clearly by Energy 4, the energy consultants have no own agency to make a change, they depend on the project manager to listens and to understand their recommendations. Further, who the energy consultant or coordinator is in contact with can vary as well, between the project

manager, design manager and installation coordinator. Energy 1 and 6 however mention that it is the design manager who contacts and raises the energy question even if it is the project manager who has the responsibility. Client 2 also describes how it is usually the contractor who has more contact with the energy consultants.

5.4 Economy

From the perspective of Energy 5 and 6, the financial aspects almost always seem like the most important, with the project managers always looking for ways to make cuts in the budget. They experience that they as energy consultants are viewed on how much they cost and not on what they can do. There has however developed more understanding with certain project managers in recent years, due to the development of personal relations. On the contrary, Energy 3 describes how the financial aspect is just one aspect. While the contractors and clients describe how money is in the end what controls it all in a project. Even if the contractors want to direct a lot of resources towards energy in a project, the budget can often be a hindrance. Contractor 4 further highlights that if the demand for energy is not met it can have financial consequences further down the line, which makes it an important aspect to prioritise early. In the earliest phases in the design process Energy 1 and the Structural engineer describe how the developers do not want to involve too many actors, you want to have a set idea before more involvement. The Architect expressed that an energy consultant can be used as a sounding board already in the sketching phase even though the respondent believes that the client and external architects, who are responsible for the overall design, have enough competence. Nonetheless, moving on they should absolutely hire an energy consultant according to the Architect. It was also highlighted by the respondent that if the energy is calculated or estimated early it often becomes cheaper, because problems can be avoided, and better solutions can be implemented. This was also highlighted by Client 3, who explained that when the budget is already set it can be difficult to make changes.

Another economic aspect regarding energy performance and energy efficiency is that it can be an important business strategy and opportunity to brand the building, as mentioned by Energy 1, 3, Contractor 1 and 4. It has in the recent years become more and more important, along with people becoming more aware of the climate and the energy crisis, resulting in clients setting higher demands. Furthermore, Client 5 raised the perspective of making buildings that are too climate and energy optimised that are not always attractive for the customer, regarding the design. In the end the company needs to make revenue, but some special projects are invested in where the profit margin is reduced in order to invest in greener buildings, however these decisions need to come from top management. Adding to this, Energy 3 expressed that “The benefits must outweigh the costs and it should not be forgotten that high investment can create great benefits. An added value can be created with climate smart and future-proofed buildings.” (2023).

Another financial aspect is the one raised by Contractor 2 and 4, they expressed that until recent years energy has been very cheap, but now, as of 2023, when the prices have gone up so much, everyone wants to improve energy efficiency. The shift is not noticeable yet in the industry, but they believe that it will come, the LCC calculations will also be completely different.

5.5 Internal vs External Energy Consultants

The difference between internal and external consultants was described by multiple interviewees, some describe that there is no difference in the work or collaboration. Contractors and clients instead highlight that it is the personal relationships that determine who they choose, whereas some respondents mention that the internal energy consultants are more expensive.

Diving deeper into the difference in price, the internal energy consultants describe how in many cases much more is included in their tender documents. Along with the external energy consultants often adding expenses along the way, which can make it even out. It was also expressed by Contractor 1 that the tender document could be made clearer for someone who is not an expert on the subject. Adding to this, a distinction on what is "the basic package"/the bare minimum, and what is add-ons would be beneficial. There is also a belief from the client and contractor that the internal energy consultants do their calculations with both belt and braces. While Energy 6 describe how they view it as they have a certain quality assurance. Contractor 4 also describes how many contractors do not know what they are comparing, which is why they often choose the cheaper external consultant.

> It bothers me that we are internal consultants, I don't know if it is possible to change. But we can do so much more. It is a hinderance to invoice, there is no room for the little extra if the project asks for it. (Energy 6, 2023)

Client 4 describe that they have in the past chosen external consultants, not only because of the money but also out of convenience, they have had several types of consultants from the same company. Adding that in big projects the energy calculations are not seen as expensive they rather choose where the competence is the highest. Furthermore, the respondent also adds that in the last project the company doing the HVAC work also had energy consultants. Working with the same company within both these questions closely affecting each other made the job easier for the respondent as well as the communication between the installation coordinator and energy consultant clearer.

