WHEN COMES THE SUN?

A STUDY OF STAKEHOLDERS, DRIVING FORCES AND FUTURE SCENARIOS OF SOLAR POWER IN SWEDEN

Rebecka Marklund and Carolina Ramberg

ABSTRACT

By using a combined methods approach, this master thesis project used a case study, of a distribution system operator in the southern part of Sweden, and survey, in the form of a two-round Delphi study, to explore driving forces and potential scenarios on the future market for on-grid solar power in Sweden. The project identified seven key stakeholders on the current market, along with both intrinsic and external driving forces that influence the development towards more solar power in the grid. The stakeholders were found to, to varying degree, be driven by the four intrinsic forces financial benefits, environmental concerns, creating a sustainable profile or striving towards self-sufficiency. External forces took the shape of mega trends such as increased environmental awareness, flexibility in usage and supply as well as more decentralized production and more fluctuating electricity prices. The thesis project also resulted in four distinct scenarios that could depict possible pathways into the future, based on the two conditions relative financial benefits of solar power and prioritization of environmental concerns being fulfilled to alternating degrees. In general, the study revealed a bright perception of the future of solar power in Sweden, but changes and adaptations are needed if the market is to disrupt and solar is to become a significant part of the Swedish energy mix.

Keywords: *Combined methods research, Delphi study, Distribution system operator, Foresight, Photovoltaics, Scenario building, Solar power, Stakeholder analysis*

PREFACE

This master thesis was written to report on the final project of the Master of Science in Industrial Engineering and Management at the Faculty of Engineering at Lund University. The thesis covers one semester of 30 credits, marking the summit of an education of five years and 300 credits. The project was a collaboration with E.ON Energy Networks in Malmö, who helped defining problem boundaries and assisted with guidance along the way.

First, we would like to express our warmest appreciation to our supervisor Ola Alexanderson at the Division of Project Management at the Faculty of Engineering, for all the support and guidance you have given us throughout the project - always with great engagement. Secondly, we would like to give thanks to Peter Andersson, Sofia Persson and Kristofer Andersson at E.ON. Your thoughts and ideas have contributed a great deal to the development of the project.

Finally, we would like to show gratitude to all the experts that participated in the two survey rounds of this project's Delphi study. You provided us with truly interesting input into understanding the possible development of the market for solar power in Sweden. We hope you find the result satisfying and that it can help you in your work. This project would not have been possible without your help and expertise - thank you!

Lund, May 2018

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EXECUTIVE SUMMARY

Title: When comes the sun? A study of stakeholders, driving forces and future scenarios of solar power in Sweden.

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Background: In order to decouple from carbon dioxide, alternative, renewable energy sources need to replace traditional fossil fuels. The fastest growing renewable technology has for the past years been solar, more specifically in the form of photovoltaics (PV). With the support of policy schemes, solar systems are being installed on rooftops of private houses and corporations - and are increasingly being connected to the grid. The decentralized nature of solar, as well as the intermittency of it, are characteristics that place new demands on the distribution network. This entails changes for the electricity market and its actors, whose future roles and activities are yet to be determined. What influencing factors are key in the development and what pathways are plausible can help the different stakeholders adapt to the conditions of the future.

Purpose: The purpose of this project was to examine driving forces for different stakeholders on the current Swedish market for solar power. It also aimed to study if and why the roles of different stakeholders will change over the years ahead. The research project further intended to explore driving forces and potential scenarios on the future market.

Research question: The main research question in this thesis paper was the following:

RQ What driving forces and distribution of roles could characterize the future market for solar power in Sweden?

This was divided into three sub-questions:

RQ1 What stakeholders can be identified that are connected to increased levels of solar power in the Swedish distribution network?

RQ2 What drives the different stakeholders on the electricity market, today and in the future?

RQ3 What potential scenarios could depict the future market for solar power?

Method: The project had an abductive, qualitative approach but also included quantitative elements. The method design used was a combination of a case study and a survey. The case study was of a Swedish distribution system operator (DSO) and provided a basis for the building of a survey. For the survey, a two-round Delphi study was used. The Delphi technique gather the opinions of a panel of experts within a field, such as the one of solar power, through an iterative process. The thesis project as a whole was of an exploratory-descriptive nature.

Delimitations: This thesis project was limited to the Swedish market of on-grid solar power.

Conclusions: The project identified a range of seven key stakeholder segments on the current market, along with both intrinsic and external driving forces that influence the development towards more solar power in the grid. Intrinsic driving forces were *financial benefits*, *environmental concerns, sustainable profile* and *self-sufficiency,* that influence the different stakeholders in varying ways. External driving forces were captured in a set of mega trends influencing the market development. These included among others increased environmental awareness, flexibility in usage and supply as well as more decentralized production and more fluctuating electricity prices.

The thesis project also produced four distinct scenarios that could depict possible pathways into the future. These were constructed using the two axes *relative financial benefits of solar power* and *prioritization of environmental concerns*. Different stakeholders were identified as enablers of, and obstacles for, the different pathways for development, along with other elements of vitality for more solar in the grid. The results implied that the rise of solar as a prominent energy source in Sweden is closely connected to changes in roles of the current stakeholders. In general, the study revealed a bright perception of the future of solar power in Sweden, but changes and adaptations are needed if the market is to disrupt and solar is to contribute a significant part of the Swedish energy mix.

Keywords: *Combined methods research, Delphi study, Distribution system operator, Foresight, Photovoltaics, Scenario building, Solar power, Stakeholder analysis*

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ABBREVIATIONS AND DEFINITIONS

Abbreviations

ANT	Actor Network Theory
DSO	Distribution System Operator
PV	Photovoltaics
TSO	Transmission System Operator

Definitions

Market actor	Participant in an action or process, used synonymously to stakeholder in this research project.
Off-grid solar	Stand-alone solar panel system.
On-grid solar	Solar panel system with grid-connection.
Photovoltaics	The most common type of solar power technology, in which cells use what is known as the photovoltaic effect to transform sunlight into electricity. Often many photovoltaic cells are connected, creating photovoltaic panels.
Prosumer	Actor that functions both as producer and consumer of electricity.
Stakeholder	Group or individual who can affect, or is affected by, the achievement of an organization's purpose.

1 INTRODUCTION

This first chapter introduces the concepts of the thesis project and presents the foundation it is built upon. It gives the background to the project and describes its purpose and deliverables. Limitations are also defined along with the research disposition.

1.1 Background

The public perception of a "solar power boom" has spread across the globe with an endless number of articles and reports praising the process of harnessing the sun into renewable energy (Hirtenstein, 2018; Zhou, 2018; Holmes, 2017). Solar was the fastest growing energy source in 2016, with a price drop of 70 % since 2010. Photovoltaics (PV), the most prominent source of solar power, has seen a growth larger than any other form of electricity generation in a range of countries (IEA, 2017). The interest in solar based electricity has spread to Sweden, with many claims that the explosion of the Swedish market for solar energy waits just around the corner (Björklund, 2017; Söderblom, 2018; Hylander, Sidén, Stenqvist & Winkler, 2016; Unger Larson & Goldmann, 2017; Gefle Dagblad, 2017). Despite optimistic claims and years of continuous growth, solar still only contributed 0,09 % of the Swedish energy mix in 2016 (SCB, n.d.), and if, or when, the solar revolution is to occur is not clear. To enable decoupling from carbon dioxide through the integration of new alternative renewable energy sources, a major disruption in production and supply is needed in the electricity system (World Energy Council, 2016). Within this transformation, the roles of and driving forces for various market actors or stakeholders (hereafter used synonymously) shape the forthcoming system (Energimyndigheten, 2016a; KTH Green Leap, 2016; Byman, 2016).

One of the parties affected by the changing characteristics of the electricity system is the facilitator responsible for the electric grid, known as the distribution system operator (DSO). The activities of the DSOs are changing, partly because more intermittent energy sources require major reinvestments in the distribution system (Damsgaard et al., 2014). Other actors such as regulators and power suppliers are also recognizing a need to invest in infrastructure, balancing tools and storage systems to cope with the characteristics of renewable energy sources. The incentives for these investments are influenced by both current regulations of the grid (Förvaltningsrätten i Linköping, 2016), and the sharing of risk and responsibilities between the different parties (Diskin & Keane, 2015).

As seen in e.g. Carlman Bydén and Persson (2016), it is probable that economical and managerial risks caused by intermittent energy sources will increase over the years ahead, and that this has implications for the activities of the participants in the system. Regulators need to ensure stability and trust in the energy network to support the market transition, and all actors can in different ways contribute to the transition (Byman, 2016). In the specific context of solar based electricity, the research group KTH Green Leap (2016) also stated that normative and behavioral drivers, such as a desire for self-sufficiency, help build a potential market.

The importance of studying the changing distribution of roles is emphasized by for example The Swedish Energy Agency in their report Vägval 2020, which concerns the transformation of the Swedish energy market (Energimyndigheten, 2015). The topic has also been discussed in a range of studies of both academic and private nature, for example Sandoy et al. (2010) and Thema Consulting Group (2015). Nonetheless, changing roles and driving forces within the energy industry focusing on solar power and the Swedish future market is a research area in need of development. This is due to scarce research available in the field, along with a rapidly changing environment. Stakeholder analysis - the process of identifying key participants in a system or network (Mitchell et al. 1997) - is often seen as the basis of scenario building and becomes an essential starting point for capturing roles. This is an approach often taken in the context of both national and international energy markets, e.g. Varho, Rikkonen & Rasi (2015), Foxon (2016) and Energimyndigheten (2016a). It has also been applied more specifically to national electricity networks, as reported by Ault, Frame, Hughes & Strachan (2008) and National Grid (2017). This type of analysis can show implications for how the future market could develop, and plausible scenarios for the future can determine how the various stakeholders can position themselves on the market in order to build relationships and create sustainable businesses.

1.2 Purpose

The purpose of this project was to examine driving forces for different stakeholders on the current Swedish market for solar power. It also aimed to study if and why the roles of different stakeholders will change over the years ahead. The research project further intended to explore driving forces and potential scenarios on the future market.

1.2.1 Research questions

The main research question addressed in this thesis project is the following:

What driving forces and distribution of roles could characterize the future market for solar power in Sweden?

In order to assess this question, the three following sub-questions were developed:

RQ1 What stakeholders can be identified that are connected to increased levels of solar power in the Swedish distribution network?
RQ2 What drives the different stakeholders, today and in the future?
RQ3 What potential scenarios could depict the future market for solar power?

1.2.2 Deliverables

This research project will deliver an overview of stakeholders and their activities on the market for solar based electricity in Sweden. It will also propose driving forces and scenarios for these stakeholders in a future setting. General emphasis will be on increased levels of solar based electricity in the distribution network. This project will deliver a report, a summarizing article and a presentation held at the Faculty of Engineering at Lund University in the spring of 2018.

1.3 Delimitations

This thesis paper centers around the future development of the Swedish market for solar power in terms of roles in the electricity network. It is limited to the market of on-grid solar power. The main technology for solar power today is PV, which is also the principal technology of attention for this report. No other sources of energy are discussed, nor is specific technological development described to a larger extent. The first part of the research project, which took the form of a case study, was limited to the perspective of a single major energy company, specifically focusing on its division operating distribution systems. No other market participants were assessed in-depth via primary sources, but these were included in the second part of the research project in order to revise or confirm the perceptions found in the case study.

A few national and international cases of distribution of roles, driving forces and scenario building were reviewed for the survey building. However, no general perspective comparing Sweden to other markets was conducted. This was due both to the scale of the project and the general differences of markets in geographical, social, political and cultural respect. There was no perspective on the potential influence of international policy factors on Swedish development, although the institutional governance of the Swedish market is dependent on regulations set by the European commission and international undertakings with global coverage, such as the Paris Agreement. The changing policy interventions decided on a European and international level were assumed to be reflected in the initiatives and ambitions set by the Swedish policy makers and the Swedish market. This follows the structure of the reports Vägval 2020 and Fyra Framtider (Energimyndigheten, 2015; Energimyndigheten, 2016a) which only focused on Swedish regulators and the national market. The policy decisions relating to the electricity market in Sweden was seen as fairly fluctuant. For instance, specific revenue cap regulations for the DSO were not considered to be fixed obstacles for possible driving forces within the market.

1.4 Thesis outline

Chapter 1 Introduction

This introducing chapter gives the background, purpose and scope of the research project. The research question is divided into three sub-questions. The chapter also presents deliverables and delimitations of the thesis paper.

Chapter 2 Methodology

In the second chapter, the methodological framework is presented with an explanation of the research strategy, its design, the data collection method and analysis. The chapter also illustrates the work process and trustworthiness of the chosen methodology.

Chapter 3 Theory

This chapter gives an overview of the academic foundation on which this thesis project is built. It discusses scientific, economic and social theory relevant to assess the research questions of the paper. The first section consists of the areas stakeholder theory, stakeholder analysis, actor network theory and characteristics of a natural monopoly. The second part with more dynamic research areas concerns change in markets and roles and consists of theory on foresight studies, scenario building and Delphi research.

Chapter 4 Setting the context: The electricity market

This chapter provides the context for the project through an overview of the electricity market in Sweden, along with specifics on solar based electricity. It also presents a literature review of distribution of roles and foresight studies conducted in the area of energy networks and renewable energy sources.

Chapter 5 Case study

This chapter presents the results of the case study. The case of one specific DSO acting in today's market is introduced. Company facts of strategy and operations are presented along with the DSO's stakeholder network.

Chapter 6 From case to the market: a generalization

Chapter 6 provides a generalization of the findings of the case study and literature review as to capturing the current market for solar power. It portrays stakeholders and their driving forces, and also presents the analysis that supports the survey building in the second part of the project.

Chapter 7 Survey

In this passage, the process of the survey with the Delphi study is presented. The results from both survey rounds are followed by analysis of the findings and their implications for the development of the market for solar based electricity.

Chapter 8 Discussion

This chapter presents the discussion of the project. The findings of each of the chapters 4 to 7 and their connections to the research questions of this report are discussed. These findings are also integrated in a general evaluation of answering the research questions.

Chapter 9 Conclusions and suggestions

This chapter presents the conclusions of this thesis project. This is followed by the project's contributions to theory and practice, along with reflections upon methodology, theory and trustworthiness. Finally, areas for future research within the field are suggested.

2 METHODOLOGY

This chapter presents the methodological basis of the research project. It describes the research strategy, the research design and the data collection method. The chapter also illustrates the process of data analysis and discusses the academic quality of the paper.

2.1 Research strategy

2.1.1 Different approaches

A research project can according to Denscombe (2017) take either a *quantitative* or a *qualitative* approach; the two are suited for different situations. While a quantitative study is appropriate when using numbers as a unit for analysis, qualitative research typically uses words. Qualitative research often explores a problem within its context, considering different perspectives, while the quantitative method allows the study of isolated numbers. A quantitative approach is normally suitable when conducting research on a larger scale, while a qualitative approach is appropriate for smaller research projects (Denscombe, 2017).

As stated by Höst, Regnell & Runesson (2006) a research project can also be defined after its purpose, being either *descriptive, exploratory, explanatory* or *problem solving* in nature. While a descriptive study aims to show how something functions, an exploratory one goes into the particulars of understanding why. Explanatory studies aim to clarify why something functions as it does, while problem solving research has the ambition to find a solution for a certain issue (Höst et al., 2006).

A third way of characterizing research is through whether the reasoning takes an *inductive*, *deductive* or *abductive* approach. Deductive research, stated Kovácks & Spens (2005), uses theory to form a preliminary hypothesis which is then tested in an empirical context. In inductive research, on the other hand, empirical observations are used to create a theoretical framework (Kovács & Spens, 2005). Abductive reasoning is a combination of the two, involving a constant interaction between ideas and observations, and is often considered suitable when conducting qualitative research (Starrin & Svensson, 1994).

2.1.2 Chosen approach

Since this thesis project aimed to define and explore roles of stakeholders, a qualitative approach was deemed suitable. The small scale of the project supports the use of qualitative rather than quantitative research. The thesis project as a whole is of an exploratory or exploratory-descriptive nature. The first two research questions aimed to identify the roles and driving forces of the solar power market in a descriptive fashion, without quantification. The third research question aimed to explore future scenarios relating to driving forces on the market.

This research project can be described as having an abductive approach, although the starting point originates in a deduction of established academic stakeholder theory and analysis, actor network theory and foresight studies. These findings were followed by empirics on market structure and the division of roles in the current setting of a case study company, that served as a basis for the exploration of driving forces and future market characteristics.

2.2 Research design

Höst, Regnell & Runesson (2006) states that the design of a research project can take various shapes, were experiment, case study, survey, action research or mixed methods are some of the most common types. Mixed or combined methods research is a way to broaden the perspective on a certain research domain by using multiple methods instead of a single one (Denscombe, 2014). This is a useful approach to increase the credibility of scientific results in line with the triangulation framework, where combined methods (sometimes called convergent validation) use mixed methods of research as complementarities (Jick, 1979). It can further allow the researchers to develop the analysis sequentially, where one method provides background information for the other. The usage of the method "combination research" results in a more complex data analysis and is generally more time consuming. This limits the scope of the research area to compensate for the available time frame (Denscombe, 2014).

The research design used for this thesis project was twofold and took the form of a case study combined with a survey. The combined method design was chosen for different reasons. A case study on its own would not easily allow for projections into the future, nor would it capture the wider views taken in the exploratory scenario analysis made in the second part of the project. The in-depth understanding of the current roles gained in the case study allowed building a better survey, which was important to assess the considerable uncertainties in the future scenarios. This approach was strengthened by having access to primary data from knowledgeable employees, which helped capturing the current stakeholders and driving forces in the case. The credibility of the scenario building in phase two was strengthened by the examination of the present situation. The aim of using a combined sequential study was thereby to produce insights in current roles on the market for solar based electricity in Sweden and subsequently to explore future changes of the stakeholders and their roles.

2.2.1 Case study

Case study research is according to Flyvbjerg (2006) the best way to describe how relationships and human behavior affect real-life situations and is by Denscombe (2014) described as one of the most common choices in small-scale research. It is often associated with primarily qualitative research and is used to gain deep understanding of a specific phenomenon in a well defined setting (Denscombe, 2014).

The aim of the present case study was to explore key questions that the market actors face, i.e. the problems and opportunities associated with the current market for solar power in Sweden. Essentially the study aimed to assess the first of the research questions: "RQ1 What stakeholders can be identified that are connected to increased levels of solar power in the Swedish distribution network?", as well as to gather knowledge necessary for answering the second research question: "RQ2 What drives the different stakeholders, today and in the future?" It aimed to verify the problems identified by the DSO and other players on the market of solar power, and to generate knowledge for the survey building in the second part of the research project.

2.2.1.1 Setting of the case study

A clear definition of the setting and identity of the case at hand is a fundamental part of performing a case study. A case is according to Denscombe (2014) essentially defined as fulfilling two criteria:

- being a completely separated unit
- having distinctive borders

Examples of cases that can be used are a specific event, process or organization (Denscombe, 2014).

The context of this study was specified as the current Swedish market for solar power and the distribution of roles in the distribution network. In the case design, a specific DSO in the south of Sweden, E.ON Energy Networks (E.ON Energidistribution), was used to develop the problem description and to explore the stakeholder network in the context of solar based electricity. Collaboration with employees working in the headquarters in Malmö was possible, which enabled access to internal documents, data and knowledge. The sample was limited to PV as the exclusive solar power technology for the selected DSO on this market.

Roles, being social constructs, are created when stakeholders are interacting with each other (Banton, 1996). This makes it useful to explore roles in a general system perspective. Roles were defined as activities performed by stakeholders with an interest in increased levels of solar based electricity in the Swedish national grid and the relationships between these stakeholders. Even if the view gradually expands, the case is not to be seen as a sample unit that allows statistical generalization. Instead, the case mainly functioned as a backdrop to the more generalized survey and the conclusions of the case were reconfirmed and discussed in the later part of the project.

2.2.2 Survey

Survey methodology represents another type of research design and attempts to ask a set of questions to a number of respondents, using questionnaires and interviews to collect data. Empirical research is an essential part of survey studies, and they often have a wider and more inclusive coverage than other research designs (Denscombe, 2017). Panel surveys, that have multiple data collection points for a recurring sample of respondents, are a specific type of survey that has become more frequent in recent years (Joye, Wolf, Smith & Fu, 2017).

In the second part of the research project, an adapted version of a Delphi study was made using the knowledge of a sample of relevant people in the field.

2.2.2.1 Delphi study design

A Delphi study is an interactive approach which through two or more rounds compiles the knowledge and opinions of independent experts in order to reach some kind of shared conclusion (Denscombe, 2017). Essentially, experts reply to a round of questionnaires and subsequently receive representation of all the participants' responses in a repeated process, with the hope of converging towards something close to consensus. Consensus is in Delphi studies, according to Diamond et al (2014), often defined in percentage agreement, where 75% is often the value of reaching strong agreement within an issue. A Delphi study encourages anonymity and reduces some of the unsought aspects of group interaction such as social dominance and pressure towards conformity (Skulmoski et al., 2007). It is a flexible approach that has been used in a range of different settings to explore uncertain scenarios, forecast the future and in the absence of a general consensus about a matter (Okoli & Pawlowski, 2003).

Denscombe (2017) describes a Delphi study as a process with seven steps. These were followed during this research project.

1. Define the problem
2. Tailor the research design to the resources available
3. Establish contact with suitable experts
4. First round of questions
5. Initial analysis and feedback
6. Subsequent rounds of questions and feedback
7. Final report

Hsu & Sandford (2007) describe a common structure as having three basic rounds, where more rounds can be added if deemed necessary. This is supported by Denscombe (2017) who presents the classic form of the Delphi technique as consisting of three or four rounds, although some cases of up to five rounds have been found in literature (Fattah et al., 2016). In graduate research, two or three rounds have been suggested to be feasible due to the limited scope and resources of such projects (Skulmoski et al., 2007; Denscombe, 2017). It is also advised that two rounds may be enough when there is an established knowledge base in the field of study (Iqbal & Pipon-Yong, 2009). Therefore, this project made use of two rounds when conducting the Delphi study. The first questionnaire was based on the literature review and the case study. After synthesizing the answers from the first round, the results were sent out together with supplementary questions that asked the participants if they agreed with the group's collective opinions. In the case of disagreement, round 2 gave the participants the opportunity to explain why. In-depth questions concerning certain topics found interesting in round 1 were also included.

2.3 Data collection

According to Denscombe (2017), the four main methods for collecting data are *questionnaires, interviews, observations* and *documents*. In this project, three of the four methods were used, with emphasis on questionnaires and documents. A literature review compiled information from different types of documents relevant to the setting of the field of study. The case study was followed by semi-structured interviews aimed at confirming the general findings and gaining input from unexplored avenues of research within the field. Finally, questionnaires - taking the shape of a Delphi study - were used during the second part of the project to collect data from experts.

2.3.1 Literature review

As presented by Denscombe (2017) a literature review serves to put the research into context by for example "identifying intellectual origins of a work" or to "show familiarity with existing ideas, information and practices related to the area of interest" (p. 371). Guidelines for good practice include having a thoroughly systematic approach and using logging of details in the information gathering (Denscombe, 2017). Höst et al. (2006) also state that a literature review should be an iterative process, since an increasingly focused search is made possible as the orientation of the research is becoming clearer. By the end of the project it is also useful to compare its findings with the literature once again (Höst et al., 2006).

In this project, a literature review of qualitative and (to a lesser extent) quantitative sources was used as a basis for the project, specifically to provide an exploratory mapping of the roles and driving forces found on the current Swedish market. The review covered general knowledge on stakeholder mapping, foresight studies and other relevant theory, as well as today's Swedish electricity market, specifically that for solar power. The findings of the review can be found in chapters 3 and 4 of this report. This was carried out by collecting publicly available, credible information from peer-reviewed academic journals and books, which were found using databases such as LUBsearch, DiVA, Google scholar and Econbiz. Some search words included in the literature review were: "stakeholder", "stakeholder analysis", "actor network", "foresight", "scenario building", "Delphi", "solar energy", "PV market", "distribution system operator" and "solar energy business model" as well as similar phrases and synonyms. Searches and sources were logged using Excel sheets and Endnote libraries to provide an overview of available sources. Due to the research area being rather new, some non-academic sources such as periodicals (e.g. Bloomberg, Forbes, Financial Times) were also included. In the case study, internal information on the distribution network and the energy company was further used. The literature review helped to transfer the ideas emerging in the case study to the general market.

2.3.2 Interviews

An interview can according to Höst et al. (2006) be categorized based on whether it is structured, semi-structured or open in nature. In a structured interview a predetermined list of questions is strictly followed. A list of questions is used when conducting a semi-structured interview as well, but in this case the order and phrasing of the questions are flexible. Similarly, some kind of list or interview guide with topics to discuss is in the third category, however, in that case the interviewee has a lot of influence over both the order and the actual content of the discussion (Höst et al. 2006).

In this project, semi-structured interviews with a few knowledgeable people from the case company were used to confirm the findings of the case study. The aim was to determine the case at hand and validate the identified stakeholders as well as their driving forces. Although the same questions were covered in the different sessions, the order of them was not fixed, allowing for the interviewee to influence the direction of the conversation.

2.3.3 Delphi study questionnaires

Delphi studies can be conducted using physical or online questionnaires. The latter make it possible for experts in various locations to participate without increasing the costs of the project. This enables the inclusion of a wider range of people, and possibly opinions, which is an important advantage, especially when conducting small-scale research with limited resources (Denscombe, 2017). Based on these benefits, online questionnaires were chosen in the present study. After evaluating alternative software types, Google Forms was considered the most appropriate one. This was due to considerations such as price tag, user friendliness and the possibility to use questions of different structure and visualization of answers using tables, diagrams and graphs. Further, the answers could easily be transferred to the software Microsoft Excel, where response analysis could be conducted. The questions for round 1 and 2 of the survey can be found in appendix A.1 and A.2 respectively. In a few cases where the corporate intranet disallowed participants from opening the survey link, the document version was sent out and filled out manually using Microsoft Word. The results from these respondents were then manually transferred and added to the collected results.

In the two rounds of the survey there was an aim to provide clear, intelligible questions as well as to incorporate an element of provocation to help increase response rate. A draft version of each questionnaire was tested through a pilot study, using both people qualifying as participants and individuals without expert knowledge. This was done to ensure the quality and the understanding of the questions. After an iterative process, a version of questions that felt comprehensive and that could possibly be subject to disagreements, without demanding unrealistic amounts of time from the respondents, was finalized. The questionnaires were estimated to require 15 minutes each.

Both questionnaires made use of ordinal data using Likert scales. Likert scales, also referred to as similar scales, is the most common way of collecting quantitative data in small-scale research. The Likert scale requires respondents to rate their agreement or disagreement with a statement or to assign numbers from one extreme to another (Denscombe, 2017). This type of scale has been used in a range of Delphi survey examples, e.g. Kembro et. al. (2017) & Varho et al. (2016). Space for comments was provided throughout both questionnaires. The two rounds were conducted in Swedish, considering that all experts were Swedish and the notion that the respondents would be more willing to fill a questionnaire in their native language.

2.3.3.1 Experts for Delphi Study

Adler and Ziglio (1996) define experts relevant for a Delphi Study as fulfilling four different characteristics:

- Knowledge and experience with the issue under investigation
- Capacity and willingness to participate
- Sufficient time to participate
- Effective communication skills

In line with these characteristics, the participants of this study were expected to be knowledgeable in the Swedish energy market in general and the area of solar energy specifically. Four segments were identified as possessing the necessary knowledge for the task and ability to provide potentially valuable insights: *Academia, Regulators/institutions, Internal Knowledgeable* and *External Knowledgeable*. *Academia* included researchers and scientists working at universities and research institutions. *Regulators/institutions* referred to employees working in institutions and organizations within the public sector such as the Ministry of Environment and Energy (Miljö- och energidepartementet), the Swedish Energy Markets Inspectorate (Energimarknadsinspektionen), the Swedish Energy Agency (Energimyndigheten), and municipalities. *Internal* and *external knowledgeable* distinguished between private sector professionals working in the energy industry such as power suppliers and DSOs while external knowledgeable included professionals working in real estate management, energy consultancy and journalists reporting on the industry.

There is no general agreement on the optimal sample size of Delphi studies; as few as 15 experts (Burns & Fiander, 1998), up to several hundred (Wehnert et al., 2007), has been found in literature. A sample consisting of at least 10 experts is deemed to be sufficient to ensure credibility (Okoli & Pawlowski, 2004; Denscombe, 2017). The number of people contacted initially included a safety margin to ensure a sufficient number of participants throughout the study, and to mitigate the impact of respondent losses between the first and second round. Appropriate participants for each panel were identified using a range of methods. Already established connections with relevant people resulted in recommendations for other suitable participants, creating a snowball effect. Relevant people working at institutions and companies were found through their websites. Searches of newspapers and other news outlets were also made to identify people appearing in the context of solar energy. Authors of texts used in the literature review were also considered suitable participants. All candidates were compiled using a spreadsheet, with information on the panelist's experience and contact information.

In the different panel groups, some requirements were formulated to ensure better sample credibility. Within *academia,* researchers were expected to be first or second author of at least two peer-reviewed journal articles within the field of either the future electricity market or renewable energy. Participants in the group *regulators/institutions* were expected to currently be working with strategy and decision making on the energy market or having specific responsibility of renewable energy and solar power on a regional or national level. Professionals within *internal knowledgeable* needed to be employed in a company within the electricity market and qualified candidates were specifically wanted to have either responsibility for solar power or small-scale renewables, or in some other way be responsible for a broad, more strategic view of the future electricity market. *External knowledgeable* needed to be involved or connected to the electricity market and the area of solar based electricity, and having worked in reporting, consulting or overseeing the energy market. As an additional precaution, the panelists were asked to estimate their own expertise (as seen in Varho et al., 2016) both in the field of solar and the energy market. They were also asked to state their number of years of professional experience in the industry.

In total, 101 experts were identified (26, 25, 26 and 24 individuals respectively from the four panels *academia*, *regulators/institutions, internal* and *external knowledgeable*). To establish contact, an initial email was sent out inviting them to participate in the study. To lower the threshold of participation, no demand for acceptance to participate was made, but questions and concerns were welcome. Out of the initial sample, 22 were removed before survey 1 was sent out due to various reasons put forth, such as time constraints, not feeling suitable to participate, or be it sick or on parental leave. The resulting original sample consisted of 79 individuals, out of which 42 responded to the first questionnaire. Throughout the process, confidentiality and anonymity of the individual responses and participants were strictly kept up. An anonymized list of the participating experts can be found in appendix A.3.

2.4 Data analysis

Data analysis is used to synthesize information into meaningful insights (Denscombe, 2017). The information gathered in this project was mainly qualitative in nature, making the analysis qualitative. The case study placed large emphasis on qualitative findings from documents and semi-structured interviews. The Delphi technique used for the survey is often presented as being semi-quantitative (Popper, 2011) and thus contributed quantitative elements.

2.4.1 Quantitative data analysis

Quantitative data can be categorized in various types, for example ordinal, nominal, interval and ratio. In small-scale research projects the data often originates from questionnaires (Denscombe, 2017). The quantitative data analyzed in the Delphi rounds of this project can be classified as mainly ordinal. Ordinal data stems from the relative rating of items against each other, such as when using Likert scales. Using median or average as a measure for central values, together with standard deviation to describe dispersion, is a common way of analyzing small-scale quantitative data. Frequency distribution is often used when analyzing ordinal data (Denscombe, 2017).

2.4.2 Qualitative data analysis

Qualitative data analysis differs from the quantitative kind, specifically in that it is generally more flexible. Often the process is performed iteratively. The collected data is reviewed in order to connect segments (of for example interviews or documents) to certain keywords. These are later grouped to create clusters that for example display what different interviewees have said regarding a specific topic. From these clusters, conclusions can be drawn (Höst et al., 2006).

Denscombe (2017) presents advantages and disadvantages of using qualitative data analysis. It benefits from acceptance of uncertainty and ambiguity that may exist within the field, however, due to the small number of units studied, generalization of the findings can prove difficult. Höst et al. (2006) also emphasize the importance of traceability of the conclusions when conducting qualitative data analysis. It is essential that it is possible to trace results to the primary source, making documentation of data collection a crucial part of the process (Höst et al., 2006).

2.5 Work process

An overview of the work process of this project is presented below in figure 2.1, illustrating the sequential method combination and the research design.

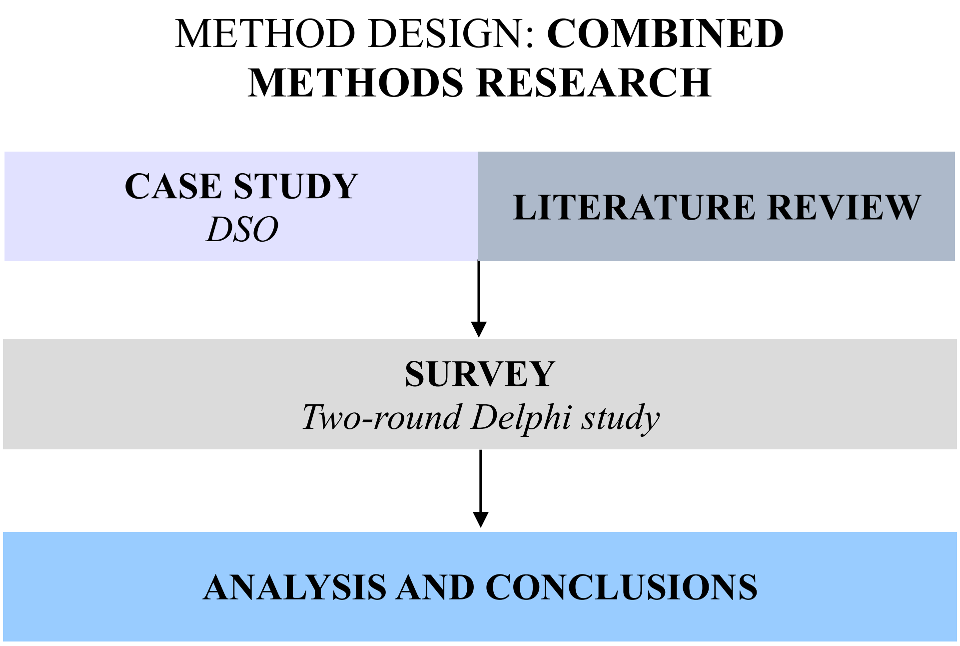

Figure 2.1. Schematic illustration of the work process of this thesis project.

2.6 Trustworthiness

To gauge trustworthiness of a research project means evaluating several potential sources of error in the method (Shenton, 2004). Krefting (1991), following Guba (1981), defines four commonly referenced criteria for rigor in research: credibility, dependability (reliability), transferability and

confirmability (Krefting, 1991). Denscombe (2017), limits the quality of research to ensuring reliability and validity, used synonymously to credibility. Establishing credibility is argued to be one of the key elements of qualitative research (Lincoln & Guba, 1985).
The trustworthiness of this research project relates mainly to credibility and validity of sources. Transferability in case study research and reliability in quantitative findings are further aspects of trustworthiness to consider. Triangulation was used in combining secondary sources in the literature review with primary sources in semi-structured interviews. To strengthen the quality of the literature review, an iterative process of changing search words, collection of literature and evaluation was performed. Triangulation and iteration are both common ways of increasing credibility in research (Shenton, 2004).

Adopting a well established research method is one way of ensuring credibility (Shenton, 2004). Although the combined method of a sequential case study and survey has not explicitly been encountered in literature, the usage of a pre-study (or extensive literature review) is a common tool in scenario building, foresight studies and applications of the Delphi technique.

The first part of the twofold method combination, being a single case study of one unique DSO, can be considered to have limited transferability. The specific roles, relationships and driving forces captured in the case study only depicts the current situation through the perception of this DSO, with interest in pursuing more solar power in the distribution network. This could be partially accounted for in the mixed methodology, were the findings on the current market could be tested and reaffirmed in in the survey.

Critique of the Delphi method is often caused by poorly constructed surveys and the quality of the participating experts (Hsu & Sandford, 2007). These areas need to be properly addressed to ensure the quality of the study (Fink et al., 1991). In the construction of the survey, the usage of a sequential method helped in the development of a credible base for the first round of the Delphi, which was discussed and confirmed in the semi-structured interviews. The survey rounds also gave the respondents the opportunity to leave comments on all the assumptions made, supposing they felt they did not agree with the findings. This was therefore a way to reconfirm the findings made in the previous steps of the research project. In the data retrieved in the survey, the opportunity in Google Forms to mark questions as mandatory also minimized the potential loss of data.

The selection of the experts according to the four panels with predefined criteria in each group helped to ensure a broad sample base, where a minimum number of respondents for validity were set in each panel. However, in the identification of participants suitable for the Delphi study, allocation of the participants to different panels was not always clear. Some individuals had experience of being in different capacities, researchers may have been employed within institutional governance, consultants may have had previous internal business experience.

The respondents were purposefully chosen to originate from a wide range of companies and research institutions, to avoid bias. Despite such considerations the fact that the experts wanted to participate in the study could indicate a general belief, or interest, in solar power. This may have created a bias towards positive assurance. The qualification of the participants was further influenced by having access to relevant contact information. The credibility and validity of the respondents' answers strongly relied on experience and knowledge in the field, and the qualification of the participants in the different panels was strengthened by their own declaration of professional experience and estimation of their knowledge in both the area of solar power and the energy market at large.

3 THEORY

The theoretical framework used in this thesis paper is divided into two different sections. The first section consists of the areas stakeholder theory, stakeholder analysis, actor network theory and characteristics of a natural monopoly. The second part with more dynamic research areas concerns change in markets and roles and consists of theory on foresight studies, scenario building and Delphi research.

3.1 Theory on role and market characteristics

3.1.1 Stakeholder theory

Stakeholder theory, here used in the context of stakeholder identification and analysis, is an approach to identify all relevant stakeholders of an organization or project with the purpose to determine the best strategy towards them, usually from the point of view of an organization (Mitchell et al. 1997). To understand the concept of stakeholder theory, one must first understand the interpretation of a stakeholder. There is as of today no general consensus in the literature on the definition of a stakeholder, and the idea of stakeholder theory is by many perceived as an umbrella concept that is lacking in empirical support (Wasieleski & Weber, 2017). Miles (2017) has reviewed literature in stakeholder theory and emphasizes that a central source of criticism of the research area originates from its ambiguous core with a range of different definitions of central concepts.

Despite varying definitions, Miles (2017) states that Freeman's definition from 1984 of a stakeholder as a "group or individual who can affect, or is affected by, the achievement of an organization's purpose" (Freeman, 2010, p. 46) remains one of the most cited in research and academia, as for example used by Mitchell et al. (1997), Bonke & Winch (2000), Mohan & Paila (2015) and Zidane et al. (2015). The stakeholders thus include both external and internal as well as directly and indirectly involved parties; some researchers even include the natural environment or the market structure (Mitchell et al. 1997). Others, e.g. Fassin (2009), distinguish between stakeholders and two additional roles: stakewatchers, acting on behalf of stakeholders, and stakekeepers, that constrain how a firm interacts with their stakeholders.

What is further noticeable in the research by Miles (2017) is the view that the lion's share of all literature in the field takes a company-centric perspective, and that few sources focus on the perspective of the stakeholder in itself. This is elaborated by Eskerod & Larsen (2018), that claim that much project stakeholder identification and analysis originates from reductionism (i.e. a way of simplifying the description of a complexity), which only focuses on a given project as unit of analysis. Researchers and managers working with stakeholders should instead try to incorporate the bigger system around the project or organization, including future expectations, relationships and activities that all the stakeholders are involved in, thus not limiting the analysis. Despite this suggestion, the authors also highlight the trade-off between collecting rich data to provide a holistic view in stakeholder analysis and too much data resulting in paralysis (Eskerod & Larsen, 2018).

Regardless of the criticism, stakeholder theory is an established way to understand and look beyond mere shareholders of an organization, entity or project, and to identify relevant actors in the network of a firm as a part in strategic management (Mitchell et al. 1997). As formulated by Wicks and Harrison (2017): “Simply, stakeholder theory puts value co-creation with stakeholders at the heart of business” (p. 251).

3.1.2 Stakeholder analysis

After identifying relevant actors in the stakeholder network, examining the attributes of different actors becomes a vital part of stakeholder analysis, since actor attributes or driving forces determine their behavior. This rules how they may influence the outcome of the context considered (Elias, 2016). Mitchell et al. (1997) proposes a typology of stakeholder classification based on three attributes that the stakeholders may possess: (1) The stakeholder’s *power* to influence the firm or project, (2) the *legitimacy* of the stakeholder’s relationship with the firm, and (3) the *urgency* of the stakeholder’s claim on the firm or project (in terms of time sensitivity and criticality). These characteristics are based on their strategic importance for decision making within an organization (Mitchell, Lee & Agle, 2017).

Stakeholder analysis is often performed through the concept of stakeholder mapping. This yields an understanding of the prioritization of various stakeholders and how they relate to each other in the network. This is a difficult but important step within strategic management (Zidane et al. 2015). There are several ways to perform stakeholder mapping, that lend differing importance to various factors. One established way of stakeholder mapping, as seen in e.g (Bonke & Winch, 2000), is the power/interest matrix, presented by Johnson and Scholes (1999), which was simplified and adapted from the power/dynamism matrix by Mendelow (1981). The power/interest matrix illustrates to what extent stakeholders have an interest in a project or organization in relation to the degree of power the stakeholder has over the firm or activity (Mitchell et al., 1997).

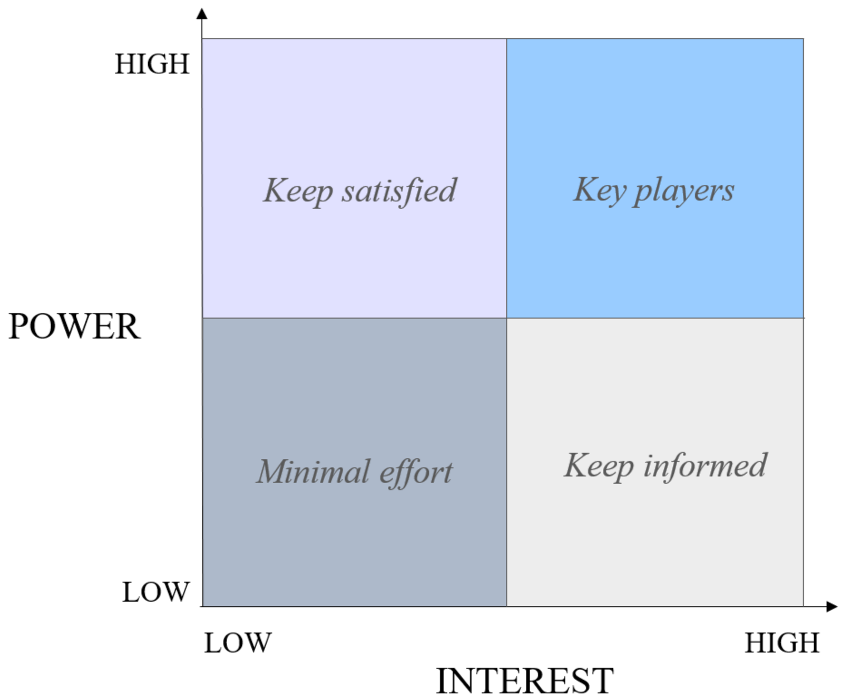

Figure 3.1. The Power/Interest Matrix adapted from Johnson & Scholes (1999)

If the stakeholder has both high power and interest, placed in the upper right corner, it can be seen as a "key player". This type of stakeholder is the most important in the stakeholder network and essential in the research of stakeholder management (Bourne & Walker, 2008).