Client 3 highlighted that there is a lack of competence within the field of energy, and that they as a company need someone with this competence. They cannot at this point state whether they need it inhouse at CDN Gothenburg or if a close collaboration with an energy consultant at Skanska Sweden would be just right. The respondent sees a lot of advantages with someone from Skanska Sweden instead of a person inhouse at CDN Gothenburg. Because of the long cycles a lot happens, and you need to keep up with the technology, therefore it could be favourable to have someone working with different clients and projects to learn insights from and bring back to CDN Gothenburg. Moreover, Client 6 agrees upon this and adds that CDN Gothenburg also needs someone with better knowledge of the HVAC and technology. The respondent stated that this lack of knowledge often leads to not knowing what questions to ask and thereby the question might get forgotten. CDN Gothenburg need someone holding it all together, could be an energy consultant from Skanska Sweden but they need to get to know us and how we are working and our systems. The respondent sees an opportunity for a long-term relationship working together on these questions, someone to ask for the right information to get the understanding you need to get the decisions right.

5.6 Relationships and Communication

There are many factors affecting how to collaborate with energy questions. However, there is one subject that almost all of the respondents always come back to regardless of what question has been discussed. In the construction sector and especially in the early phases of the design process, it always come back to the relationships. In the end you want to work with persons that you know you can collaborate with. For an example it can be worth it to pay some extra if you know who you are working with, the risk is smaller when you have a record of great projects together. Energy 3 and Contractor 2 especially highlighted the importance of getting the people together from the beginning of a project. Contractor 2 continues with the possibility of co-projects. Allowing the involved parties to get to know each other in a value-creating way and the importance of how Skanska consciously can create effective organisations. In addition, contractor 4 stated "You must create relationships, personal chemistry is important. With the energy crisis and climate crisis, this is now more relevant than ever." (2023). Furthermore, the respondent thinks that the energy consultants need to be more open and proactive in order to fulfil this. They cannot sit and wait to be served tasks, on the other hand to be able to give them the opportunity to be more proactive the contractors also need to invite the energy consultants to project planning meetings. Something a lot of the energy consultants are mentioning as a request, to be invited more often to meetings to get the chance to create relations and by that easier know with who and when to talk about these questions with.

It should be noted that many of the respondents (Structural engineer, Contractor 3, 4, Energy 4, 6, Client 2 and 3) highlighted the possibilities with sub-meetings focusing on energy to make it more efficient. Energy consultant's do not necessarily need to be invited to all project planning meetings however, because of ineffectiveness and discussions of questions not relating to energy. Undoubtedly, they should be invited to the first project planning meeting to be able to understand the set up both technical and social. Moreover, many of the respondents stated that one takes for granted that the energy is sorted out and that one will get the reports needed at the right time. A lack of understanding and willingness to highlight the energy question has been identified at several clients and contractors. While some find it interesting and want to understand the demands and reports to be able to grasp the alternatives and possible solutions as they often become the decision maker.

The first step to understanding is to communicate and to be able to communicate the relationship needs to be introduced. Energy 5 explained that the energy group in Gothenburg is a quite small group and recently has changed. A group that until now have been busy and have not had the strategy to marketing themselves. This is something the responded highlighted as a possibility for the group in Gothenburg. Energy 2, 5 and 6 stated that the client and contractor must understand that energy is needed, that is controlling what is prioritised. Contractor 1, Client 5 and 6 also agreed upon the fact that there are no established relationships between the energy consultants and the developing units. The energy consultants need to start marketing themselves, for an example invite themselves to management meetings. Communicate who they are, getting to know the developing units and explain what they are offering and how they can be an asset for the projects. Getting to know the energy consultants will make it easier to get in touch with them when it is needed. Also, this will make it easier for the energy consultants to introduce the questions to a project earlier when it is still possible to make a change.

5.7 Potential Improvements

The energy consultants at Skanska believe that achieving even better results when it comes to energy performance is possible. This requires more involvement and agency of energy consultants to be able to make changes earlier in the projects.

Moreover, higher demands from both society and within the company require energy to be considered earlier in the process according to Client 2, this could be regarding how the building geometry is structured for example. Client 2 further describes how energy possibly could be introduced already in the feasibility study to facilitate an energy efficient design, “After all, it is much cheaper to change something early than it is to change something late.” (2023). CDN Gothenburg has not reached that point yet, but thinking about it earlier will make it easier to reach the demands. The interviewee further describes how it is their responsibility to invite an energy consultant from the energy department at Skanska Sweden for an example as a sounding board, but that it is not a part of their general process, yet. Client 3 adds on to this that it would be favourable for CDN Gothenburg to work with energy in early phases. Before the project planning document phase there are only volumes of the building confirmed, set from the detailed plan, not the exact geometry. Client 3 argues that deciding volumes is something they need to do before including energy, when the energy interviewees argue that having conversations before the volumes are set would be favourable.

The Architect also agrees upon the possibility to improve the energy by involving an energy consultant earlier in the project. Further, the respondent mentioned the importance of having the right person doing these early analyses, someone who can determine how far and deep you can go in these early phases. The architect continues with the possibility to do a fast simpler energy calculation or just using experience to estimate the energy performance and especially avoiding big mistakes regarding energy. This was also highlighted by all the energy respondents, they believe that they can make a big difference by doing estimations at an early stage. Energy 4 also mention that volume studies are very important to do early on in the design process. Energy 2 states that this can lead to better business for the whole company. Adding to this, Contractor 4 explains how society and their clients are becoming more and more aware, making them have higher demands. This in addition to the energy crisis, makes the energy performance of buildings a current topic.

The Energy interviewees describe that they can contribute to a better building already in the idea stage. While Client 2 describe how they need to review it at least earlier than the construction documents, as they usually do today. Contractor 4 describe how it depends on the detailed plan. Energy 2 also highlights that better energy performance can for example be achieved through passive design the earlier one starts.

6. Discussion

The following chapter contains a discussion around the sub research questions, comparisons between the literature study and the interview study to finally be able to discuss the main research question.

6.1 Energy Performance Prioritisation

The research question being discussed in this subchapter:

How is energy performance prioritised in the early phases of the design process?

The most notable factors effecting the prioritisation are organisational differences, experience and knowledge, competence level of the project managers, certifications, complexity of the project and absence of routines.

It was established in the case that energy is a critical risk, however how energy is prioritised is not standardised in the design process according to the interview study. Depending on what part of the organisation the employee works for CDN Gothenburg, Building 2 Gothenburg or the energy department they also have different ideas about when the right time is to involve an energy consultant. The project managers at CDN Gothenburg and Building 2 Gothenburg have to coordinate many disciplines, while at the same time staying within budget and schedule. While the energy consultants wish to evolve and perform high in their field. At the same time, the company wants to be on the forefront regarding the environment and energy, and to be competitive on the market, whilst also making money. Therefore, the big question is how to balance this, how to prioritise and who should do this? On the other hand, several respondents mention that better energy performance do not necessarily mean a higher costs during the design process. If energy is handled at the right time in the right way, it might benefit the economy of the project. Furthermore, the time of crisis might possibly be the extra push that is needed for changes to be implemented.

In projects today energy is prioritised very differently, depending on the people involved, their experiences and knowledge. It also depends on if the building is to have some sort of certification and how complex the project is. There are no set routines on how they all work with energy as project managers, regardless of, if internal or external energy consultants are hired. According to the interviews and the literature, how people do their work is also heavily dependent on their personal relationships. A good relationship makes it easier to reach out and to ask questions. Close collaboration regarding energy would be highly beneficial and would most likely lead to it being a more prioritised question. This also demands the prerequisite of it being a partnering project, this is however according to the interviews almost always the case when CDN Gothenburg collaborates with Skanska Sweden.

In Skanska's internal documents it is stated that energy calculations need to have been made in the project planning phase, this is quite late in the design process as stated by the energy consultants, making it difficult to influence the project at this time. Apart from this there is no set routine for when an energy consultant needs to be contacted, this applies to both internal and external consultants. Also, according to the interviews it varies a lot, as can be seen in figure 4.

The study has shown that there are several consultant roles that often get overlooked. These roles want to be prioritised and it can be challenging for the project managers to know what to prioritise at what stage. Because a project manager is often more of a generalist than a specialist. Regarding the competence level of the project managers, they cannot be experts on energy, however they need to know when to ask the right questions, and when to prioritise what. For instance, if the project manager had the knowledge that the geometry of a building has an impact on the energy performance and that it is important, then they would potentially contact an energy consultant for a discussion early on.