The power/interest mapping approach is applied in a case study context by e.g. Olander & Landin (2005). The authors highlight the changing time frames of project development when investigating stakeholder influence in construction projects (stakeholders may have varied interest and power in different stages of projects). The life cycle perspective of stakeholder commitment is also articulated by e.g. Bourne and Walker (2008) and Burga & Rezania (2017), both conducting stakeholder mapping in three different phases of a project.

Alternative classification characteristics of stakeholders have been found in project management and has for example lead to the development of the Stakeholder Circle introduced by Bourne & Walker (2008). The model assesses relative influence, expectations and appropriate engagement to identify key stakeholders (Bourne & Walker, 2008). Influence (relative importance) follows the framework of Cleland (1999) and is in the Stakeholder Circle defined as power, urgency and proximity, closely related to the stakeholder classification of Mitchell et al. (1997). Expectations come down to how the stakeholder is expected to be affected by the project outcome, and proximity is in regard to actors being directly or only indirectly involved in the project or organizational work (Bourne & Walker, 2008).

Essentially, different stakeholder analysis methods can be used where varying drivers and characteristics are analyzed and mapped for a range of different stakeholders. Recurring is the initial step of identification, followed by differentiation and categorization of said stakeholders (Reed et al, 2009). At core it is the representation of the stakeholders according to some sort of mapping. Though this need not be so, theories often take the point of view of a company or organization.

3.1.3 Extending stakeholder analysis

In contrast to the criticism of stakeholder theory as being overly focused on the single perspective of the focal firm or project, actor network theory (ANT) is a method that applies network thinking and flexibility to study emergence and interplay of various "actors" in a certain setting (Iskandarova, 2017). Building on social theory focusing solely on social participants, it is a method that puts both social and technical impact alongside one another in a heterogeneous network of interconnected nodes (Latour, 1990). This enables the study of large systems of knowledge development with a range of factors or "actors" such as technical, organizational, scientific and political elements, all connected in relational ties. ANT is often associated with treating non-human and human relations equally, which has created some controversy in the research domain. It essentially defines an actor as any entity that promotes change within a network or in any way affects actions of others, creating a difficulty in interpreting what an actor (specifically non-human) actually is (Sayes, 2014). It should be noted that the analysis mainly targets the actor-network process, rather than specific characteristics of objects (Callon, 1999).

ANT as a method to study technological development in a big techno-sociological system has been used by e.g. Iskandarova (2017), who studied co-evolution of policy development in a wave energy project in the UK. The author used ANT-thinking by seeing "policy as an evolving actor-network" (p. 480), meaning an evolving phenomenon consisting of both human and non-human objects such as budgets, network operators, academics, consumers, and even material things such as the national grid itself. The analysis showed that ANT-thinking could prove useful when investigating policy development and change, specifically in the complex relations of renewable energy and policy networks (Iskandarova, 2017).

Another example where ANT has been applied is in the study of accountability in a network surrounding a building (Burga & Rezania, 2017). As in the case of Iskandarova (2017), the data gathering was conducted by collecting primary data in real time from a number of different "actors" through interviews with e.g. project managers, industry experts, government officials and other social groups interested in the project. An analysis of the network showed that accountability and project success may be perceived differently by different stakeholders, highlighting the importance of analyzing the outcome of a project from different perspectives (Burga & Rezania, 2017).

Taking a social network perspective represents another way of extending stakeholder analysis (Frooman, 1999). Moving beyond bilateral, independent relationships between stakeholders towards a model where one relationship is affected by other relationships in the network, tendencies can be studied in the whole network of intertwined relationships (Rowley, 1997). Interactions can be complementing or competing, and the nature of the relationships between different actors, such as alliances and other forms of cooperation, will affect the actions toward the basic issue under consideration (Neville & Menguc, 2006).

3.1.4 Natural monopoly characteristics

According to Pataki, Sagi & Kábok (2011) there is a widely spread consensus around the inefficiency of a monopolized market, meaning such markets are not optimized from an economic standpoint and causes an unnecessary waste of resources. There remain, however, some natural monopolies that differ from artificial monopolies. An electric power distribution system is a common example of a natural monopoly; tap water distribution is another. While the artificial kind of monopoly should be prevented, Pataki et al. (2011) argue that natural monopolies do provide economic benefits since it is clear that it would not be economically efficient for competitors to construct parallel systems in such cases. Yet, regulation is deemed crucial in this type of market as it helps to increase efficiency as well as to protect customer interests (Družić, Štritof & Gelo, 2012).

3.2 Theory on role and market development

3.2.1 Foresight studies

The area of foresight is a part of the broader field of future studies and is defined by the European Foresight Monitoring Network as ''a participative approach to creating shared long-term visions to inform short-term decision-making processes'' (Calof, Miller & Jackson, 2012, p. 83). It can be described as exploring uncertainties, implications, driving forces and outcomes in alternative futures (Bishop, Hines & Collins, 2007, p. 7), and is the way of describing the future through new tendencies, ideas or issues. Unlike predictions, which are based on existing trends and their possible development, foresight studies are often modeled before tendencies are established as trends. This can be done using various qualitative and quantitative methods including expert panels, workshops, Delphi studies, extrapolation, roadmap construction and scenario building, or through a combination of several methods (Popper, 2011).

Popper (2011) has mapped and analyzed over 2000 examples of foresight studies on a global scale between the years 2004 and 2008, and found examples in different research areas, mainly within social sciences, medical research, engineering & technology and natural sciences. There is clear evidence that foresight research often originates from or relates to policy decisions, and that foresight studies typically has a time horizon between 10 to 20 years (Popper, 2011).

3.2.1.1 Qualitative scenario building

A general approach to studying changes of roles in foresight studies can be taken through so called scenario building. This is where iterative discussions with relevant stakeholders, in for example workshops or consultations, generate a number of different narratives, or scenarios, all plausible to occur in a future setting (Bishop et al., 2007). According to Schwartz (1996), the process of scenario building begins with searching for the driving forces that influence outcomes of certain events. Scenarios can be constructed using pairs of particularly driving forces (trends or tendencies), as stated by Lindgren and Bandhold (2009). They have in their work with scenario building found the "scenario cross" to be a well functioning model. After identifying a number of trends or forces, two driving ones are selected, preferably two implying large uncertainties. These will form the axes, generating four scenarios, as seen in e.g Future Energy Scenarios (National Grid, 2017) and Klimatsäkrat Skåne (Hall, Lund & Rummukainen, 2015). The aim is to achieve four distinctive scenarios, but deciding on applicable uncertainties may pose a challenge. Several crosses can be created relating to the same matter. It is - according to the authors - not wise to use more than one cross at a time, since it is difficult for the people evaluating the scenarios to keep several dimensions in mind. Comparing and weighing very different quartets of possible scenarios against each other is not likely to be meaningful, caution Lindgren & Bandhold (2009).

Lindgren and Bandhold (2009) also present some guidelines to follow in order to effectively communicate the messages that the alternate scenarios carry. For example, they recommend the use of interesting names for the different scenarios. An example of this is "Forte", "Legato", "Espressivo" & "Vivace" from the scenario building conducted by Energimyndigheten (2016a), originating from the world of music and expressing a driving force in the specific scenario. In addition, it is, according to the authors, essential to create a satisfying storyline for every alternative and that each storyline is logically distinctive. To be able to capture the audience and provide a sense of reality, a narrative description can be a good way to develop the scenario title. It can consist of a more or less detailed portrayal of the situation of the scenario (Lindgren & Bandhold, 2009).

3.2.1.2 The Delphi technique

The Delphi technique, named after the Oracle of Delphi and developed by the Rand institute in 1948, is a systemic approach to obtain consensus from experts in an iterative process (Fink et al., 1991). One of the most common applications of the Delphi method is in a forecasting context, and specifically for scenario building. Here both qualitative and quantitative studies can be found (Jakšić, Džodan & Tomšić, 2014). To define a process as a 'Delphi', four characteristics are expected to be fulfilled; anonymity, iteration, controlled feedback, and statistical aggregation of group response (Rowe & Wright, 1999). As quoted by Helmer-Hirschberg (1967), researcher at Rand organization: "The Delphi technique, in its simplest form, eliminates committee activity among the experts altogether and replaces it with a carefully designed program of sequential individual interrogations (usually best conducted by questionnaires) interspersed with information and opinion feedback." (p. 7)

Anonymity against the other members of the sample group is guaranteed through the usage of questionnaires. Iterations take the shape of using at least two rounds of questionnaires, where the second round is accompanied by controlled feedback from the first round. Feedback mechanisms in Delphi studies can take various shapes, but illustration of the specific respondents' answers along with aggregated results for the entire group and how they relate to each other is common (Okoli & Pawlowski, 2004). Maclennan, Kirkham, Lam & Williamson (2018), studied the specific design of feedback in the Delphi technique using three variations of feedback in a setting with high initial agreement. The sample group consisted of two different panels, and the participants received either only representation of peer-results (from their own panel), representation from both panels separately, or all participants combined. The results indicated that the panel specific feedback design created no changes in number of outcomes and no variability reductions compared to the complete sample (Maclennan et al., 2018). Research findings in the area of construction engineering and management showed no general way of using feedback among a selection of different Delphi studies. Some used mean value and interquartile range, while others chose not to display what type of feedback was used. This strengthened the notion that the Delphi technique is often altered and applied in different ways in research (Hallowell & Gambatese, 2010).

Delphi method forecasting has been demonstrated in a range of settings, including healthcare (e.g. Eubank et al. 2016), information systems (e.g. Kendall et al, 1992), supply chain management (e.g. Kembro, Näslund & Olhager, 2017) and renewable energy (Varho, Rikkonen & Rasi, 2015). Reviewing the Delphi technique as a forecasting method, Rowe and Wright (1999) examined other research papers that attempted to evaluate the method in this specific context. These evaluating papers all showed different conclusions, where some claimed that the Delphi method as a forecasting tool was more useful than others. Generally, Delphi panels tended to be more accurate than unstructured interacting groups, but because of great variation in how the technique was applied as well as in the definitions of what was considered an expert group, the usefulness could vary (Rowe & Wright, 1999).

4. SETTING THE CONTEXT: THE ELECTRICITY MARKET

This section provides an overview of the current structure of the electricity market in Sweden. It also covers a literature review of stakeholder mapping and foresight studies as applied to energy and electricity markets, both national and international.

4.1 The Swedish industry structure

In Sweden, electrical energy is provided in an extensive network of lines and cables known as the grid. From power plants and other production sites the electricity is transferred long distances using the high voltage transmission grid. The 15 000 km long transmission grid (Nohrstedt, 2018) is connected to the medium voltage grid, which in turn is connected to the low voltage grid. Through the low voltage lines, power is transferred to the consumers, although it is common that energy-intensive industry sights receive electricity through direct connections to the medium voltage grid (Lindholm, 2017a). The Swedish high voltage grid is, through 16 connections, linked to neighboring countries, forming a larger network that include Denmark, Finland, Norway and the Baltics (Svenska Kraftnät, 2017). Through further extensions Sweden is joint with other countries in Europe, allowing for power to be transferred over the continent. There are however many bottlenecks within the system which limit this possibility (Svenska Kraftnät, 2018; Appunn, 2018).

The high voltage transmission grid is, through the transmission system operator (TSO) owned by the Swedish government and reaches all regions of the country (Svenska Kraftnät, 2018). The medium and lower voltage grids are regional and local, and are owned by different DSOs. The Swedish electricity market has been deregulated since 1996, making customers free to choose their own power supplier. As the infrastructure of an electricity grid creates a natural monopoly, customers have no choice of DSO (Vattenfall, 2018). Government regulations strive to ensure a reasonable pricing, as the requisites for a well working market are absent (Wallnerström et al., 2010). There are around 170 public and private DSOs in Sweden, out of which three are considerably larger than the others. These are Vattenfall Distribution, E.ON Energy Networks and Ellevio. Together these three provide more than half of the customers in Sweden with electricity (Kungliga Ingenjörsvetenskapsakademin, 2016) and deliver 97,2 % of the transferred energy (Energimarknadsinspektionen, 2016a).

The TSO in each country, which in Sweden is Svenska Kraftnät, is responsible for the balance of the electricity system. If a deviation in the frequency occurs - for example because malfunction causes a power plant to decrease or stop its production - the operator has to restore the balance within 15 minutes. To be able to act quickly in this type of situation, energy producers are contracted to provide backup power with very short notice. Since the weather and seasonal changes have great impact on both the demand for and the supply of electricity this is important factors to examine when determining the need for backup power (Nohrstedt, 2018).

The total consumption of electricity in Sweden amounted to 140 TWh in 2016 (Lindholm, 2017b). Hydropower and nuclear represented 80 % of the total production. The remaining 20 % stem from thermal, wind and solar based power, with the first two types contributing around 10 % each.

Meanwhile solar contributed 0,09 % of the total electricity produced in 2016 (SCB, n.d.). The main part of the electricity produced in Sweden - around 90 % - is traded on Nord Pool, a power exchange owned by the TSOs in Sweden, Norway, Denmark and the Baltics, integrating the markets of these countries (Lindholm, 2017d). Nord Pool also trade power in the German and UK markets. The price of electricity is determined every hour based on the current supply and demand. When the price increases, this gives an indication of where there is a lack of either production or capacity in the grid (Nord Pool, 2018). Sweden has been characterized by low electricity prices since 2012 (Energimyndigheten, 2017), especially when compared to the prices of 2010 and 2011. The price peaks during these years were caused by a combination of factors such as malfunctions in nuclear plants and unusually cold weather (Lindholm, 2017c). Noticeable is that the price development of the first three months of 2018 showed a break in the trend with low prices, with prices reaching levels the market has not seen for many years (Fortum, 2018).

4.2 Regulations and policy framework

Since 2016, the Swedish government is aiming for an electricity system based on 100 % renewable energy sources in 2040. Various forms of support are used to achieve this creating a policy framework of grants, laws and regulations (Lövin & Baylan, 2016). The Swedish energy market is monitored by a regulatory authority, the Swedish Energy Markets Inspectorate, acting on behalf of the government. Its main purpose is to represent and protect the interests of the customers by ensuring adequate power supply in terms of quality and price. It is charged with controlling the legal compliance of the actors of the energy market and it carries out investigations in order to develop regulations, normally on the instructions from the government (Energimarknadsinspektionen, 2018a).

4.2.1 Policies for renewable energy and solar power

Policies relating to renewable energy in Sweden originate from different areas. Environmental taxation is one example, which on a broad level regulates environmental impact of fossil fuels (OECD, 2014). Sweden is also, through its membership in the EU, obliged to follow the regulations set on a European level, such as the Energy Efficiency Directive (Directive 2012/27/EU) and the Ecodesign Directive (Directive 2009/125/EC) which influence and measure energy efficiency and ecological requirements for products respectively (Axelsson, 2015). The Swedish Energy Agency (2016b) presents that one of the main policy instruments to promote the generation of renewable energy in Sweden is electricity certificates. For every produced MWh of electricity, producers receive a certificate, while specific industries are obliged to buy a certain number of certificates. The trade with certificates is set with a quota liable system for certain consumers and producers (Energimyndigheten, 2016b). It is a market-based support system that aims at increasing the amount of renewables in Sweden in a financially sustainable way. Solar panel systems benefit from the certificate system during their first fifteen years of production (Solelkommissionen, 2017).

A report conducted by the Swedish National Audit Office (Riksrevisionen) in 2017 investigated the collective policy support for solar power in Sweden. Besides electricity certificates, solar-specific policy instruments also included investment support and tax deductions. Current investment support was as of the first of January 2018 set to 30 %. This support is equal for private customers, corporations, public sector and real estate companies and is applied by the county administrative board (Solelkommisionen, 2018). In only the first three months of 2018, 1600 applications for investment support came in compared to 6000 for all of 2017. The waiting times can be up to two years for a majority of the Swedish counties, and if the budget is sufficient to cover the increased demand is unclear. This is confirmed by Sara Bargi, head of the Swedish Energy Agency, in an article published by SVT Nyheter in March 2018 (Kaveh & Grill, 2018).

As stated by the Swedish National Audit Office (2017), in line with the goal of 100 % renewable energy sources, the judgement of decision makers was that solar has the potential to provide 5 to 10 % of the total electricity in 2040, up from today's share of 0,09 %. The support to solar power was considered high per produced kWh compared to other sources of renewable energy covered by the electricity certificate system. Small production units were also more costly than larger ones due to economies of scale (Riksrevisionen, 2017).

The Swedish National Audit Office mentions that technology neutrality is an issue under investigation, where the investment support to solar can be argued to be biased, favoring solar power technologies over other energy sources (Riksrevisionen, 2017). Technology neutrality is a subject emphasized by the European Commission (2017), which argues that all sorts of policy should aim to not favor any specific technology. This is considered important to mitigate the risk of supporting inefficient and unprofitable technology; instead it is preferred to let the market determine the winning technology (European Commission, 2017). Whether innovation policies (in Sweden and the EU) are actually neutral is a debated issue (Morgan, 2017), and the perception of Swedish policy makers "over-supporting" solar technologies, is sometimes articulated in the public opinion, e.g. Kågeson (2015) & Rosell (2017). The issue is affected by the fact that different technologies are closer, or further from, competitive market prices. Electricity certificates can for example be seen as favoring wind energy, as wind is a more mature technology which is closer than solar to being financially competitive. This factor combined with differences in time perspective could motivate the use of policies directly aimed at benefiting solar power, such as the current investment support (Parry, Pittel & Vollebergh, 2017; Energimyndigheten, 2015).

The evaluation of the current policy framework by the Swedish National Audit Office (2017) emphasized that there was a lack of analysis of cost efficiency along with long-term stability, two necessary elements of a satisfactory regulatory system (Riksrevisionen, 2017). Shum and Watanabe (2009) emphasize that potential financial incentives set by policy makers in order to promote renewable energy, and solar energy more specifically, need to make it optimal for all contributing stakeholders to operate, and to broaden the incentives from focusing on only users or suppliers. This goes in line with considering solar power technology in a bigger system perspective, where for example housing manufactures can increasingly integrate PV-panels in newly built houses (Shum & Watanabe, 2009).

4.2.2 Revenue cap

Every four years the Inspectorate determines a revenue cap for the DSOs, in order to control how much they can charge their customers. The current regulation, for 2016-2019, allows for the DSOs to charge fees big enough to cover expenses for maintenance and development with a margin to make a "reasonable" profit. If a company reports a disproportionate revenue, the Inspectorate will decrease the revenue cap for that company for the following period. Large deviations can lead to additional charges (Energimarknadsinspektionen, 2016b).

In the fall of 2017, the Inspectorate published its proposed regulation for the upcoming period, 2020-2023 (Energimarknadsinspektionen, 2017). The main issue discussed in the report was what is to be considered a "reasonable" profit. The vagueness of this concept, the report says, has resulted in uncertainty where neither the DSOs nor their customers have known what is to be considered a reasonable fee. In many cases, the DSOs has taken the matter to court, causing considerable financial losses for involved parties. Despite several trials, the conditions of the market have remained unclear. To cope with the current situation, the Inspectorate proposed Weighted Average of Cost of Capital (WACC) as a new method to be used along with Capital Asset Pricing Model (CAPM) to regulate the yields of the DSOs. This is a commonly used method in the regulation of electricity networks around Europe. Other suggestions in the proposal include differentiated depreciation time and tougher consequences for disproportionate revenue (Energimarknadsinspektionen, 2017).

4.2.3 Unbundling

For corporations operating as DSO, power supplier and/or production firm simultaneously, certain legislation regulate how the business can be organized. This legislation, referred to as unbundling, is set on a national level but originates from decisions of the EU (2009/72/EC) (Energiföretagen, 2016). The unbundling of electricity supply and generation from transmission and distribution helps to ensure free competition by preventing utilities from denying competitors access to necessary infrastructure (European Commission, 2018). In Sweden, the unbundling can be divided into legal and functional separation. Legal separation apply to all DSOs. It separates the legal person of any net distributor from energy production or supply. In energy companies with more than 100 000 connected customers, functional separation also applies, meaning strategic decisions need to be made independently for the separate units. No board members, CEO or signatory responsible can hold positions in both the separate units at once (Marcelius, 2016). Current regulatory framework of unbundling in the EU is in many cases somewhat complicated and presents challenges in both implementation and surveillance (Gao, 2010; Energiföretagen, 2016). The Swedish market was subject to an extensive surveillance by the Energy Market Inspectorate in 2017, when compliance of a range of DSOs was investigated. The results were to be presented by June 2018 (Energimarknadsinspektionen, 2018b).

4.3 Solar based electricity

There are two main types of technology used to transform the energy of the sun into electricity; photovoltaics (PV) and concentrating solar power (CSP). CSP consists of a number of mirrors mounted in specific angles to reflect sunlight, in order to concentrate it to a focal point. There the heat usually boils water for steam turbines, used to generate electricity. In PV-panels the photons of the sunlight excite electrons, creating an electric field across a silicon cell (US Department of Energy, 2013). PV is by far the most common of the two technologies and is usually the one considered in the context of solar power (Solar Region Skåne, 2016).