The diverging levels of competence among the project managers regarding energy further means that their insight to what an energy consultant is able to do is limited. An energy consultants job includes so much more than simply doing energy calculations. According to the interviews, it can be established that the project managers from the client particularly have bad insight into what an energy consultant does. Thereby, this affects how they prioritise and when to include an energy consultant in the projects.

6.2 Roles and Responsibilities

The research question being discussed in this subchapter:

How are the roles and responsibilities regarding energy in a project structured?

The most notable factors effecting the roles and responsibilities are clarity, agency, lack of standardisation and coordination, different perspectives and knowledge levels.

Firstly, it needs to be sorted out whether energy coordination or energy calculations is discussed since the answers of the interviewees differed based on this. Most respondents agreed upon that the responsibility of the energy questions is on the project manager, who has the ultimate responsibility of the project. Whereas the project manager outsources the energy calculations and hires an energy consultant with expert knowledge in the field. This is a shared picture of almost all of the respondents in contrast to who is responsible for the energy coordination. Even if the shared picture was that the project manager had the responsibility it was not equal to a clear energy coordination role. Often energy was not handled thoroughly, and energy was only a must do in energy calculations. When the energy coordination was outsourced a common answer from the client and contractor was that this often is done by an installation coordinator. With naturally focus on the impact of the systems of HVAC have on the energy performance and not the other factors affecting it further. Consequently, after the interviews it was clear that there was no standard role taking responsibility for the energy question. In spite of the fact that the shared picture from the energy consultants was that this is needed for a project. Moreover, if the energy is not considered from the start, it is difficult to make a difference that has impact.

Furthermore, it was highlighted how crucial it is with clear roles. Supported by the literature where Safapour et al. (2019) stated the importance of a good project management team and the connections to communication and its impact of the engagement, costs and time schedule. Therefore, it should be discussed if an energy coordinator makes the responsibility clearer and easier keeping the energy together.

What can be discussed is if the incorporation of one more role early in the design process makes it clearer or if this makes the coordination even more difficult. Because of the complexity of

the construction sector many roles are needed in the design process to fulfil the demands and goals set up for the project. Is energy one of the needed roles to incorporate or is it excessive? Based on the interviews it can be confirmed that the developing units and the energy consultants have different perspectives on this. One of the reasons to this can be the different perspectives as well as the different knowledge levels regarding energy. Overall, the role of an energy coordinator is today unclear and seems of be different based of who you are talking to and what is being referred to. Often the client and the contractor see the energy question equal to only the energy calculations done by an energy consultant. Based on this it might be excessive with an energy coordinator since they do not see the need of further coordination. On the other hand, the energy consultants as well as Dervishi and Baçi (2023) mean that there is much potential to do changes if reviewing the energy performance earlier. An energy consultant acting as an energy coordinator can come with feedback on for example the geometry, window to wall ratio and orientation which affect several roles and therefore needs coordination. The most important of these roles is the architect and the installation coordinator. Furthermore, when working with CDN Gothenburg, they often use external architects, however this should not be a hindrance for connecting them with an energy coordinator for collaboration.

To get the project manager to understand the importance of including an energy consultant as energy coordinator early in the design process the energy consultants need to actively work with this. According to the interviews, they need to take the lead and start marketing themselves. Showing the project managers how much potential there is and what can be done in order to make the energy performance of buildings more effective. This will create a higher awareness of technical possibilities as well as a first step in creating new relationships. Giving them insights to the value it can add to a building and not only view it as a cost. Along with, making it easier to reach out in the future.

Based on the interviews it became clear that depending on the experience of the interviewees, their age and their department they had vastly different perspectives. Their age and experience might have influenced their openness to work in new ways as well as their ability to adapt. It can be concluded that the younger respondents were more open to new perspectives and the older respondents relied more on their knowledge that only considerable experience can offer. This highlights that diversity and openness is needed to be able to cover different perspectives.

6.3 Energy Consultants' Collaboration

The research question being discussed in this subchapter:

How do the energy consultants collaborate with the other professionals in the design process?

The most notable factors effecting the collaboration are inter-organisational relationships, knowledge of each other, uneven competition and lack of knowledge.