4.3.1 Market development

Over the past years, the PV industry has experienced a rapid technological development and growth. In 2016 the installed capacity of PV amounted to over 300 GW globally (off-grid systems included), up from around 240 GW the year before (Fraunhofer ISE, 2018). About two thirds of new capacity was found in Asia, with China being the biggest contributor. China now accounts for a fourth of the global solar based electricity production (REN21 Secretariat, 2017). Prices for solar modules have dropped considerably during the past years, which is mainly a result of China's entry into the market both as a producer and consumer of panels (Runyon, 2017). Despite the price decrease, solar power technologies cannot compete with other sources of energy in a strictly financial sense for all market actors at this time (Sivaram, 2018).

Solar panels in use today consist of many individual photovoltaic cells that are interconnected, creating the commonly seen checkered pattern. The panels are versatile and can be coupled to each other into long arrays. This makes it possible to construct solar systems of various size and voltage current trade-offs (Solar Region Skåne, 2016). PV-appliances are currently not subject to much customization for the end users, but is a technology that is installed directly on customer sites. An amount of the work needs to be performed in the field, which affects the outcome of deployment and installation in solar power (Shum & Watanabe, 2009). The panels can be installed as a stand-alone system, which means it is only used to generate for local consumption, or they can be connected to the electric grid. Connected systems decrease the need to buy electricity externally and create sources of income through the sales of excess power (Solar Region Skåne, 2016). In Sweden grid-connected systems dominate in terms of installed capacity with over 90 % of market share (Energimyndigheten, 2017). Globally, off-grid systems are popular in rural areas, in particular in developing countries where there is a lack of extensive national networks (REN21 Secretariat, 2017) or where service is unreliable and outages are frequent (Sivaram, 2018).

4.3.2 Specific properties and market implications

When the traditional electricity consumer becomes a producer of electrical power (prosumer), new demands are placed on the grid itself. To cope with the new requirements, one example being electricity going in two directions instead of one, modernization of the distribution network is necessary. In the new type of grids, so called “smart grids” , operators make use of information technologies to monitor the increasingly complex flows of the grid (E.ON, 2010).

Due to its intermittent nature, the increasing levels of renewable energy not only need to be monitored but also require increased flexibility to maintain delivery reliability (Energimyndigheten, 2017). During the sunny hours of the day, solar production peaks, causing great amounts of power to be fed to the grid. This type of uneven and weather dependent electricity generation makes it difficult for Svenska Kraftnät and its peers to maintain the balance of the grid, since the need for backup power (to be used when the sun is suddenly clouded for example) grows with the expansion of solar in a region. In reverse, if the weather is sunnier than expected, other generators will have to decrease its production. Many power plants in use today, such as the ones run on nuclear, natural gas or coal, cannot be turned on and off with short notice, and are not profitable when only used sporadically (Sivaram, 2018). In Sweden, the substantial amount of hydropower contribute to keeping stable flows in the grid (Energimyndigheten, 2017). Additionally, market demand does not follow the increased production during the sunniest hours of the day; as a consequence the price of electricity drop (Sivaram, 2018). This makes for an unpredictable source of income, as the reduction can be substantial. This has for example been seen in Chile where the electricity price hit zero in 2015 and 2016 (Dezem & Quiroga, 2016), and in Germany in 2017, where the considerable amount of both wind and solar has caused the price to actually become negative (Reed, 2017).

The specific properties of solar not only create new needs for investments in the grid; solar may potentially disrupt the current distribution of roles. New responsibilities, opportunities and risks are likely to affect the stakeholders of the electricity market (Shum & Watanabe, 2009). This is in line with the general view in innovation management of new technological paradigms (Dosi, 1982). It is also connected to the classic concept of “creative destruction” coined by Schumpeter in 1942, where existing market players fail to react and adapt to the changing technology landscape, and are consequently forced out of the market (Schumpeter & Emily, 1994).

4.4 Mapping of roles on the energy market

4.4.1 Stakeholder division on the Swedish electricity market

Mapping of roles on the energy market, and specifically in the context of the energy network, has been made in various initiatives.

4.4.1.1 Pathway choices to 2020

The Swedish Energy Agency was on behalf of the government assigned to provide roadmaps, highlighting challenges in the country's transformation towards a sustainable energy system. Vägval 2020 (2015) is a report that sums up discussion and developing material as a backdrop to developing energy scenarios for the Swedish market (Energimyndigheten, 2015).

The report emphasizes that the distribution of roles and responsibilities is vital for the transformation towards a sustainable, secure future, but that there is little consensus on the optimal way forward. It also states that the distribution is neither obvious nor constant over time. The report distinguishes between the public sector (including government, parliament, institutions and regional and local decision makers), the for-profit private sector (energy companies, energy intense industries, construction and building companies and environmental technology companies) and non-profit private sector (households, environmental organizations and housing cooperatives). Historically, the government regulators have had the main power and control over the Swedish energy system and has taken virtually all initiatives to investments. Through decentralization, globalization and privatization this is now changing and a range of actors have gained increasing influence in the system (Energimyndigheten, 2015).

Role of the public sector

In order to provide assurance and trust within the system, there is according to Vägval 2020 (2015) a need for the public sector to share big and high risk investments with other market actors. This can include investments in demonstration facilities and infrastructure for electrical vehicles. The public sector needs to support and promote new technology and drive change (for example by introducing solar tariffs) but at the same time influence the phasing out of old technologies. Public procurement for innovation is another example of public actors "nudging" the market towards a new direction. Although technology-specific policy regulations should be introduced with precaution, solar power is recognized by the government as a promising technology in need of strong public support (Energimyndigheten, 2015). The public sector can increase impact through strong and creative collaboration with the private sector, similar to the proposals brought forward by Butcher & Gilchrist (2016) and Chabbi, Loescher & Dillon (2017). This can often be best done by starting off on a small scale (Energimyndigheten, 2015).

All forms of changes in government policy need to be introduced in a credible way, providing reliable game rules for the market participants. Enabling the entrance of new electricity producers by removing barriers is seen as one of the key responsibilities of the regulators. Municipalities have a big role to play in the development by carrying the major responsibility for matters such as transport and city planning (Energimyndigheten, 2015); for instance local governments become large buyers of electric vehicles (Lundberg, 2016). Deregulation has changed their roles, though, as many municipalities for financial reasons sell their ownership in energy companies (Energimyndigheten, 2015).

Role of the for-profit private sector

The role of the for-profit private sector and the contribution of the business driven actors towards a "green transformation" is to a large extent dependent on the financial profitability of available technologies and business models. This is an argument for policy interventions aiming at increasing the profitability of these technologies (Energimyndigheten, 2015). Despite this, many private actors in the energy market, such as E.ON, GodEl and Skellefteå Kraft, have an explicit interest in sustainability (Sustainable Brand Index, 2017). A sustainable brand is seen as a long-term strategy, but also as a way of affecting the current situation positively. These actors have the means to invest in new technologies as well as the power to influence the shape of the market, but are also dependent on customer demands (Energimyndigheten, 2015).

Role of non-profit private sector

Non-profit sector (households, housing cooperatives and non-governmental organizations) also have strong influence on the transformation of the energy system according to the report. When non-profit actors become prosumers by putting solar panels on their roofs or joining wind-power cooperatives, their driving force can be environmental concerns, but also desire for self-sufficiency and decreased dependency on energy suppliers. This type of actor represent a large share of the overall market demand, incentivising the private actors to take note of their desires and preferences. While it can be debated how much power and responsibility can be assigned to any individual, the sector can put noticeable pressure on politicians towards sustainable regulations (Energimyndigheten, 2015).

4.4.1.2 Entrance of small actors on the market

In June 2017 a research project commissioned by the Swedish government set out to highlight the conditions for small stakeholders in the energy system by investigating obstacles for small actors and what may hold back efficiency improvements. The heterogenous group of small actors consisted of households, housing collectives and small and medium sized companies. The interim report released in the spring of 2018 (Utredningen om mindre aktörer i ett energilandskap i förändring, 2018), provided a review of the current energy market and the opportunities for small stakeholders to contribute to the growth of renewable energy. Generally the interest of the Swedish population in "prosumption" is large, with solar being the prominent energy source. Despite a positive attitude from small actors towards increased activity, the report also found a range of obstacles. Current regulations and financial and behavioral based incentives all influence and in some cases hold back these actors from contributing to issues such as increased energy efficiency, electrification and storage opportunities (Utredningen om mindre aktörer i ett energilandskap i förändring, 2018).

4.4.2 Stakeholders and division of roles on other national markets

Analysis of roles and interactions between different actors has for example been done in the UK for the Transition Pathways to a Low Carbon Economy consortium, initiated in 2008. The consortium investigated the engagement of different stakeholders, and divided them into three sectors; government, market and civil society (Foxon, 2013). Their dynamic interactions during recent decades were studied. This study found the development of the energy market to be influenced by deregulation, going from previous predominance of government players coordinated across the nation, towards a market driven situation were the market actors drive development within a policy framework. However, due to complexities and challenges of securing increased supply and climate change considerations, government actors have in recent development gained increasing importance. Civil-society actors have also been seen to rise in niche markets, taking control in operation of the energy system (Barnacle, 2017).

Another national example of changing roles and the emergence of new actors in the electricity market can be found in the Netherlands, where the role of DSO's and local energy cooperatives were investigated in a report for the International Conference on Electricity Distribution in 2015 (Verreth, Veldman & Paulusse, 2015). The study explored various business models for DSO's and their interaction with emerging local energy cooperatives, as shaper, facilitator or connector of the local grid and electricity market. Based on the different models, the DSOs were seen as having varied power and opportunity to influence the market structure. Regulatory trends that were studied indicated that the current role of the DSOs as system facilitators was not expected to experience disruptive change, unlike the case of the connector business model where they would lose all shaping and facilitating responsibilities, being taken over by the emergence of the local cooperatives (Verreth, Veldman & Paulusse, 2015).

4.5 Foresight in the field of energy and electric grids

4.5.1 Swedish energy foresights

4.5.1.1 The Swedish energy system after 2020

In the report Fyra Framtider - Energisystemet efter 2020, by the Swedish Energy Agency (2016), an exploratory scenario building capturing the Swedish energy market as a whole for the period 2020 to 2050 was done (Energimyndigheten, 2016a). This report originates from the previously presented report Vägval 2020*,* and describes four scenarios for the future energy system of Sweden. The scenarios were named "Forte", "Legato", "Espressivo" & "Vivace", all describing narratives originating from different driving forces such as individualism, global justice and safe supply of energy. The purpose of the scenario development was to create four different scenarios that did not necessarily depict the most plausible developments, but rather explored what priorities were valued most highly by the system actors and what role the energy system had in the societal development (Energimyndigheten, 2016a).

Some global "megatrends" are recurring in all four scenarios to a large or smaller extent, that have been consistently identified by a range of different scenario builders including EU's Environment Agency:

- Continued global climate change
- Decrease of poverty and increase of education levels
- Increasing importance of environmental, nature and health issues
- Digitalization develops completely new services
- Globalization connects nations in new ways
- More people need housing
- Scarcity of natural resource increases competition

In the first scenario, “Forte”, secure energy supply is the driving force for the energy system. The system is moving towards increased centralization and large-scale production facilities. Solar systems can be found on some rooftops, but solar is not contributing to the overall energy mix. Economic growth and securing delivery of energy are main characteristics (Energimyndigheten, 2016a).

In the second scenario, “Legato”, environmental awareness and sustainable development are at the top of the agenda, along with equal distribution of resources across the globe. Major investments are made in renewable energy sources and efforts in the field of increased user flexibility, energy efficiency and electrification of transportation continue to grow (Energimyndigheten, 2016a).

The third scenario is called “Espressivo”, where energy users have an increased desire for self-sufficiency. Energy is a means to express oneself, and focus lies on energy efficiency and independence from the grid, producing a range of individual adjustments and local solutions. The growth of solar in private housing is a big contributor to self-sufficiency, and solutions for storage (long-term on a seasonal basis) enable users to completely detach from the main grid. (Energimyndigheten, 2016a)

The fourth and final scenario, “Vivace”, describes a narrative where energy is an enabler of sustainable growth. Swedish policy regulations entail major investments in R&D for sustainable innovation, and the market is predominantly influenced by technological development (Energimyndigheten, 2016a).

4.5.1.2 Five pathways for Sweden - Vägval El

The Royal Swedish Academy of Engineering Sciences (IVA), an independent research academy in Sweden, conducted the research project Vägval El between 2014 and 2016. It provided policy recommendations and proposed guidelines for the future electricity system in Sweden up to 2030 and 2050. The project was divided into working groups analyzing different aspects of the future system: energy use and production, market and economics, transmission and distribution and, finally, climate and environment (Byman, 2016). A sub-project to the report specifically focusing on electricity use was conducted by the research program North European Power Perspectives (NEPP), where four groups of influencing factors were identified as shaping the future electricity market:

- Political goals, policies and other institutional decisions
- Development and availability of new technology
- Development of energy demands
- Availability and price development of different energy sources

(Rydén et al. 2015).

The final report emphasized that major changes are occurring on the electricity market that create large uncertainties for the stakeholders on the market, and for the political agenda. Both the emergence of prosumers and entries of other new actors could potentially disrupt the market. Decision makers also need to increasingly take Sweden’s greater dependency on neighboring countries and technological developments into account. The general reduction of stability makes it difficult to sketch a roadmap to the future, but policy instruments should work mainly at decreasing risks for the market stakeholders. Digitalization makes increasingly new sectors dependent on secure energy supply and emphasis is put on considering the electricity system as a part of the overall energy market, to create a suitable policy framework (Byman, 2016).

Key recommendations of the report included not phasing out the six existing nuclear power plants in Sweden but to let them operate their remaining lifetime. This could preserve security in the transformation towards a renewable energy system. Developing clear measures for securing national electricity supply was also an important pathway recommendation along with better regional collaborations to handle the intermittency of renewables (Byman, 2016).

4.5.2 Other national energy foresights

4.5.2.1 Scenario building of electricity networks in Great Britain

Looking at examples of scenario building in the area of national electricity networks, the LENS project commissioned by the Office of Gas and Electricity Markets of Great Britain (Ofgem) in 2008 was aimed at creating scenarios for the development of the national electricity network in 2050 (Ault, Frame, Hughes & Strachan, 2008). The process consisted of workshops and consultations with stakeholders in an iterative process to determine plausible pathways for a regulatory framework in order to meet the climate targets of the UK (Barnacle, 2017).

Three driving forces were identified as shaping the trajectories of the future market: *Institutional governance, environmental concern* and *consumer participation. Institutional governance* describes how government institutions will intervene in the network development. *Environmental concern* shows to what extent the environmental awareness will affect the decisions of corporations, public sector, communities and individuals. Finally, *consumer participation* illustrates the level to which all types of consumers (industrial, commercial and public) are willing to actively take part in the changes of the electricity and energy markets (Barnacle, 2017). The three themes were combined into five different scenarios, all with a specific actor at the center of development (Ault et al., 2008).

The roles and responsibilities of the various stakeholders differed between the scenarios, which heavily influenced the development of the market. There were also different driving forces leading on the transformation, such as increased environmental awareness or electricity demands. Main takeaways showed that there was an increased need for clarification of responsibilities for some of the current stakeholders in terms of quality, security, efficiency and control. Renewable energy sources create less utilization of the transmission network capacity, but also require more operational management to balance the system, and the distribution network is consistently expected to become more active in almost all scenarios. Although some scenarios stand in contrast to one another in terms of e.g decentralization and increased international connectivity, the scenarios can in reality be expected to develop somewhat in parallel (Ault et al., 2008).

Another example of scenario building in the UK is the The Future Energy Scenarios (FES) conducted by the British national TSO (Barnacle, 2017). FES is a continuously updated scenario creation developing pathways for the national grid up to 2050. The scenario building from 2017 consisted of four different scenarios using the scenario cross, where the axes were prosperity (more or less money available) and green ambition (more or less environmental focus). New development were seen as going towards varied levels of economic growth, electrification and climate mitigation. Different initiating actors (consumers or policy makers) were also seen as pushing the transformation forward, resulting in the different scenarios that emphasize large versus small-scale generation and different requirements for the distribution and transmission network (National Grid, 2017).

4.5.2.2 Scenario building of renewable energy in Finland

Assessing challenges and opportunities for actors within small-scale renewables, Varho, Rikkonen & Rasi (2015) present a Delphi study for scenario building up to 2025 in Finland. A total of 26 experts within renewable energy technologies participated in the study. The activities assessed in the renewable value chain were fuel supply, equipment production, energy production, energy distribution, R&D and consumers, where some of the roles were expected to change with new business opportunities appearing on the market. Initially, 50 identified driving forces in the business environment of distributed energy sources were identified. The process resulted in the development of five scenarios for the expected growth of renewable technologies in 2025: “Stagnation”, “Stable slow growth”, “Multifaceted reform”, “Solar business prosperity”, and “Electricity expansion at the grass root level”. The “Solar business prosperity” scenario presented a narrative where obstacles of end users transitioning to solar were eliminated. This was to be made possible by small-scale producers having widespread access to ready-to-use installation packages of solar energy. Traditional energy companies also cooperate in sales and marketing with small-scale producers to provide their energy to end customers (Varho, Rikkonen & Rasi, 2015).

The authors highlight that distributed production and decentralized systems may be a potential solution to the climate change issues associated with centralized, fossil-based energy, but that different barriers and support systems affect the potential development in different countries. Some of the most prominent obstacles found in the case of Finland were access to reliable information for potential small-scale prosumers, lack of company collaborations and immature business models. While the business environment was regarded a major influencer in the development of renewables, policy regulations were still considered an important enabler of growth (Varho, Rikkonen & Rasi, 2015).

4.5.3 International energy foresights

4.5.3.1 The European energy market (EurEnDel)

One of the first research projects assessing long-term developments in energy technologies on a European scale was the EurEnDel project, conducted between 2002 and 2004. The project used a Delphi study to combine a technology-push perspective with a social-pull perspective in order to build scenarios of the energy system up until 2030. Over 3400 energy experts from several countries were invited to take part in a web-based two-round Delphi study, which received a response rate of around 20 %. The first round resulted in the identification of 19 technological trends. For the second round, these trends were put in a coherent context within the three fields political will, external framework conditions (outside the European Union) and decisive factors, such as for example the accessibility of fossil fuels. Based on this, three scenarios were constructed. The scenarios were called “Change of Paradigm”, “Fossil Fuel Wars” and “Muddling Through Across the Gas Bridge”. “Change of Paradigm” had a strong emphasis on achieving climate targets and energy efficiency with a strongly pronounced policy shift towards sustainable development across Europe. Meanwhile “Fossil Fuel Wars” presented a scenario characterized by crisis where national conflicts weakened the policy regime. The final scenario, “Muddling Through”, still showed a shift towards sustainability but with a slower transition and with natural gas remaining important to the European energy mix (Wehnert et al., 2007).

The experts were asked to anticipate time of occurrence for the three scenarios, which included for example the two scenarios of over 5 % PV-sourced electricity in the distribution system and micro-production systems contributing to more than 30 % of European energy supply. These requisite technological developments were evaluated by the experts based on expected time of occurrence and what actions were needed to promote early development (Wehnert et al., 2007). By compiling the knowledge of the experts, the project was able to draw several conclusions regarding the future European energy system. First of all, energy efficiency technologies, which can help reduce energy use, were found to be crucial for the development. Many of the experts also had a strong belief in the potential of renewable energy sources, believing these would contribute 25 % of the demand before 2030. Sometime in the period 2030-2040, PV was believed to be able to provide 5 % of the European power. The Delphi study also concluded that solutions for energy storage and distributed generation of power were to gain increased importance in the future energy system (Wehnert et al., 2007).

5 CASE STUDY

This chapter presents the results of the case study. The case of one specific DSO acting in today's market, E.ON Energy Networks in Malmö, is introduced. Company facts of strategy and operations are presented along with the DSO's stakeholder network.

5.1 E.ON Energy Networks

5.1.1 Company facts

E.ON is a privately owned German utility which through its different subsidiaries operates in a number of European countries as well as in the US. The corporation, which is headquartered in Essen, Germany, has over 40 000 employees (E.ON, 2018a). E.ON previously operated with various energy sources, but after a major reorganization in 2016 the focus has shifted from traditional energy to renewables. The conventional energy production based on hydropower and fossil fuels is since then controlled by the new company Uniper, while the global business of E.ON is focused on three business areas: Renewables, Customer solutions and Energy networks (E.ON, 2017b). As of early 2018, following the sale of a large amount of Uniper shares held by E.ON, the two companies are no longer connected (Buck, 2018).

The Swedish operations employ 2000 people and are headquartered in Malmö (E.ON, 2017a), covering a range of activities. E.ON Energy Networks is with its extensive grid of 137 000 km one of the most influential DSOs in Sweden. The network is mainly found in the southern parts and consists of both local and regional parts (E.ON, 2017b), forming separate departments (E.ON, 2018b).

Since the split from fossil fuels in 2016, E.ON has put sustainability at the very core of its corporate strategy, with an explicit ambition to actively contribute to the fulfillment of the UN goals for sustainable development, Agenda 2030 (E.ON, 2018a). For the Swedish market, the aim is to offer 100 % renewable or recycled energy by 2025. In 2016, 55 % of the electricity sold by E.ON in Sweden came from renewable generation, while 78 % of the piped hot water sold was either renewable or recycled. The share for gas was 16 % (E.ON, 2017b). During 2016-2019, E.ON Energy Networks set out to invest approximately 12 billion SEK to secure supply and enable the growth of renewable energy (E.ON, 2017c).