According to the interview study the energy consultants are contacted either by a project manager from the client, in this case CDN Gothenburg, or from the contractor, in this case Building 2 Gothenburg. The project manager has the job to coordinate all the involved professionals and has the main contact with the consultant. The energy consultant also needs to collaborate with for example architects and structural engineers. If these consultants are also

internal consultant this collaboration and communication usually works well as they are a part of the same department and thereby naturally have created personal relationships. As Khouja et al. (2021) also highlights, this depends heavily on the inter-organisational relationships. Huemer (2004) and Safapour et al. (2019) further described that the process and workflow also depend on the relationships, something that the interview study also displayed. Some of the interviewees from different departments described how they do not know of each other, and barley know the department. Making it even more difficult to collaborate.

A complexity regarding the collaboration is that the project managers can work with whomever they want whereas the energy consultant can only work with internal projects. Some of the interviewees mention that they work with external consultants regarding energy, mostly out of habit and a good history of collaboration. Ekanayake et al. (2017) described if the external relationships receive all the focus, it can be harmful for the internal consultants. This got confirmed as something that had happened in the past by several respondents in the interview study affecting the current relationships between CDN Gothenburg, Building 2 Gothenburg and the energy department.

A further aspect regarding the internal versus external consultants is their motivations, since the internal consultants for example are regarded as expensive, they have to compete by having high quality instead, as was described by one of the energy interviewees. But this is not always something the project manager understands. Adding to this the literature described that the different organisational perspectives could impact how they work, the internal consultants should have a greater social capital. Not to say that working with external consultants is always worse, they can bring new perspectives and experiences for example, as described by Sturdy and Wright (2011) and in the interviews. Furthermore, they are also of high value when a company does not have the resources themselves, as was the case at Skanska in Gothenburg in the past regarding commercial buildings, according to the respondents.

As in the case, some of the project managers have long lasting, well-functioning relationships with external energy consultants. Meaning that they will most likely continue to work with these people since the collaboration has worked in the past, this is basic human behaviour. Once again, the respondents express a yearning to work more within the company, they can see the added value it would gather, especially in times of crisis. As stated by Khouja et al. (2021) the internal relations also need to be created and maintained, the organisational bands are not enough. Furthermore, it was also expressed that inter-organisational relationships can enhance the understanding and competence. While insufficient communication and collaboration has the potential to hold back the work process (Safapour et al., 2019). Altogether, this enhances the importance of creation and maintaining of relationships.

6.4 Adaptation of the Design Process

The research question being discussed in this subchapter is the main research question:

How can the early phases of the design process be adapted to enable better energy performance of buildings?

The most notable factors effecting the adaptation of the design process are complexity, set framework, set design process, experience, requirements, fine-tuning and being proactive.

The construction sector is project based and complex industry, therefore a lot of the work process is based on knowledge and experience. Moreover, the design process is often done routinely because of this. Although the conditions have changed because of the climate crisis and energy crisis but also because of stricter demands from society and clients.

The energy department is right now an important part of successful projects because of the high risks in energy. Despite this, they are not invited early in the process where changes are easy to make. If this is changed it can make a huge difference to the project. How the energy department work today, they are part of a very set framework, they have to do their job in a certain way. Additionally, the way the process works today does not enable an optimised workflow to achieve the best energy performance in the building. To give the opportunity to enhance the energy performance of buildings there are some adaptions that need to be considered. A system that benefits the internal consultants is needed since they only can work within the organisation. Especially in times of crisis it should be seen as beneficial to work internally since this will economically strengthen the company.

From both the case and the interviews it can be established that there are no set work process including an early consideration of energy of an energy consultant. Rather, it is today mostly based on past experience of the project manager and what has worked in the past. Despite the fact that the requirements have changed and demands new solutions. Requirements and solutions that can be difficult to understand when not being an expert and because of this sometimes never brought up to discussion. Therefore, it can firstly be stated in the internal documents that energy needs to be considered by an expert in early phases of the design process. This applies to both internal and external energy consultants, the important factor is that an expert is included early. This leads to a discussion of when in the design process it is meant by early. The respondents of the interview study gave quite differing answers based on the knowledge, experience and role as seen in figure 4. The expected outcome to invite energy early in the process is to enable better energy solutions that does not need to work against the project and different actors.

In figure 4 it can further be seen that the different phases as well as depending on what department one belongs to, the answers of when energy is or should be introduced into the design process diverged. Despite this, conclusions can be made that there is potential for earlier involvement of energy in the design process. Based on the fact that most of the respondents wanted to introduce the energy question earlier into the design process than the current state. It should be noted that the energy consultants were more positive to an earlier involvement than the rest of the respondents. This may be due to the different knowledge levels regarding energy and thereby the possibilities of an earlier involvement. Therefore, it is suggested that involvement of energy is done at least from the program document phase, preferably earlier. This does not need to be in the form of an energy calculation as most of the clients and contractors are thinking. Rather, it is encouraged to be an informal conversation where different suggestions and scenarios are discussed to highlight what the demands are requiring, what is possible solutions and what the project manager are willing to do. This will increase the understanding between the developing departments and the energy consultants. Facilitate better energy solutions and create relationships opening up for a better collaboration with higher trust in each other. Which can possibly lead to better solutions because of more freedom and trust towards each other.

What is described in the literature as fine tuning is what is needed in these questions at issue. The technical parts are not the main problem according to the findings in the interview study, rather the social parts of how to implement and work with the question therefore no major changes are a must. Fine-tuning can make a big difference and improving already set processes and methods along with establishing present roles further. Making an organisation work more towards the same goal. However, it should also be noted that Todnem By (2005) states that these small changes can be hard to achieve because of confusion and being stuck in old patterns. This is when the literature highlights the role of the boundary spanners. According to Bögel et al. (2019) definition of boundary spanners, Building 2 Gothenburg, should be working as the boundary spanners between the client, CDN Gothenburg and the energy department. Since they have a record of working with the two and therefore have knowledge of the methods as well as the important personal relationships, therefore they can bridge the gaps between them.

On the other hand, it has by the literature been established that it can be easier to adapt to bigger changes than fine-tuning, therefore another alternative could be to change the structure of the organisation. To enhance a closer collaboration and a more proactive way of working with energy. As already established, the energy department are internal consultants, meaning they can only work within the organisation. While the projects can start a tendering process and hire any energy consultant. This has been criticised by the energy department since many of the project managers do not know what is best for the project regarding energy. Often the internal energy consultants need to include more parts in the tendering documents because of demands from the company. Leading up to a quite unequal situation where the internal energy consultants need to compete at different terms than consultants from outside the organisation. This has been stated by several of the energy consultants as a hindrance to be able to compete at price, instead they try to compete by having high quality on their work. If the internal energy consultants instead of being consultants were a part of the contractor, in this case that would be the department, Building 2 Gothenburg, it would change the whole dynamic. A big change like that would be a statement, further enabling collaboration and putting more focus on energy for better solutions. It should be noted that this would require major work and for an organisation to go through this change smoothly change management is vital.

7. Guidelines

Based on the case, interview study and literature study, the following guidelines to improve the collaboration towards buildings with better energy performance have been developed. The guidelines are aimed towards construction companies trying to improve the energy performance of their new buildings, mainly construction companies with internal energy consultants. Moreover, the guidelines are ranked in order of succession based on what can and should be implemented first.

• Build relationships and trust

It is specifically important for internal energy consultants to make themselves known within a company, especially if they want to expand their area of expertise. This requires marketing of their competence area and building relationships. This should be done by inviting themselves to meetings with the project managers and present what an energy coordinator can offer. The presentation needs to be short, informative, simple and highlight the business opportunities of energy, making it easy to grasp for the project managers. Because once people have a face to the name, the distance between people reduce dramatically and the hurdle to make a small call reduces significantly. This is furthermore how one builds trust, another crucial factor in collaboration.

• Regular educational energy workshops across departments

The energy workshops should act as a space where actors from different departments, the consultants, contractors and clients, can learn together as well as getting to know each other, creating relationships. This will in the long run enhance competence levels and improve communication and collaboration. An important detail of these workshops is that they should be held across departments by an energy consultant, and they should occur one to two times per year.

• Invite energy consultant early for brief discussions

Inviting an energy consultant as an energy coordinator in the early design process for casual discussions is a prerequisite for an energy efficient and economical solution. The discussion has potential to lead to optimal solutions and coming in early can prevent unnecessary costs further down the line.