5.1.2 Strategy and collaboration

The goal of 100 % renewable energy applies to the entire Swedish company. Marc Hoffman, CEO of E.ON Sweden, presented a strong belief in the future of the company in an interview by Fremin and Eklund (2018). In order to transform from a traditional utility into an organization fit to handle the energy systems of the future, changes are, according to Hoffman, needed both in operations and culture. In Sweden - a country where power traditionally has been generated on large scale, often using hydropower in the north - individualized solutions are now gaining importance. This makes increased customer focus one of the most important challenges for E.ON to handle, in order to keep up with the metamorphosis of the market, Hoffman said, adding that he was confident that the company will succeed in achieving this (Fremin & Eklund, 2018).

Johan Mörnstam, CEO of Energy Networks says that the goal of becoming completely renewable is present in all parts of the business. The strategy already has noticeable effects on how the company is run, both on a daily basis (through for example the menu in the office cantina) and long-term (through considerable investments in the grid) (Fremin & Eklund, 2018). Mörnstam shares Hoffman's vision of the future, where customer focus will be crucial and individualization will increase. In line with this, E.ON Energy Networks will enable more small-scale renewable electricity production and storage solutions during the years ahead, as well as provide other products and services (E.ON, 2018f).

E.ON Energy Networks is, as a DSO, obliged by the unbundling directive (2009/72/EC) to be a completely separated entity from the power supplying part of E.ON. The complexity of the regulation, which is meant to protect consumer interests by keeping the entities separated, may leave some issues to interpretation (Gao, 2010; Energiföretagen, 2016). In order to mitigate the risk of being noncompliant with legislation, the collaboration between different E.ON companies is to some extent limited, perhaps even more limited than would be strictly necessary, according to employees.[1] Taking advantage of the collected knowledge and expertise of the whole company was something further emphasized through a new strategy program for E.ON Energy Networks called "New way of working", set to be initiated from May 1st, 2018. More concentrated focus on customers and customer interactions, more holistic consumer concepts and a faster, more agile way of working were emphasized as ways for the company to deal with the future development of the market (E.ON, 2018c).

Apart from the internal collaborations within the E.ON group, Energy Networks as DSO also interacts with a range of external stakeholders. Customers from private and public sector are connected to the distribution grid both as consumers and, to some extent, producers of electricity. Companies working with installations of technology using different energy sources also become important in the connection between the grid and the electricity users. Real estate organizations, municipalities, TSO, solar panel providers and the government are some of the existing relationships that currently affect the business of the company on the market for solar based electricity (E.ON, 2017d & 2018d). In the transformation of the energy system towards exclusively renewables, some market actors are highlighted by employees of Energy Networks as being potentially interesting partnerships. Server rooms of the IT sector, battery storage and digital technologies, along with car manufacturers, could all have important roles to play on the electricity market of the future.[2]

5.1.3 Solar based electricity

In the field of solar, E.ON Energy Networks connects solar systems of different capacities. Production units can be net producers or net consumers, depending on how large the production capacity is in relation to the energy needs of the specific consumer; pure producers are rare. Net producers produce more energy than they consume, while net consumers are producing less than their own demand. The driving forces of these different segments, and the demands they make, vary. Customized solutions are needed to match the different groups (E.ON, 2016).

Statistics from June 2017 showed the evolution of solar power subscriptions to the grid operated by E.ON Energy Networks. One solar power subscription corresponds to one customer with PV

[1] Sofia Persson, Connection engineer, E.ON Energy Networks, Interview, 2018-02-21
[2] Peter Andersson, Product Manager, eMobility, E.ON Energy Networks, Personal communication, 2018-02-18

connected to the grid. New connections experienced a general growth during the past five years, going from 66 new connections in 2011 to 836 new facilities connected in 2016 alone. All PV-installations were connected to the local grid, with the majority in the smallest sizes of grids with a maximum capacity of 63A and 43,5 kW. Some of the municipalities with the highest number of connections in the grid operated by E.ON Energy Networks were Falkenberg, Halmstad, Norrköping and Malmö (E.ON, 2017e).

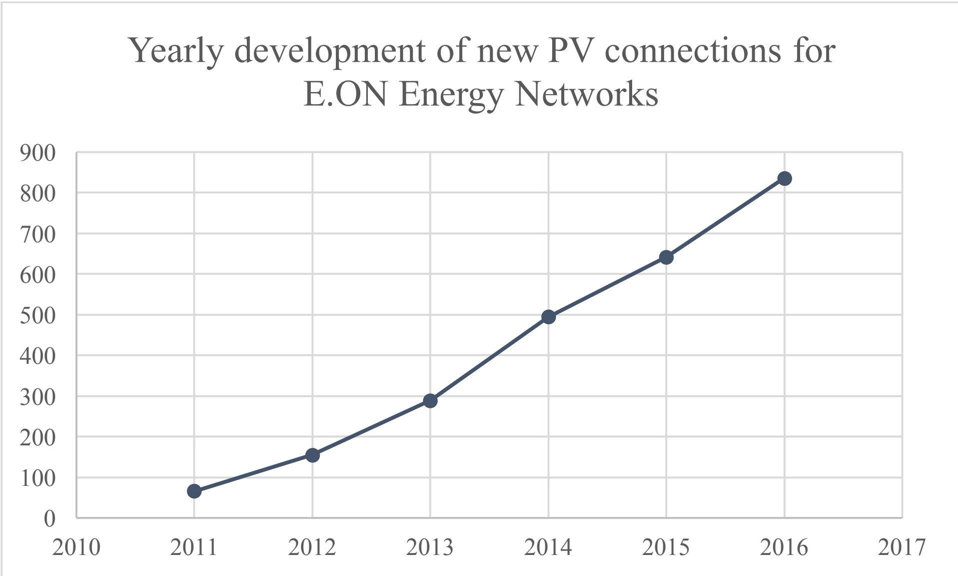

Figure 5.1 The development of solar power connections to the grid operated by E.ON Energy Networks in Sweden.

Latest available data showed that the total number of grid connections had grown to 3906 as of February 2018. The growth in installations during February was 66 % compared to the same month in 2017. Despite the increase, the number of new connections was still below company forecast (Andersson, 2018). Reasons for this include delays in the installment process due to complications in bureaucracy for customers wanting to install rooftop solar panels as well as the grid needing to be reinforced before new connections could be made possible.[3]

Although the corporate strategy of sustainability is valid for all of E.ON Sweden not all companies within E.ON perceived the benefits of achieving this equally. Being a DSO, the regulatory framework of revenue caps was making Energy Networks obliged to connect all new users of solar power to the grid, independent of size and capacity, without being able to charge a sufficient amount to cover the actual costs, specifically in the cases of smaller customers.[4] If the connection has a capacity below 43,5 kW, which is often the case of private customers, the DSO was not allowed to take out any fees, independent of the possible need for infrastructural investments. If an increase in the fuse was necessary for the installation, part of the cost could be charged back to the customer.[5]

The large investments needed in the transformation of the energy system that specifically relate to the national electricity grid is an issue highlighted by various sources (National Grid, 2017; Byman,

[3] Sofia Persson, Connection engineer, E.ON Energy Networks, Interview, 2018-02-21
[4] Peter Andersson, Product Manager, eMobility, E.ON Energy Networks, Personal communication, 2018-01-10
[5] Kristofer Andersson, Business developer, E.ON Energy Networks, Personal communication, 2018-05-14

2016). A report from 2017 regarding the transformation to a 100 % renewable energy sector in Sweden by 2050, estimated investments in the grid to be about a third of all the investments needed for production, storage and grid (Krönert et al., 2017). According to E.ON, the responsibility of providing a better regulatory framework lies with the regulators. The company has lobbied for support, such as tax reductions, to facilitate the investments needed to secure supply and develop the grid towards more intermittent energy sources (E.ON, 2017f & 2018e). This was further emphasized in discussion meetings and interviews with employees.[6,7]

5.1.4 Stakeholder network of E.ON Energy Networks

The first two research questions of the present research project aimed at capturing the stakeholders and driving forces present in the context of more solar power in the Swedish national grid. Segmentations done in previous studies on electricity markets emphasize the importance of different roles and stakeholders, but often discuss them in terms of a few large, homogenous groups (e.g. Foxon, 2013; Energimyndigheten, 2015; Utredningen om mindre aktörer i ett energilandskap i förändring, 2018). Moving beyond this, the research project used stakeholder identification in the context of one focal firm - E.ON Energy Networks - to distinguish specific stakeholders' activities and roles on the current market. The use of one case study company as a starting point was made all the more useful since there is a company or organization in the center of almost all stakeholder analyses found in theory (Mitchell et al., 1997). The aim of the stakeholder identification was to capture the stakeholders that are significant for E.ON Energy Networks in the context of the Swedish market for solar power.

All stakeholders were identified based on the definition by Freeman (2010) of a stakeholder as a "group or individual who can affect, or is affected by, the achievement of an organization's purpose" (p. 46). All actors having some sort of involvement with E.ON Energy Networks on the market for on-grid solar power were included in a first stage. These stakeholders were listed using a brainstorming process, in line with the identification step recurring in stakeholder analysis (Reed et al., 2009). See section *3.1.1 Stakeholder theory* for a theoretical background.

Long-list of potential stakeholders:

- Government
- Municipalities (local decision makers)
- TSO
- Private customers
- Corporate customers
- Public sector customers
- Net consumer
- Net producer
- General corporate strategy/board
- E.ON Customer solutions (internal sales department)
- E.ON Renewables (internal power supplier)
- External power suppliers
- External DSOs
- Real estate companies (for-profit)

[6] Sofia Persson, Connection engineer, E.ON Energy Networks, Interview, 2018-02-21
[7] Kristofer Andersson, Business developer, E.ON Energy Networks, Interview, 2018-02-22

- Real estate organizations (non-profit)
- PV installation companies
- Third party service providers
- Media
- International markets
- NGOs
- Civil society
- Battery producers
- Technology startups

After listing the potential stakeholders, a clustering and ranking process was used to determine direct or indirect stakeholder groups that had distinct relevance. In an effort to look beyond stakeholders as merely physical actors, ANT also influenced the stakeholder identification (see *3.1.3 Extending stakeholder analysis* for theoretical framework). These types of "actors" were for example the grid itself, specific policies and the external environment. Factors of this kind were considered relevant in the sense that they influenced the case, but were nonetheless left out of the stakeholder identification and instead incorporated in later steps of the stakeholder analysis, looking at framework settings within the stakeholder network.

Some stakeholders were later disregarded as they did not meet the relevance criteria of directly influencing the amount of solar based electricity in the grid. An example is international regulators, since this group was considered to be affecting the market through Swedish regulators rather than directly. Providers of PV, smaller installation companies and technology startups within the field were also classified as indirect stakeholders. This was due to their activities not necessarily being connected to the distribution network. The Swedish Society for Nature Conservation (Naturskyddsföreningen) and other NGOs, although performing substantial environmental work, were also regarded as indirect stakeholders for the same reason.

Clustering and evaluation did not only cross some stakeholders off the long-list; some actors were grouped into one stakeholder based on their similar activities. Too many individual stakeholder groups would not have allowed a comprehensive analysis, but too few heterogeneous groups would have made it harder to distinguish the possible change of a specific role or the driving forces of a specific market actor. The aim was to identify all key stakeholders, in order to later on analyze their different roles. E.ON Energy Networks was directly influenced by both internal actors, within the organization, and external actors. The board for the E.ON group decided on the corporate strategy for example, while regulations set by the government restricted some of the operations of the DSO. Both internal and external stakeholders were subject to the subsequent stakeholder analysis. The E.ON group is split into subsidiaries - their differences in interest and activities made it suitable to define two internal stakeholders. These were the supplier part, dealing with power retailing and providing customers with power supply contracts, and the company board, responsible for the overall company strategy.

Customers were divided into three segments; public, private and corporate. These all have different interests. Real estate companies formed a specific stakeholder group as they demand much photovoltaic installation and have the potential to demand much more. The stakeholders identified in the case study were verified with two representatives from the case company through semi-structured interviews, as well as through recurring discussions with other employees. The interview guide for the semi-structured interviews can be found in appendix A.4. Final selection of the relevant stakeholders led to an illustration of the “key players” relevant for proceeding with in the forthcoming analysis, as seen in figure 5.2.

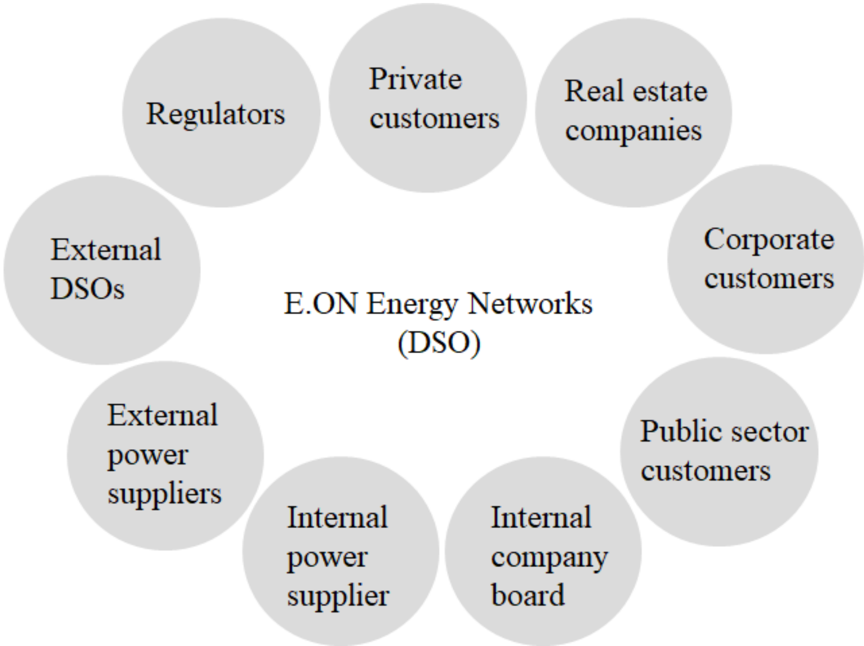

Figure 5.2. Overview of key stakeholders for the case study DSO in the context of more solar power in the grid.

6 FROM CASE TO MARKET: A GENERALIZATION

Based on the findings in the case study and the literature review, stakeholder analysis is here used to generalize from E.ON Energy Networks to the Swedish market for solar power. In the analysis, driving forces are identified.

6.1 General stakeholder analysis

Building on the findings of the case, a generalized stakeholder analysis was conducted for solar power in Sweden. The scope of the present thesis paper - increased solar based electricity in the distribution network - was the purpose for which the stakeholders were identified. Thus, the stakeholder analysis in this report expanded from the usual setting of a focal firm in the center of a stakeholder network, to centering on the issue of more solar in the grid, as a way of handling the criticism of stakeholder analysis being too concentrated on an organization in the spotlight (*see 3.1.1 Stakeholder theory)*. In line with this, the capturing was not only conducted using the version of stakeholder mapping most commonly found in theory, as seen by e.g. Bourne & Walker (2008) & Burga & Rezania (2017), that focused on a single firm and their stakeholder network. In this project, the first step of identification was used, while the analysis consisted of finding surrounding factors, mega trends and perceptions of interest.

The analysis process consisted of four steps, leading up to the network of the key stakeholders and their driving forces, in line with research questions 1 and 2 of this thesis project, as seen in figure 6.1.

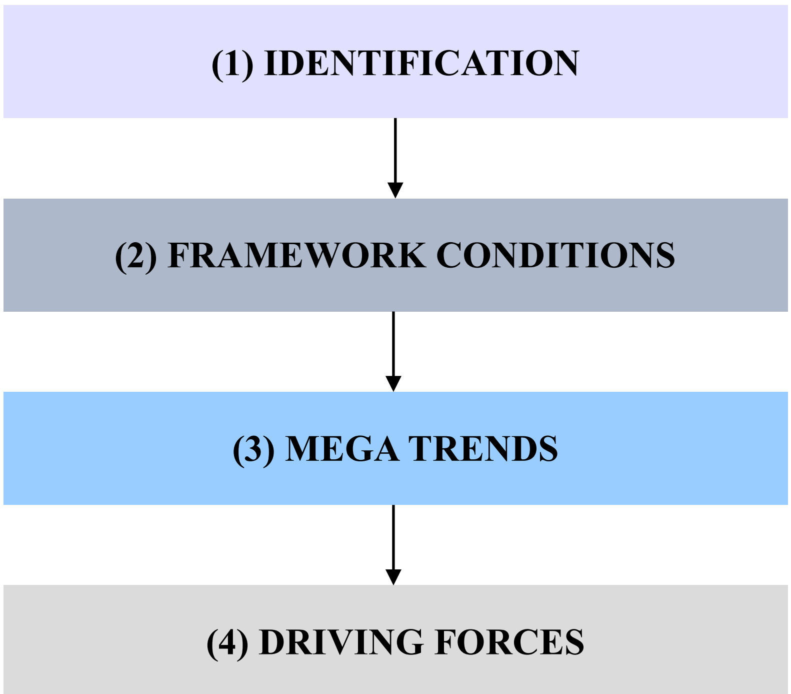

Figure 6.1. The process of stakeholder analysis used in this thesis project.

In the first step of the process the stakeholders identified in the case study were used as a starting point for finding the stakeholders in the wider context of solar based electricity in the distribution network. After identification of relevant stakeholders, the second step consisted of setting a framework for the stakeholders with factors or conditions influencing their roles, interests and power in the market. Establishing a scheme of external factors helped capturing what general driving forces could be seen as shaping the development of the market. Synthesized from the literature review and the case study, the third step included formatting the framework conditions into a set of megatrends. The final step of the analysis consisted of capturing the intrinsic driving forces of the relevant stakeholders. The findings and conclusions of the four steps formed a basis for the survey.

6.1.1 General stakeholder identification

In line with the process of identifying key stakeholders of the case, a generalized stakeholder network was constructed to build up to the survey. The issue of more solar in the grid was put in the center of the stakeholder network. The stakeholders were segmented based on sharing similar activities on the current market. External DSOs and power suppliers have largely the same interests and perform the same activities as their internal counterparts. Although there were some differences in terms of general strategy and relationship, this was insufficient to maintain them as separate stakeholders, and they were therefore clustered into one stakeholder. Both axes of interest and power was deemed high for all the stakeholders identified in the stakeholder network, considering them all “key players” in line with Johnson & Scholes (1999).

The stakeholders relevant in the context of more solar based electricity in the Swedish distribution network were the following: (1) Regulators, (2) Private customers, (3) Real estate companies, (4) Corporate customers, (5) Public sector customers, (6) Distribution system operators, (7) Power suppliers, as found in figure 6.2.

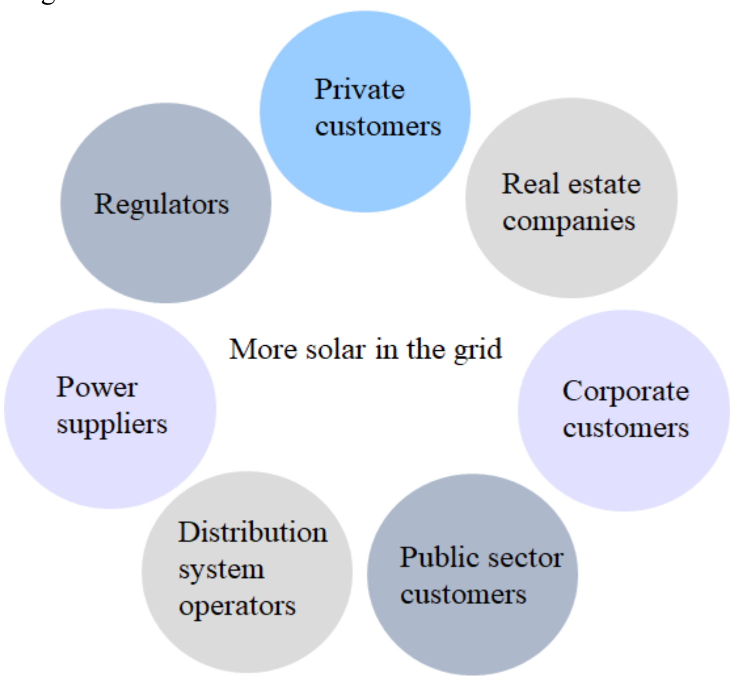

Figure 6.2. Primary stakeholders connected to increased levels of solar power in the grid.

A descriptive list of the various stakeholders along with their current activities on the Swedish electricity market is found in table 6.1 below:

Table 6.1. Direct stakeholders in the context of solar based electricity in the distribution network.

Stakeholder name	Description	Activities
(1) Regulators	Regulators are decision makers and institutions that control and regulate the market by providing framework settings within which the other actors operate (e.g. the Swedish Energy Agency, Svenska Kraftnät, Solelkommissionen).	Providing institutional governance and a regulatory framework within which all actors operate. Creating policies for promoting innovation and sustainability.
(2) Private customers	Private customers are defined as individuals and households.	Buying solar energy for private housing. Producing and consuming solar based electricity through privately owned solar systems.
(3) Real estate companies	Real estate companies include companies who build, own or manage real estate, whether public or private (e.g. Skanska, HSB, AF Bostäder).	Working with real estate management and development, potentially large installation customers.
(4) Corporate customers	Corporate customers are for-profit firms operating according to a business model, except real estate companies.	Buying solar energy for company facilities. Producing and consuming solar based electricity.
(5) Public sector customers	Public sector customers are organizations within public services and enterprises.	Buying solar energy for public sector buildings and facilities. Producing and consuming solar based electricity.
(6) Distribution system operators	The DSOs are network operators responsible for the regional and local distribution network (e.g. Ellevio, E.ON Energy Networks & Vattenfall Distribution).	Responsible for reliable delivery and the connection of new electricity producers and users.
(7) Power suppliers	Power suppliers are responsible for the delivery of electricity to consumers (e.g. Arvika Kraft, Telge Energi, E.ON Energy Solutions, Vattenfall).	Handle power retailing and provide customers with electricity supply contracts.

6.1.2 Framework conditions

To understand the setting within which the market actors operate, some framework factors were identified which together shape the current market and influence the possible roadmap towards how the electricity market may develop in the future. These were based on findings from the literature review, where some characteristics influencing all actors of the system were identified. The factors that together formed the setting were: *external environment, technology, institutional governance* and *market structure*. A depiction of the framework conditions can be found in figure 6.3.

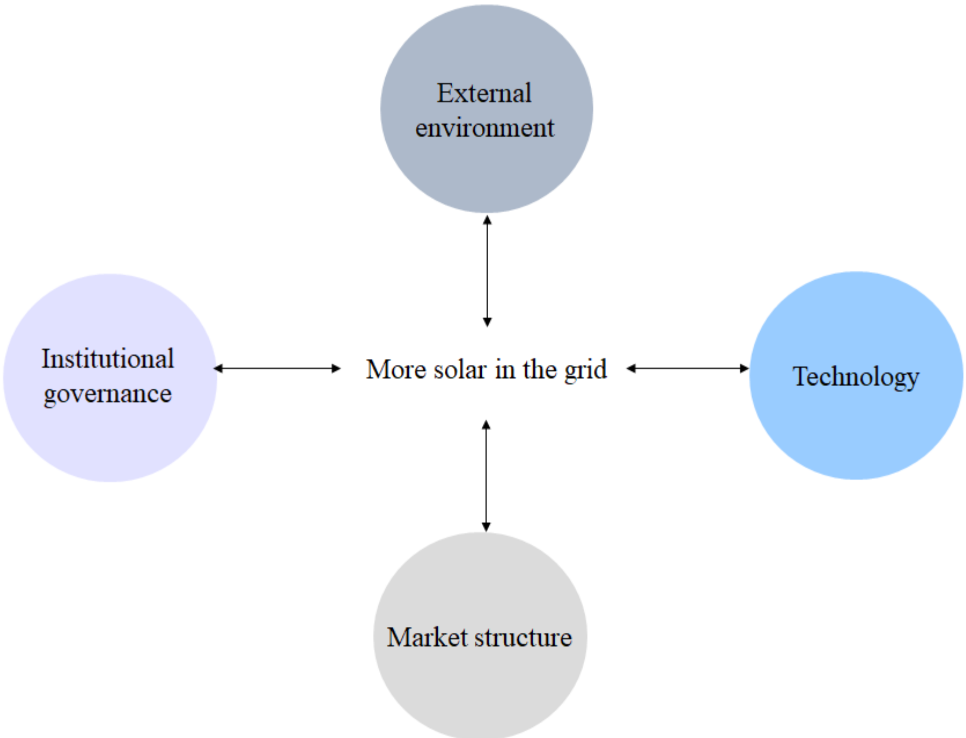

Figure 6.3. Framework conditions influencing the electricity market in Sweden and the potential for more solar based electricity in the electric grid.

1 *The external environment* and the physical and geographical conditions of the current Swedish electricity market and in the specific area of solar power influence the stakeholders on the market. This includes availability of various energy sources, prices of electricity and infrastructure development along with perceptions of environmental concerns and self-sufficiency from society and the public. Decentralization and international connectivity are also characteristics that influence the Swedish market as well as the development in neighboring countries.

2 *Technology* includes the technological conditions of the market with innovation and digitalization. Development of smart grids, storage systems and other innovation in available technologies all influence the area of solar power.

3 *Institutional governance* include policy regulations, governmental interplay and other regulations that could steer the market in different directions, both nationally and on a global or European scale.

4 *Market structure* captures the market conditions that go beyond the physical, technical and institutional factors. This includes activities of various stakeholders along with entries of new actors. Market structure also includes market characteristics such as energy use and efficiency, electrification, decentralization as well as economic and population development (BNP and population growth).

6.1.3 Megatrends

In line with the framework conditions found to be shaping the market, some megatrends could be distilled from the case study and the literature review. These were perceived as external driving forces shaping the future development of solar in Sweden and thereby also the roles and activities of the stakeholders on the market. The body of reports and research projects covered in this thesis paper conducted in the area of energy and foresight puts emphasis on different trends and factors as being prominent in shaping future trajectories.

All identified trends or tendencies were qualitatively analyzed and clustered to determine which were important in the shaping of the future market and the transformation of roles in the area of solar power. Recurring, if be it to various degrees, were:

- Changing electricity needs (energy efficiency and electrification)
- Fluctuating electricity prices
- Increased technology development and digitalization
- Increased global interconnectedness
- Increased decentralization in electricity production
- Increased flexibility (usage and supply)
- Increased environmental awareness

Changing electricity needs is a trend shaped both by increased energy efficiency and by increased electrification, highlighted by for example Rydén et al. (2015). The transportation sector is a primary source of carbon emissions, and is often mentioned as greatly influencing the future electricity needs. Energy efficiency of buildings and products is another factor that on the other hand brings down the electricity needs. The general perception is that electricity demand will increase in the future, especially in cities (Energimyndigheten 2015 & 2016a). There is also a general belief in more fluctuating electricity prices as more intermittent energy sources enter the system (Krönert et al, 2017).

Technological development and increasing digitalization is often mentioned in literature as key enablers on the electricity market, for example Energimyndigheten (2016a), Rydén et al. (2015) & Wehnert et al (2007), but what opportunities technical innovation will create, and when, remain unclear. Technological innovations include smart meters and battery storage solutions which improve performance and financial profitability of solar power technologies (Varho, Rikkonen & Rasi, 2015; E.ON, 2010). Related to technological development are the two trends increased interconnectedness and decentralization of production. Increased interconnectedness between different regions and countries is sometimes emphasized as an enabler of secure supply in the presence of more intermittent energy sources, making distribution and transmission networks more efficiently balanced (Energimyndigheten, 2016a). At the same time, decentralization of energy production with more small-scale and off-grid solutions is growing (Varho, Rikkonen & Rasi, 2015; Utredningen om mindre aktörer i ett energilandskap i förändring, 2018; Verreth, Veldman & Paulusse, 2015). A large number of small-scale production units mean more connections to the distribution network and a more complex need for balancing, while off-grid solutions make fewer consumers dependent on the grid at all (Wehnert et al., 2007). The development of secure supply, interconnectedness and decentralization develop at the same time as increased flexibility in both usage and supply, making the future demands uncertain (Energimyndigheten, 2015). The growing importance of environmental concern also influence the transition of the market, making other driving forces, such as financial incentives, less dominant (Barnacle, 2017; Energimyndigheten, 2016a).

6.1.4 Stakeholders' driving forces

After stakeholder identification, and description of their activities, along with the development of the framework within which the stakeholders operate, intrinsic driving forces of the stakeholders were distinguished. These underlying factors influence the stakeholders' actions in a specific cause, and need to be considered in analysis of stakeholders (Mitchell et al, 1997). The perception of power and the potential of hindering or enabling a certain development was deemed interesting aspects of the stakeholder network, with different views on which stakeholders could be seen as having most power to influence more solar power in the distribution grid, and in different ways. This was seen as relating closely to the roles of the different market actors, and them being able to hold back or enable certain development. The view of the current power distribution was difficult to form an opinion on solely based on the findings of the literature review and case study, why distribution of power was considered a suitable issue to explore in the survey. It was also seen as changing over time, as being highlighted by for example Olander & Landin (2005). Another key factor in the stakeholder analysis of this project was the concept of "interest". Interest was seen as capturing various dimensions that influence the behavior of actors.

The dimension of interest in the stakeholder analysis was divided into four driving forces:

- Financial benefits
- Environmental concerns
- Sustainable profile
- Self-sufficiency

High interest in terms of *financial benefits* indicate that a stakeholder has desirable economic benefits of pursuing more solar based electricity in the distribution network. *Environmental concerns* indicates the way in which an actor values preservation of the environment and creation of a sustainable energy system. *Sustainable profile* represents the interest that stakeholders have in pursuing a sustainable brand. For companies, a sustainable profile can imply indirect financial gains, whereas individuals/non-profit customers may want to display a sustainable profile to others in society. *Self-sufficiency* captures the need and demand to become increasingly independent of others, that is companies or households wanting to become less dependent on energy suppliers, but also regulators in Sweden wanting the country to be less dependent on imported energy. In the cases of power suppliers and DSOs, *self-sufficiency* affects them in so far that their customers become self-sufficient.

7 SURVEY

In this section, the development of the Delphi study's two questionnaire rounds are presented along with the findings from each round. Both quantitative and qualitative results are discussed. First, the general process is covered, followed by the construction and results of the two rounds separately. Lastly, an analysis on the Delphi as a whole is presented.

7.1 General process

For the Delphi study, the seven step process as described by Denscombe (2017) was followed. A detailed description of the work process, survey design and the selection of experts can be found in sections *2.2.2 Survey* and *2.3.3 Delphi study questionnaires*.

7.1.1 Survey building

In the survey building, the aim was to capture and explore questions where there was a lack of consensus among researchers and others knowledgeable in the field. While solar power is affected by a complex interplay of many factors, the aim here was to focus on one or a few aspects in-depth. Throughout the case study and literature review, a range of driving forces that influence the trajectory of the future energy system was identified. Roles and stakeholders had recurrently been presented as affecting the development of the market. To build foresight scenarios using the scenario cross, there was a need to determine which driving forces were expected to shape the distribution of roles within the energy system by impacting the actions of the stakeholders. These driving forces were discerned to be different for different stakeholders. Which stakeholders could be considered powerful in terms of both the ability to positively influence the market development and the ability to prevent or block it was also relevant. Substantial power could both originate from for example regulatory power, but could also depend on how much influence the stakeholder had over public opinion or how much investment power it had in the development towards more solar power in the distribution network. Depending on the perceived power and influence from certain driving forces or stakeholders, together with perception of the timeline, the idea was to go forth with scenario building of distinct scenarios with large uncertainties.

7.1.2 Results of the survey

In total, 79 experts received the first round of questions via email. The respondents had 13 days to respond to the survey; a reminder was sent out a few days before the deadline. Out of the 79 individuals, 42 responded within the requested time frame (53 % response rate). After three weeks, dedicated to the analysis of round 1 and construction of round 2, all 42 participants were sent the second questionnaire. They had 10 days to answer round 2, and a reminder was once again sent out before the deadline. Out of 42, 32 completed the survey in round 2 (76 % response rate). The results of the questionnaire process are found in figure 7.1.

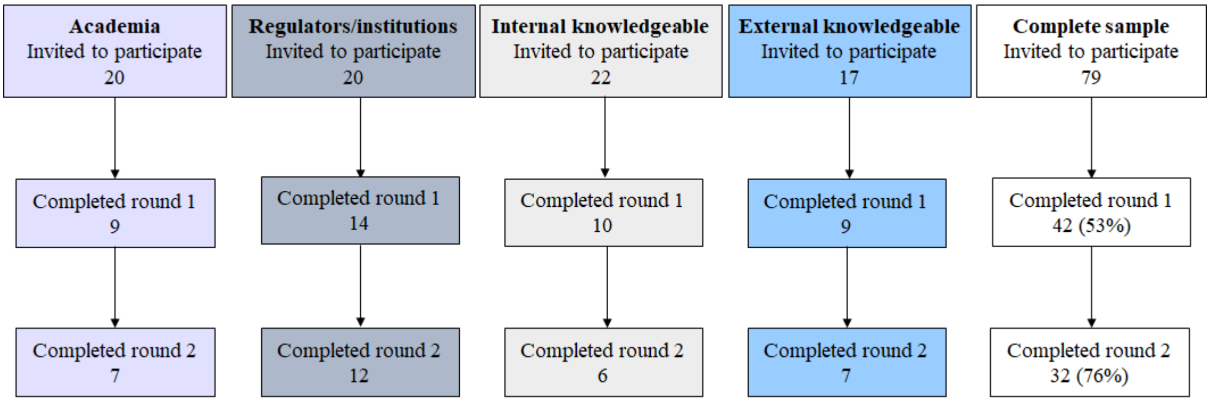

Figure 7.1. Flow diagram of the questionnaire process.

Round 2 was followed by specific email contact with certain respondents for clarification and the chance for the respondent to explain and develop their line of thinking.

All responses of round 1 and 2 were analyzed using Microsoft Excel. The perceptions among the participants were generally scattered, with different opinions and ideas concerning the development of the market for solar based electricity in Sweden. The synthesis of the first round, which included driving forces of the market actors, power, obstacles and time horizons, achieved 91 % consensus, meaning 91% agreed with the stated perceptions. Prominent findings from the two rounds were that participants regarded the power and influence of regulators as strong. Regulators are believed to possess ability to both enable and hold back the progress of solar power. Other stakeholders that could potentially hinder the development were the DSOs and the power suppliers. This can be traced back to the central roles of these stakeholders in the network, along with complicated bureaucracy. Providing a long-term stable policy regime, benefitting all stakeholders financially, was identified as a key element in the development of a market with more solar energy. Another strong implication for a growth in solar power is achieving relative financial benefits of solar compared to other energy sources. Technical development is a part of this, along with infrastructure suitable for the characteristics of solar power.

Despite the consistent perception of the importance of regulators, there was also a belief in a power shift from public towards private actors. A general belief in power shifts entailed by the future scenarios constructed in round 2 was also noticeable. There was further a common belief in a change in roles connected to the growth of solar power, with both new and existing stakeholders entering the market with new and changing activities.

7.2 Round 1

7.2.1 Survey building round 1

The first round focused on the four identified driving forces (*financial benefits, environmental concerns, sustainable profile* and *self-sufficiency*) and to what extent these affected the different stakeholders. A first draft of the first questionnaire was put together and sent to personnel at the case study company as well as the faculty supervisor and other individuals for input before it was sent to the participants. The questionnaire used Likert scales, with a range from 1 to 6 as to not allow selecting a mid-range when insecure. Additional space for open comments was also included.

The questionnaire was divided into two sections: one regarding stakeholders and their specific driving forces, and one regarding power and obstacles. The first section asked the respondents to what extent each of the identified seven stakeholders was acting according to each of the four driving forces. The participants were asked about the situation of today, as well as of the future. The respondents were also asked when they foresaw a potential shift in these areas. The time horizons were defined according to mandate periods, ranging from the upcoming period of 2019-2023 up to the choice of "After 2030". The second part asked what stakeholders could be perceived as having the most power to influence the development of more solar power in the distribution network. Power was defined as a stakeholder's ability to influence and control the development of the market. The aspect of certain market actors functioning as obstacles for the growth of solar power in Sweden was also asked upon. A stakeholder acting as an obstacle could be hindering the development of the market due to being opposed to solar, but could also be holding it back involuntarily due to current responsibilities and obligations. The questions on power and obstacles were also followed by questions concerning when a possible change would occur. The questions of the first round of the Delphi study can be found in appendix A.1.

7.2.2 Findings round 1

A total of 79 identified experts were invited to participate, with a response rate of 53 % (42). The ordinal, numerical data was plotted in terms of frequency distributions, central tendency (median and mean) and dispersion (standard deviation) in Microsoft Excel. This was done both for the sample as a whole and for the four expert panels separately. The comments were analysed qualitatively by clustering and identifying recurrences that could indicate opinions shared by several respondents. The findings of round one per panel were generally coherent with the findings of the complete sample of experts, why emphasis on the analysis was on the entire sample.

7.2.2.1 Quantitative analysis

On average, the respondents had 12 years of experience in the field of energy. They rated their knowledge of the energy market as numerical mean 4,5 out of 6, and as 4,3 out of 6 within solar based electricity. The four panels *academia, regulators/institutions, internal knowledgeable* and *external knowledgeable* had average experience of 16, 9, 10 and 13 years respectively.

Numerical results concerning driving forces ascribed to the different stakeholders showed relatively large spread, without any heavily overweighting driving forces. Medians ranged between 2 and 5 for all questions concerning driving forces. Some answers had wider dispersion than others, with standard deviations per question ranging from 0,67 to 1,69. Frequency distribution of the driving forces for the different stakeholders, for the complete sample, was plotted in bar charts and can be found in figures A.5.1 to A.5.28 in appendix A.5. Each of the four underlying driving forces was plotted for each stakeholder, both in the perspective of today and of "in the future".

Main driving forces

The investigated forces were: *financial benefits, environmental concerns, sustainable profile* and *self-sufficiency.* By evaluating the mean and frequency distribution of forces ascribed to all stakeholders, two principal forces could be identified for each stakeholder - both for today's situation and for the future. The median was first used to distinguish the two most prominent driving forces for each stakeholder, followed by mean average if two or more forces had equal median. A full compilation of the main forces for each actor, as identified by the respondents, can be found in table 7.1.

Table 7.1. Main driving forces for each stakeholder "today" and "in the future", as rated by the participating experts.

Stakeholder	**Main driving force (today)**	**Main driving force (in the future)**
Regulators	● Sustainable profile ● Environmental concerns	● Sustainable profile ● Environmental concerns
Private customers	● Financial benefits ● Environmental concerns	● Financial benefits ● Environmental concerns
Real estate companies	● Financial benefits ● Sustainable profile	● Financial benefits ● Sustainable profile
Corporate customers	● Financial benefits ● Sustainable profile	● Financial benefits ● Sustainable profile
Public sector customers	● Sustainable profile ● Environmental concerns	● Sustainable profile ● Environmental concerns
Distribution system operators	● Financial benefits ● Sustainable profile	● Financial benefits ● Sustainable profile
Power suppliers	● Financial benefits ● Sustainable profile	● Financial benefits ● Sustainable profile

Comparing the plotted frequency distributions for "today" and "in the future" for each question, the results showed strikingly small changes. The median was either constant or with an increase in one step on the Likert scale for all questions. Thus the driving forces for each stakeholder were rated consistently over time. The for-profit stakeholders were by the respondents regarded as valuing *financial benefits* and the pursuit of a *sustainable profile* highest, while private customers and regulators were rated highly within *environmental concerns* and *sustainable profile*. *Self-sufficiency* was consistently rated the lowest out of the four driving forces for all market players, both today and in the future, but was also the force believed to increase the most in importance with time.

Time horizon

If the responses of "today" and "in the future" varied, the respondents also had to assess during which time period they anticipated the change to occur, presented in the c.) questions of the questionnaire. Bar charts on the timeslot distribution can be found in figure 7.2 and 7.3, both for each question focusing on a specific stakeholder, and for all the questions in total.

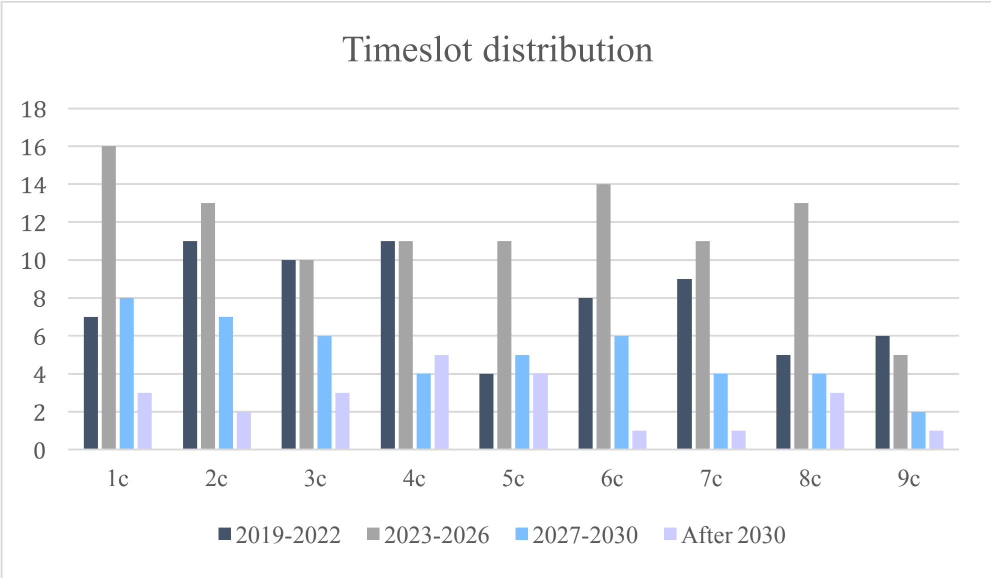

Figure 7.2. Number of responses for each timeslot for questions 1c to 9c, "If a change in the distribution of driving forces occur, when is this expected to happen?".