• Standardisation of internal documents for alignment of the energy question in new construction

The standardisation of the work process in the internal documents is a necessity because the process today varies so much from person to person. If the adjusted process receives a proper introduction into the company and is followed by the involved actors, it will most likely make a huge difference. This is because the process today in the internal documents is not always

followed, but actors rely more on experience. Therefore, this adjustment will be a learning process.

• Add incentives to work in-house

Adding incentives to work more in-house will enhance the closeness of the collaboration regarding energy. In this case, the removal of hindrances can imply adapting the organisation structure, meaning that the energy consultant should not work as internal consultant where they have to invoice every hour. It can also mean that it should be more natural to invite energy consultants to project meetings. The adding of incentives can for example mean that the client and contractor can receive a discount when they use internal consultants as opposed to external consultants. Alternatively, incentives could also be to propose to work with a certain part of internal consults to further their opportunities.

• Contact person

The different departments should have a contact person at each office, someone who is easily accessible, not depending on where the department manager is located. The contact person should be clearly marketed on the internal channels, making it easier for people to reach out before relationships have been established.

8. Conclusion

Based on a case together with an interview study, guidelines were formulated in order to help companies achieve better energy performance of new buildings through closer collaboration early in the design process. During times of crisis, companies must prioritise climate and energy through change management in order to maintain their positions on the market. Today the energy consultants at Skanska generally get attached to the design process in the phase where most parameters are already decided. Making it difficult and costly to make changes that do make a difference regarding energy performance of the building. Therefore, it can be argued for an earlier involvement of energy in order to make an improvement to the energy performance without incurring significant rework and costs.

In light of these considerations, it is recommended that energy consultants should be involved in the project as early as the feasibility study, or with participation at the latest in the program document phase, depending on the specific project. A brainstorming meeting between the project manager, architect and energy consultant is recommended in order to generate ideas and ensure that multiple perspectives are considered. Moreover, energy is a complex field and in order to be on the forefront as well as achieving the sustainability goals that Skanska and the European Union has set out, being proactive is a prerequisite. Therefore, it can be argued that the old requirement of simply an energy calculation, is now the bare minimum. As has been discussed in this thesis, several other factors in the energy consultant's competence area have a huge impact on the energy performance.

Lastly, it is argued that a more holistic view is necessary, with energy consultants serving as energy coordinators throughout the design process and overseeing follow-up on the building. By taking a proactive approach and incorporating a more comprehensive view of energy performance, companies can achieve its sustainability goals and make more effective improvements and savings for all parties involved.

9. Future Research

The thesis has resulted in an awareness of how the work with energy questions are prioritised, and structured or as concluded unstructured working methods. Furthermore, suggestions have been made to introduce an energy coordinator earlier in the design process to enable better energy performance of buildings. Therefore, it would be interesting to investigate how this would perform if practiced. How the relationships could develop between the different departments. Along with how this would affect the trust between the consultants, contractors and clients and thereby the freedom and creativity of future solutions. Moreover, recognition of different technical solutions for easy early energy calculations would be useful for further development of the technical parameters.

Another aspect would be to study how the collaboration and working culture is at the other Skanska Sweden offices, since it was brought to the authors attention that it varies in the different cities. It was also communicated that other departments at Skanska Sweden have closer collaboration, therefore sharing the knowledge between them would be interesting.

Finally, doing calculations to evaluate how much money and energy could be saved by early involvement would be of value since it can generate exact results. The results should thereafter be presented to the company, accomplishing more change.

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Appendix A - Interview Template Contractor

1. Vad har du för bakgrund?

2. Vad är din roll på Skanska, vad har du för arbetsuppgifter och hur länge har du haft din roll?

3. Hur stor del av ditt arbete är kopplat till hållbarhet?

4. Hur viktig är energifrågan i de projekten du är med i?
    a. Hur betydande är energi i ditt hållbarhetsarbete?

5. Vem är ansvarig för energifrågan när ett projekt startas?
    a. Har ni en dedikerad energisamordnare?
        i. När blir hen involverad, i vilket skede?
    b. Vem beslutar om vad som ska beaktas och inte kring energifrågan?

6. Vem brukar du vara i kontakt med kring energifrågor?
    a. Hur fungerar kommunikationen?

7. Hur ofta är energiingenjörer med på projekteringsmöten?

8. Hur jobbar ni med energi mer konkret i de olika faserna? Från idé/förstudie till produktion
    a. Hur fungerar det idag?
        i. Varför jobbar ni såhär?