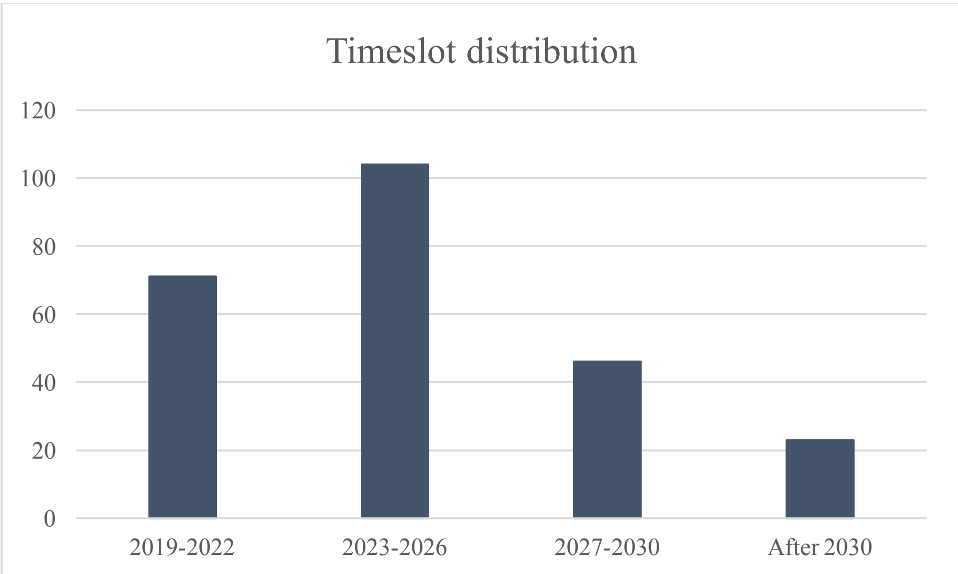

Figure 7.3. Number of responses for each timeslot of the perceived future for all questions.

The timeslot distribution was found to be rather scattered but with the period "2023-2026" being the most prominent. Since the question concerning time perspective was optional, and only to be answered if the respondent had indicated a change when answering the two previous questions, the response rate was lower than on the mandatory questions concerning driving forces. The response rate also varied for each question. The last question, 9c, had a response number of only 15, compared to question 1c with 34 answers.

Power and obstacles

In terms of distribution of market power and anticipated obstacles, round 1 asked the participants to rate the power of the stakeholders and their potential for acting as an obstacle to more solar power in the grid. This was done using a decreasing scale of 1-3 with 1 being the stakeholder with the most power or functioning as the biggest obstacle. Frequency distributions were plotted in bar charts for both time horizons found in figures 7.4 to 7.7. Analysis on the frequency distribution was further done based on a point-based rating system, where a ranking of 1 resulted in 3 points, rank 2 gave 2 points and rank 3 gave one point. These points were then added up for all stakeholders in terms of power and as obstacles, today and in the future. The resulting points can be found in table 7.2 and table 7.3.

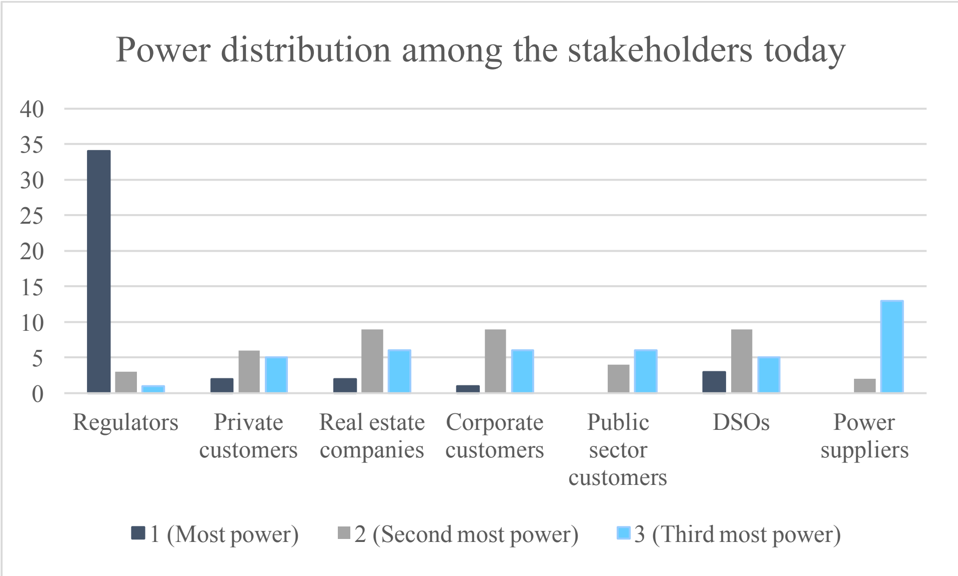

Figure 7.4. Distribution of answers when rating stakeholders with the most power to influence the current market of solar based electricity in Sweden (1-3 decreasing scale).

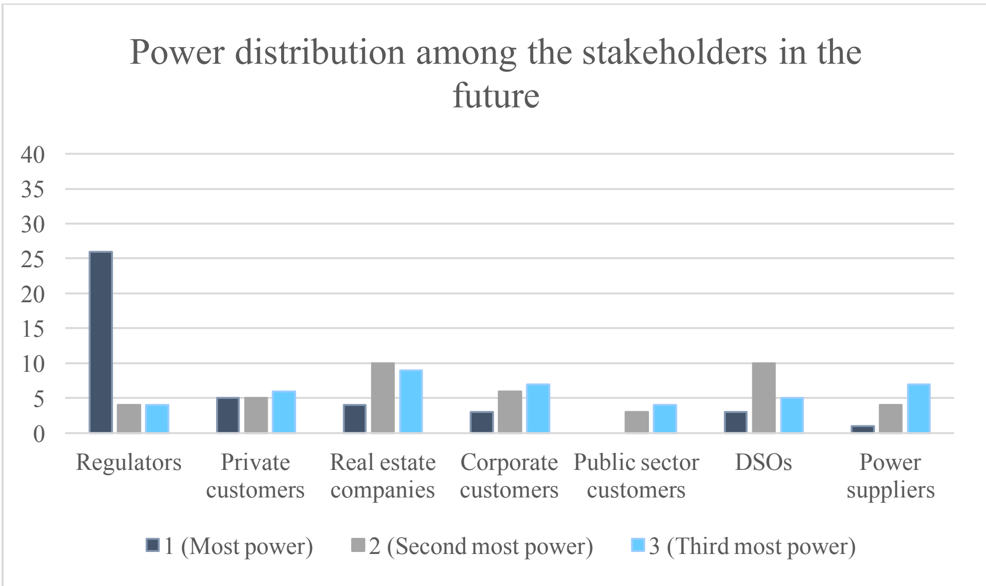

Figure 7.5. Distribution of answers when rating stakeholders with the most power to influence the future market of solar based electricity in Sweden (1-3 decreasing scale).

Table 7.2. Total rating of power for the various stakeholders (3-1 points based on decreasing scale).

	Regulators	Private customers	Real estate companies	Corporate customers	Public sector customers	DSOs	Power suppliers
Today	109	23	30	27	14	32	17
In the future	90	31	41	28	10	34	18

It was clear that regulators were considered to have the most power to influence the solar power market, both today and in a future perspective. The stakeholders considered to have the second and third most power based on the point rate system were real estate companies and DSOs. The answers were, however, more widely spread among the different actors, and there was no general consensus on the power distribution based on the responses of round 1. A power shift could also be seen along the timeline from today to the future, where all public actors (both regulators and public sector customers with exception of public real estate companies) see a decrease in power in favor of private actors. Real estate companies were the group rated to see the biggest increase in power from today to the future.

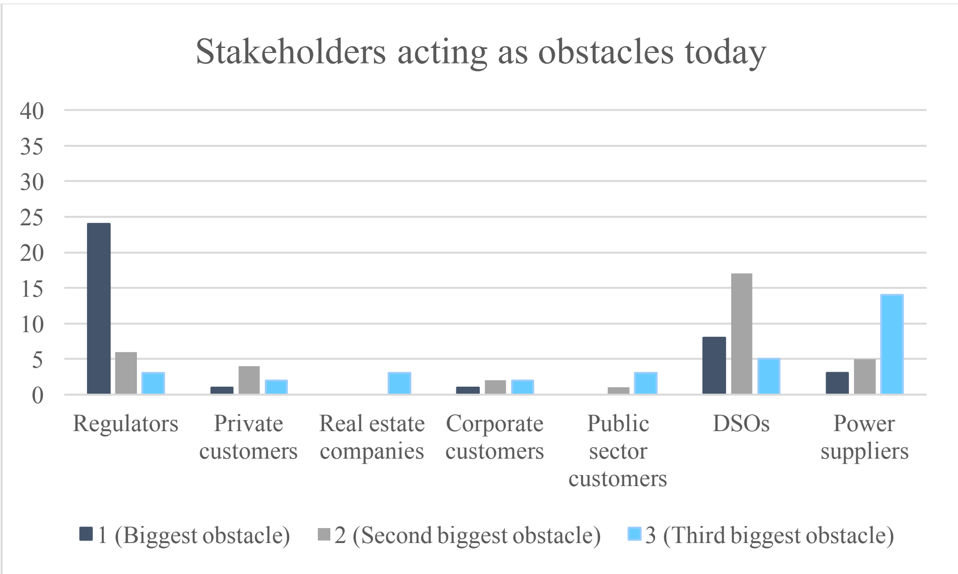

Figure 7.6. Distribution of answers when rating stakeholders acting as obstacles for the current market of solar based electricity in Sweden (1-3 decreasing scale).

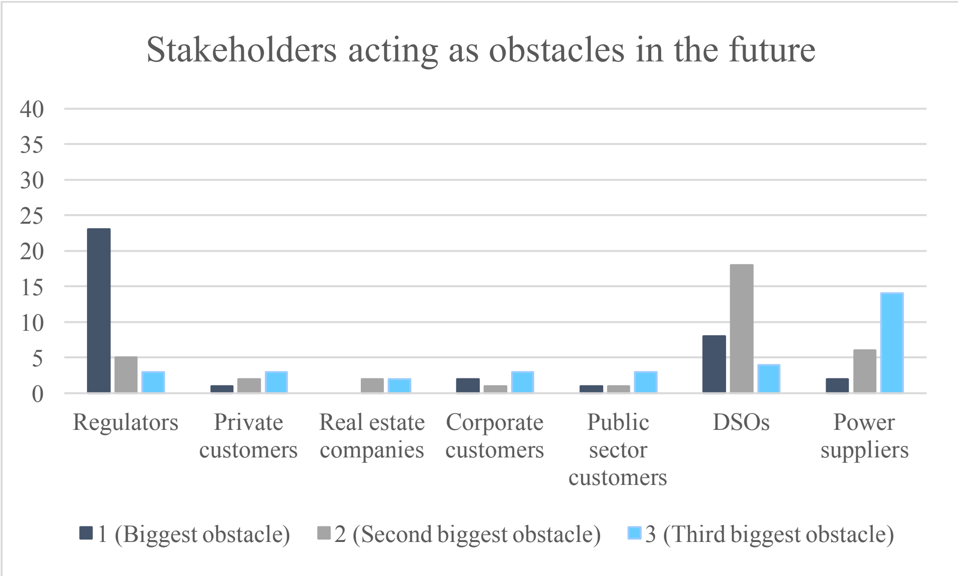

Figure 7.7. Distribution of answers when rating stakeholders acting as obstacles for the future market of solar based electricity in Sweden (1-3 decreasing scale).

Table 7.3. Total rating of stakeholders as obstacles (3-1 points based on decreasing scale).

	Regulators	**Private customers**	**Real estate companies**	**Corporate customers**	**Public sector customers**	**DSOs**	**Power suppliers**
Today	87	13	3	9	5	63	33
In the future	82	10	6	11	8	64	32

As in the case of power, it was clear that regulators were considered to be the biggest obstacle to more solar based electricity in the distribution network, followed by the DSO - both today and in the future. Power suppliers came in third in terms of possibly holding back the development.

7.2.2.2 Qualitative analysis

Each part of the survey provided a field for comments, thoughts or ideas. Although not all respondents left any comments, there were a considerable amount of comments that needed to be analyzed. Qualitative analysis of comments included clustering to identify common perceptions along the lines of Denscombe's process for qualitative data analysis (2017). Comments with similar content were bundled together.

For the first part of the questionnaire, five topics were recurring among the comments:

- Solar panels: price and profitability
- Price of electricity
- Sustainable profile
- Electricity storage
- Situation of DSO's

Several people expressed a belief that the price for solar panels will continue to decrease. This was in some cases associated with a belief in an increase in economic profitability; on the other hand some thought that the profitability would in fact decrease, partly due to changes in governmental subsidies. The profitability of operating solar panels was by many believed to be largely dependent on the price of electricity. A few respondents were expecting that buying electricity on the market will become more expensive in the future, and also that the price will become increasingly unstable. Increased electricity prices could yield financial motives to invest in solar panels, some believed, in contrast to the current situation where most customers, corporate as well as private, install systems motivated by environmental concern and sustainable profiling.

A sustainable profile was by many believed to be of increased importance in the future. The increasing environmental concern of customers is by several respondents believed to have effect on the development of solar energy, largely through affecting the course of action for actors such as energy companies, corporations and real estate companies, as well as the public sector. One comment, as an example, voiced the opinion that electricity companies who lack a sustainable profile, by offering renewable energy, will completely disappear from the (Swedish) market. Another believed that it will be of great relevance for real estate companies to build a sustainable profile around solar energy for many years on. For the public sector, some respondents stated that a sustainable profile will be of increased importance as renewable energy will become a more crucial political matter and the citizens will expect the authorities to take the lead.

A few respondents also emphasized the role of energy storage, believing that cheaper and more efficient batteries will contribute to the expansion of solar power, made possible by investments in R&D by battery producers. One person mentioned increasingly fluctuating electricity prices as a reason for investing in storage solutions, which in turn could enable installation of more solar capacity. Lower costs for the panels themselves are by another respondent believed to justify further investments in storage systems from a financial standpoint.

Several comments concerned the distribution companies (DSOs) and their challenging situation when it comes to solar, due to small economic benefits for this particular actor. There is a belief in growth in desire for *self-sufficiency*, expressed by a number of respondents, and that as that progresses, the dependence on DSOs is likely to be shrinking. Meanwhile, the intermittent nature of the sun places new demands on the grid, calling for considerable investments in order to maintain a reliable electricity supply. With more customers installing solar capacity there will be fewer customers to bear the costs which is likely to cause difficulties for the grid owners, one respondent commented. Several respondents were of the opinion that a great amount of adaptation to the new reality is needed from the DSO's. For instance, one comment stated that the current situation will result in changes in the business model of the DSO, as the operators will have to find alternative ways to make money.

For the second part of the questionnaire, concerning power and obstacles, the recurring themes were:

- Control of regulation equals power
- Difficulty in identifying stakeholders as obstacles

Several respondents shared the opinion that the regulators held most power, since they are the ones creating the rules within which the other stakeholders will have to act. Some also pointed to the power possessed by the customers, through which they could affect the public opinion and hence the direction of the entire market. Regarding obstacles, a couple of the respondents commented that the regulators were the most important obstacle for increasing levels of solar energy in the grid, for example because of a lack of consistency and predictability in the regulation of the market. Several other respondents also stated that they had difficulty identifying any stakeholders as obstacles.

When asked whether any stakeholders or driving forces were missing from the survey, more than a third of the participants responded. Among the missing stakeholders, entrepreneurs and companies working with development of solar energy solutions and installation of solar panels were mentioned by the most respondents. Other suggested stakeholders were battery producers, the oil and fossil-based industry, energy and climate advisors in municipalities, investors and different climate policy movements. One person also mentioned that large corporations and brands, such as IKEA and Electrolux, could become potentially important actors by selling solar panels since this could contribute to challenging the existing norms that are now forming obstacles. Only one respondent commented on driving forces missing in the questionnaire, focusing on the progress of electric vehicles and the positive effect that this is likely to have for solar power.

7.2.3 Synthesis of round 1

The findings of the first round were gathered in a summary of the areas were general agreements where found. This synthesis was shared with the respondents, in round 2, to verify that it contained a correct representation of the answers. If they were not satisfied they were asked to elaborate on why. Making the synthesis also allowed for identification of interesting topics to raise in round 2.

7.2.3.1 Collective insights

The first part of round 1 asked about driving forces for a range of stakeholders both today and in the future connected to increased levels of solar power in the Swedish national grid.

1a. The results showed tendencies of all the driving forces becoming more important in the future compared to today. This was valid for all stakeholders. Desire for *self-sufficiency* received the lowest valuation, although it was slightly higher for private customers. This force also saw the highest relative increase with time for all market actors.

1b. For commercial stakeholders (corporate customers, DSOs, power suppliers and some real estate companies), *financial incentives* was repeatedly the most crucial driving force, followed by the pursuit of a *sustainable profile*. This was consistent over time. For public actors (regulators, public sector customers), *environmental concerns* and a *sustainable profile* were prominent in shaping their interests in the market. Private customers were foremost rated to be affected by *financial incentives* and *environmental concerns*.

1c. Considering the time perspective, changes are deemed to occur in a close (if not imminent) future. There is a common perception that the time horizon of 2023-2026, and to some extent the upcoming mandate period 2019-2022, can see a breaking point within the area of solar power in Sweden, both in terms of driving forces and a power shift.

The second part of the questionnaire dealt with power in the stakeholder network and individual stakeholders as obstacles on the market.

2a. The general opinion was that regulators have the most power of all the stakeholders in the network, both today and in the future, although it was thought to decrease over time. In the ranking of other actors with power to influence the growth of more on-grid solar power in Sweden, there was no general consensus.

2b. In the case of specific stakeholders functioning as obstacles on the market and potentially holding back the growth of solar, most participants agreed that regulators are the most prominent, by some believed to be due to a lack of stable, long-term regulations. The regulators were followed by DSOs and power suppliers as the stakeholders on the market that could potentially hold back the development. A few respondents were opposed to the concept of stakeholders functioning as obstacles, claiming that there were no stakeholders hindering the development.

Finally, round 1 asked if there were any other key stakeholders that had not been mentioned in the questionnaire.

3a. A number of participants mentioned solar panel installation companies and entrepreneurs working with solar technologies. Others mentioned battery producers, investors, the oil industry and political movements within climate change, but there was no consensus on other key actors in the system.

7.3 Round 2

7.3.1 Survey building round 2

Round 2 of the Delphi study consisted of two elements. First, question were there were high level of agreement in round 1 were summarized and given as controlled feedback to validate agreement. Some questions were enhanced in order to generate more profound understanding of driving forces, power and obstacles. The second part of round 2 consisted of scenarios, built on the preliminary analysis of the results of round 1 and findings from the case study and literature review. Questions following the scenarios regarded plausibility of occurrence, distribution of roles and power, and timeline. Round 2 was sent to all experts that had participated in the first cycle. The questions used for round 2 of the survey can be found in appendix A.2.

7.3.1.1 Elements of feedback and in-depth questions

Based on the findings presented by Maclennan et al. (2018), which indicated no difference in variation or level of agreement using group specific feedback in the context of a Delphi study, no panel specific feedback was provided. This was also due to the fact that the mean, median and standard deviation of the complete respondent sample of round 1 was found to be largely coherent with the separate expert panels. The division of the respondents into the different panels also minimized the sample size of analysis to 9, 14, 10 and 9 respectively, which could be argued to be on the verge of insufficient panel sizes, see e.g. Okoli & Pawlowski (2004).

The summary in the feedback section of round 1 was limited to one page that gathered the shared thoughts of the respondents. They were then asked whether they agreed with the findings or not. If they did not agree, they could specify why this was so in a free text section. The summary can be found within *7.2.3.1 Collective insights.*

In addition to the summary of agreement, in-depth questions were also formulated regarding certain areas of round 1. *Self-sufficiency* was found in both the case study and literature review as having significance in the development of the market. However, the first round showed that this desire was not perceived as important for any stakeholder today, with the exception of private customers for whom it was thought to have some limited importance. An in-depth question therefore asked if desire for *self-sufficiency* for private customers was indeed an important driving force. The power on the market was in the first round found to be almost exclusively concentrated to the regulators, which rose questions of what characteristics of power were most important. The potential perception of powerlessness among the other stakeholders was also deemed interesting. The plausibility of a potential power shift was further included. The three stakeholder groups considered to be obstacles were probed further by asking why they could be seen as obstacles.

7.3.1.2 Scenario building

Based on the literature review, the case study findings and the results of round 1, a scenario cross was developed (according to the guidelines of Lindgren & Bandhold (2009), see section *3.2.1 Foresight studies* for a recollection of theory on scenario building). In line with Schwartz (1996), the process started with identification of driving forces that might shape the different trajectories that the market could potentially follow. The scenarios were then explained in a narrative fashion.

One aspect that was perceived to be crucial in the first round of the questionnaire was the driving force of *financial benefits*. This was ranked highly for all the private and especially for-profit stakeholders. A *sustainable profile* was also judged important. That can indirectly function as an important creator of business value, as can *environmental awareness*. Despite *financial incentives* providing a driving force, the actual financial benefits of current solar technologies are influenced by aspects such as fluctuating electricity prices, technological development and available infrastructure and remain difficult to quantify (Sivaram, 2018). The relative financial benefits of solar is also different for different stakeholders, where for example DSOs are subject to regulations in terms of revenue cap and connection and balance obligations.

Round 1 also showed that *environmental concerns* was ranked quite differently for different stakeholders. The non-profit driven actors (private customers, regulators and public sector customers, along with some real estate companies) were seen as driven by *environmental concerns*, as well as by a *sustainable profile*. In the case of regulators, the perception of what *environmental concerns* actually imply in terms of a regulatory framework presented some uncertainties. A long-term stable regulatory framework was in both the literature review and the case study identified as having great importance in the development of the market.

These two aspects involved large uncertainties, but also provided the possibility to create distinct scenarios, as seen in figure 7.8.