9. Hur är energi prioriterat i dessa faser?
    a. Vad beror detta på?

10. Hur ofta jobbar ni med interna/externa energikonsulter? Vad är det som avgör?
    a. Hur funkar det om externa energikonsulter används?
    b. Vad är arkitekternas bidrag till en lyckad energiprojektering?
        i. Vad efterfrågar ni för energikompetens när ni handlar upp arkitekten?

11. Hur styrande är ekonomiska faktorer för involvering av en energikonsult genom projektet?

12. Hade du velat ändra processen? Hur och varför/varför inte i så fall?

13. Finns det någon mall kring energi på VSAA för projektledare/projekteringsledare? Följer ni den?

14. Hur samarbetar ni med Skanska Fastigheter/ andra kunder/ konsulter?

15. Har du något exempel på projekt som fungerat extra bra när det gäller samarbetet kring energi? Vad tror du att det beror på?

16. Har vi missat något?

Appendix B - Interview Template Client

1. Vad har du för bakgrund?

2. Vad är din roll på Skanska, vad har du för arbetsuppgifter och hur länge har du haft din roll?

3. Hur stor del av ditt arbete är kopplat till hållbarhet?

4. Hur viktig är energifrågan i de projekten du är med i?
    a. Hur betydande är energi i ditt hållbarhetsarbete?

5. Vem är ansvarig för energifrågan när ett projekt startas?
    a. Har ni en dedikerad energisamordnare?
        i. När blir hen involverad, i vilket skede?
    b. Vem beslutar om vad som ska beaktas och inte kring energifrågan?

6. Vem brukar du vara i kontakt med kring energifrågor?
    a. Hur fungerar kommunikationen?

7. Hur ofta är energiingenjörer med på projekteringsmöten?

8. Hur jobbar ni med energi mer konkret i de olika faserna? Från idé/förstudie till produktion
    a. Hur fungerar det idag?
        i. Varför jobbar ni såhär?

9. Hur är energi prioriterat i dessa faser?
    a. Vad beror detta på?

10. Hur ofta jobbar ni med interna/externa energikonsulter? Vad är det som avgör?
    a. Hur funkar det om externa energikonsulter används?
    b. Vad är arkitekternas bidrag till en lyckad energiprojektering?
        i. Vad efterfrågar ni för energikompetens när ni handlar upp arkitekten?

11. Hur styrande är ekonomiska faktorer för involvering av en energikonsult genom projektet?

12. Hade du velat ändra processen? Hur och varför/varför inte i så fall?

13. Hur samarbetar ni med hus/konsulter?

14. Har du något exempel på projekt som fungerat extra bra när det gäller samarbetet kring energi? Vad tror du att det beror på?

15. Har vi missat något?

Appendix C - Interview Template Consultant

1. Vad har du för bakgrund?

2. Vad är din roll på Skanska, vad har du för arbetsuppgifter och hur länge har du haft din roll?

3. Hur viktig är energifrågan i de projekten du är med i?

4. Vem brukar du vara i kontakt med kring energifrågor i projekt? När och hur sker detta i designprocessen?
    a. Vem ansvarar för/ leder energifrågan?
    b. Vem är beslutsfattare?
    c. Hur mycket kan du påverka?
    d. Hur ofta blir du energisamordnare, när blir du involverad?

5. Hur jobbar ni med energi i de olika faserna? Från idé/förstudie till produktion.

6. Hur är energi prioriterat i dessa faser?
    a. Vad tror du att det beror på?

7. Hur fungerar det idag?
    a. Varför jobbar ni såhär?
    b. Finns det tillräckligt med kompetens hos projektutvecklarna kring energi?

8. Är det skillnad på hur samarbetet fungerar vid externa/interna arkitekter?

9. Hur styrande är ekonomiska faktorer för involvering av en energikonsult genom projektet?

10. Hade ni velat ändra processen? Hur och varför i så fall?

11. Följer ni mallen från VSAA gällande energi? Varför/ Varför inte?

12. Hur samarbetar ni med Skanska Fastigheter/ Hus/ andra kunder?

13. Skiljer det sig hur man samarbetar om det är flerbostadshus/kontor?

14. Finns det något du vill lägga till?

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