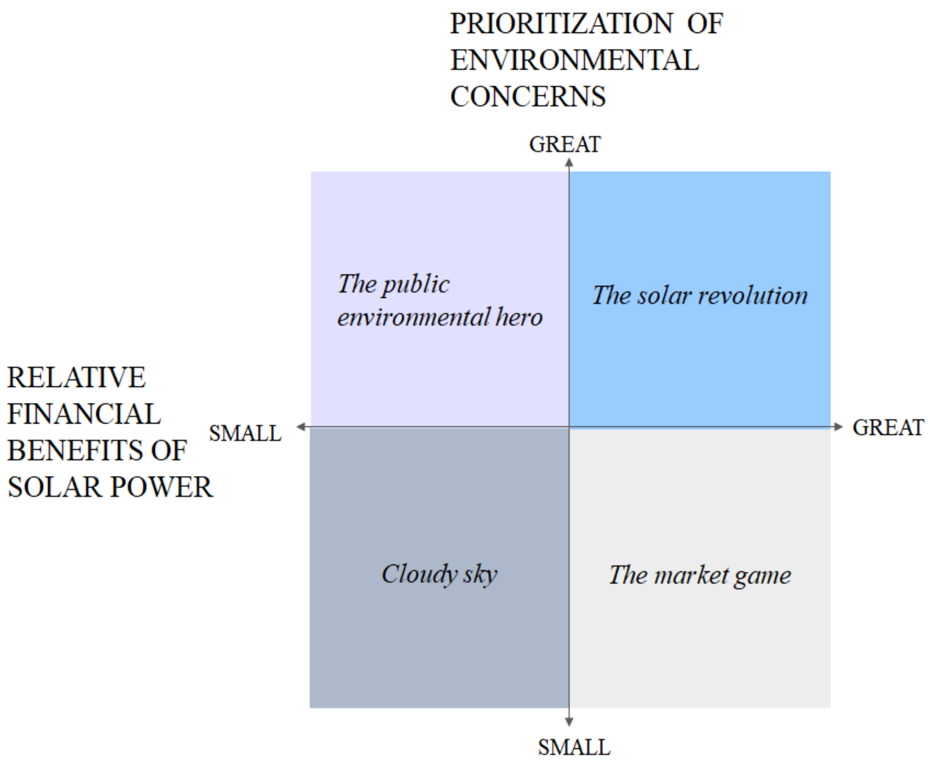

Figure 7.8. Scenario cross for the scenario building process.

Here, the X-axis represents relative financial benefits of solar compared to other technologies for electricity generation. Great relative financial benefits means that it is profitable to use solar power for all stakeholders on the market from a purely financial standpoint. The Y-axis depicts prioritization of environmental concerns and to what extent this influences the market development. High priority of environmental concerns (foremost among regulators and private customers) indicates clear and stable decisions for sustainable development on a long-term with an ambitious regulatory framework that enables investments in infrastructure for more solar power in the grid. Great or small influence of the two axes created the four different scenarios that are defined below.

Scenario 1: Cloudy sky

- Lack of relative financial benefits of solar power.
- Environmental concerns are lowly prioritized among decision makers and customers.
- The development of the market for solar power has stalled, and solar remains an insignificant part of the Swedish energy mix.
- The few users of solar power that do exist are to a large extent driven by philanthropy.

The "solar power boom" that many people thought was just around the corner has not yet occurred, and solar represents only 1 % of the Swedish electricity consumption. Some blame the uncertain regulatory framework, while others claim it is due to that the environment and climate change issue has fallen out of the political spotlight. The solar power in production originates from small facilities, and among private customers solar power is mostly something for enthusiasts interested in technology and the environment. The lack of relative financial benefits has led to a stall in market development, and despite solar technologies remaining cheap since the large price drop in the beginning of the 21th century, the financial outcome still presents some shortcomings.

Scenario 2: The public environmental hero

- Environmental concerns are highly prioritized among decision makers and customers.
- Relative financial benefits of solar power are small.
- Regulators, public sector and private customers dominate the market development.
- The regulatory framework benefitting renewable energy is ambitious and long-term stable.
- Private customers influence the public opinion through consumer power.
- Desire for self-sufficiency is experiencing a positive trend.

After the US declared its exit out of the Paris Agreement, the rest of the world has done its best to limit global climate change. The Swedish government has placed large emphasis on ambitious policies promoting renewable energy. This sends clear signals to all market actors to steer activities towards sustainable infrastructure, where for example changes in revenue cap and other legislation benefit sustainable investments from all stakeholders. Environmental concerns are at the top of the public agenda. Although small-scale off-grid solutions are also growing, thanks to a widespread desire towards self-sufficiency, there are other renewable energy solutions, such as wind power, that really grow on the Swedish market.

Scenario 3: The market game

- Great relative financial benefits for solar power.
- Environmental concerns are neglected by regulators and customers in favor of other issues.
- The regulatory environment is characterized by large insecurities and instability.
- Commercial actors drive the market development, while new stakeholders enter the market.

Disruptive innovation leads to an extreme price decrease for solar compared to other energy sources. The business of solar power can now sustain itself without heavy policy instruments, and the commercial actors of the market are active in the transformation towards a partly solar driven Sweden. Despite the thriving market, the politicians are lagging behind, with unreliable and fluctuating policy instruments, where DSOs, real estate companies and other actors still lack a stable, long-term regulatory framework to rely on in order to invest in solar power on a large scale.

Scenario 4: The solar revolution

- Great financial benefits of solar power compared to other energy sources.
- Environmental concerns are highly prioritized among regulators and customers.
- The market for solar power has exploded.
- Both companies and regulators are investing in technical development and infrastructure.
- Solar stands for a considerable share of the Swedish energy mix.
- The growth of storage systems is large, and the flexibility in the grid is increasing.

Roofs and walls of many buildings are covered in solar power solutions. On the countryside, land has been dedicated to solar farms. Technology has developed quickly due to a combination of relative financial benefits and an ambitious and stable policy regime. In line with the explosive development, balancing and storage systems such as batteries have improved over the recent years. The electrification of industries and the transport sector makes Sweden a prominent leader of a sustainable society.

The presentation of the four scenarios was followed by questions on what specific actors could be perceived as enablers of, or obstacles to, each scenario, along with questions regarding potential power shifts and changes of roles. The participants were also asked to rank the four scenarios in terms of plausibility, both in a near and a more distant time frame. The year 2026 was chosen as the breaking point, considering that 2023-2026 was identified as an interesting period of change in round 1. The questionnaire of round 2 can be found in appendix A.2.

7.3.2 Findings round 2

In total, 32 out of the 42 experts that participated in round 1 responded to round 2, representing a response rate of 76 %. Answers were analyzed both generally for all respondents and separately for the four expert panels, using Microsoft Excel. The comments were analyzed qualitatively by clustering and identifying similarities that could indicate opinions shared by several respondents.

7.3.2.1 Quantitative analysis

Elements of feedback

The first section of the questionnaire presented the summary of round 1, and asked if the respondents agreed with the findings. Out of the sample, 91 % (29) agreed with the synthesis. The three respondents that did not agree stated the reasons: (1) the period 2023-2026 was too far away in time, (2) the regulators were not as prominent as stated and (3) that the driving force of *self-sufficiency* was not seen as becoming more important in the future.

Desire for self-sufficiency

In the case of private customers and the driving force of desire for *self-sufficiency*, the respondents did not have a coherent opinion on its importance for shaping the development of the market for solar power in Sweden. While 63 % (20), thought that it was indeed an important driving force, the remaining 38 % (12) did not consider it important for the market development. See figure 7.9 for a depiction of the distribution.

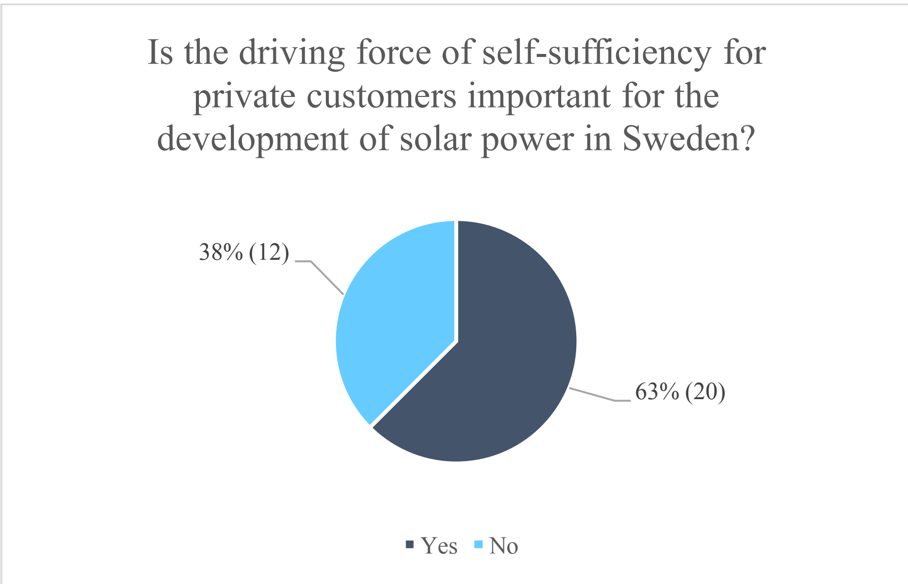

Figure 7.9. Respondent's answers for the question of self-sufficiency being an important driving force for more solar power in the grid.

In the subsequent question, concerning whether greater importance of self-sufficiency for private customers consequently meant a market with more small-scale, personalized solutions, 29 respondents (91 %) agreed with this being the case. Distribution can be found in figure 7.10.

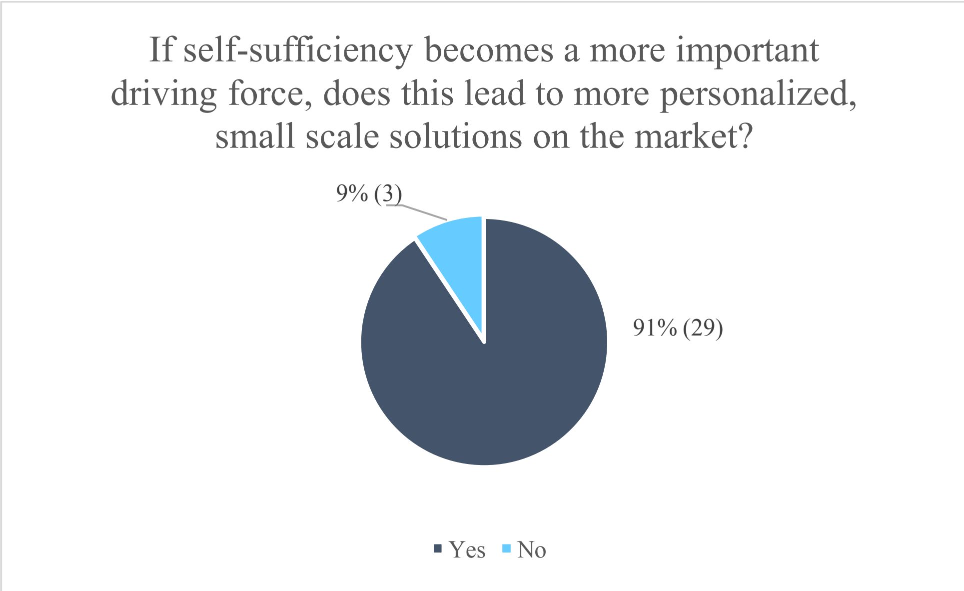

Figure 7.10. Respondent's answers for the question of self-sufficiency resulting in more personalized, small-scale solutions on the market.

Power and obstacles

In line with the general perception identified in round 1 of regulators having the most power in the stakeholder network, the questionnaire of round 2 asked what the most vital part of this power consisted of. The creation of financial incentives, i.e. making it profitable to produce and consume solar based electricity through grants and other economic policies, was seen as the key element of power to influence the development of more solar in the grid (69 %). Figure 7.11 depicts the distribution of answers. Legally binding legislation received 4 votes. Two of the participants choosing "other" stated that two or all three alternatives were vital, while the rest highlighted that long-term stability, energy taxation or simplification of current legislation was the key element of power possessed by regulators.

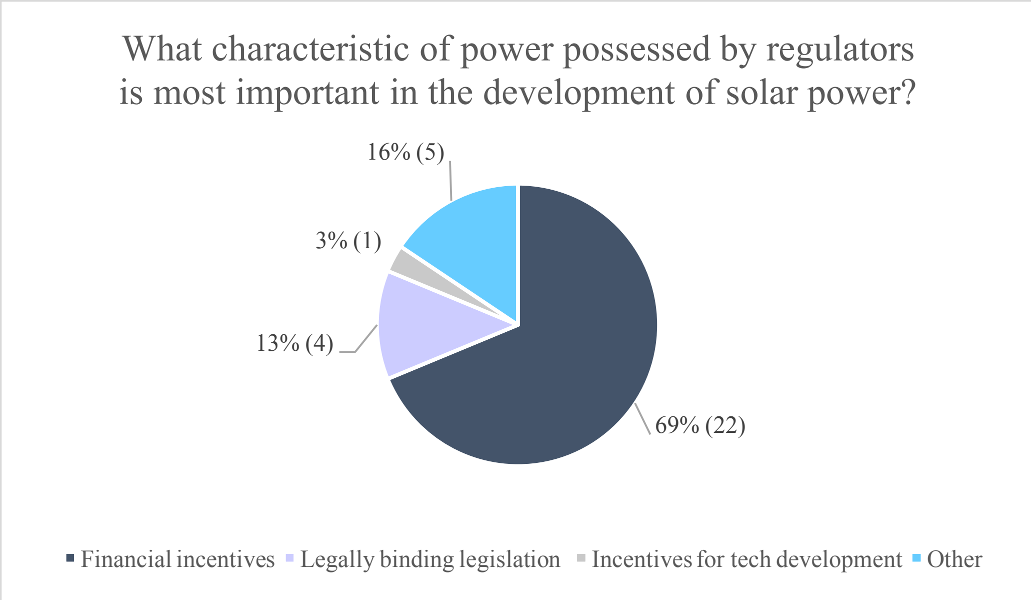

Figure 7.11. Distribution of answers regarding what factor of power was considered the most important among regulators for increased levels of solar power in the grid.

Continuing on the theme of power possessed by regulators, the following question focused on powerlessness, asking whether this was a feeling experienced by other stakeholders. A majority, 75 % (24), answered no, but a few commented that the answer was both yes and no and that it varied among the different stakeholder groups. Distribution of answers can be found in figure 7.12.

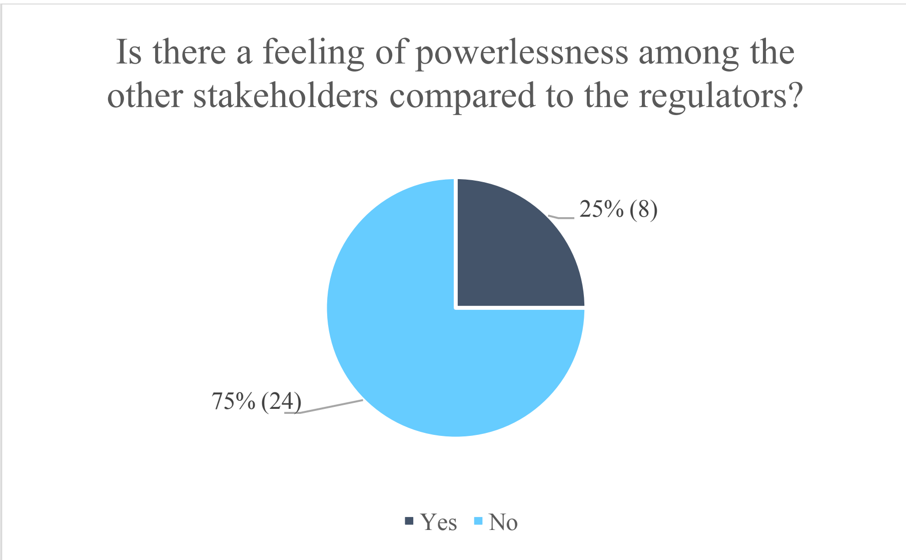

Figure 7.12. Respondents' answers for the question concerning powerlessness among the market actors (except regulators).

When looking at the responses separated per panel, some particulars were noticeable. The findings showed discrepancy in the perception of powerlessness, with the two groups *internal* and *external knowledgeable* displaying higher fractions of experts agreeing with the existence of a sense of powerlessness compared to the panels *regulators/institutions* and *academia. Academia* and *regulators/institutions* disagreed to 100 % (7) and 92 % (11) respectively. In the panels *internal* and *external knowledgeable* only 50 % (3) and 43 % (3) disagreed, while the remaining 50 % and 57 %

thought that there was in fact a feeling of powerlessness present among market actors. When considering these panels together, 95% of *academia* and *regulators/institutions* did not recognize a general feeling of powerlessness, while *internal* and *external knowledgeable* had 54 % agreeing with the existence of such a feeling.

The questions of powerlessness were followed by the idea of a potential power shift from public to private market actors on the electricity market. Here, a majority of the respondents (63 %, 20 people) were of the opinion that power is being redistributed from public to private actors. The remaining 12 experts did not agree, as seen in figure 7.13.

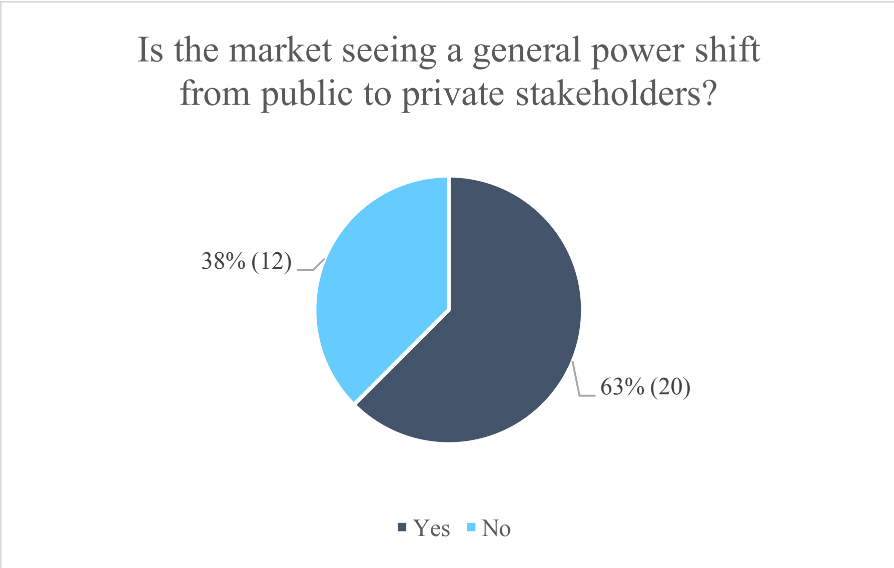

Figure 7.13. Respondents' answers to the question regarding a potential power shift from public to private stakeholders.

When looking at the answers divided between the different expert panels, half of the respondents in *regulators/institutions* did not believe in a power shift (50 % or 6 individuals), while *external knowledgeable* had a strong majority of 86 % (6) believing in a transformation of the power division among the stakeholders. As in the case of perceived powerlessness, a few commented that the answer was both yes and no and that it was difficult to provide a clear response.

Building on the previous questions and discussions on which stakeholders could be seen as obstacles, round 2 intended to define the reasons behind these actors being regarded as holding back the development. The answers were scattered, but with a trend (38 %) towards highlighting "complicated bureaucracy". Having a "central role on the market" was also a relative often recurring answer (28 %). Answers are displayed in figure 7.14. The participants selecting "other" sighted a difficulty in characterising the main factor hindering the development due to differences between the three stakeholder groups.

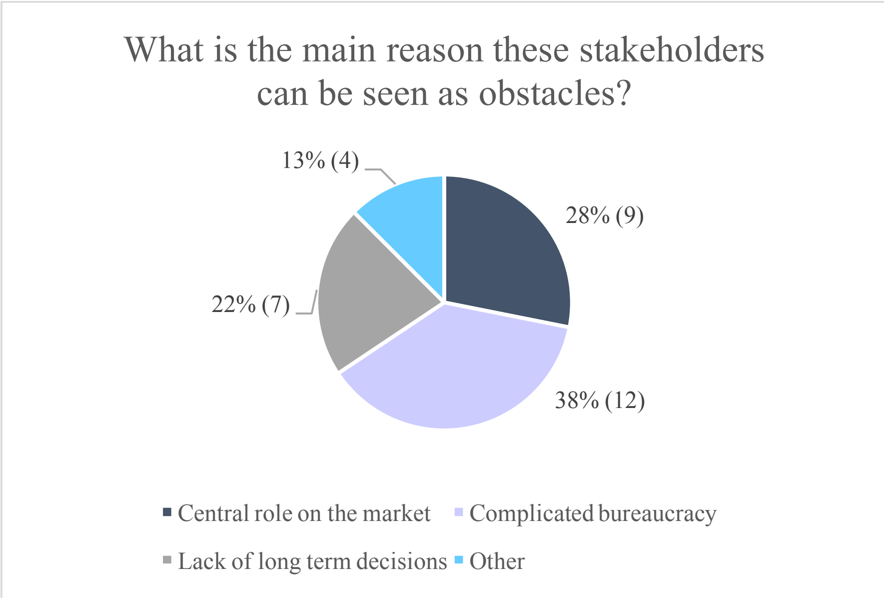

Figure 7.14. Distribution of answers regarding reasons for perceiving of stakeholders as obstacles for the development of solar based electricity in Sweden.

Future scenarios

In the second part of round 2 the scenario cross, with its four distinct scenarios, was presented. Alluding to the first scenario, "Cloudy sky", the questionnaire asked whether this scenario represented a plausible future, given that the current policy decisions, financial benefits and infrastructure stay in place. The distribution is displayed in figure 7.15 and shows a general disbelief in the plausibility of the scenario.

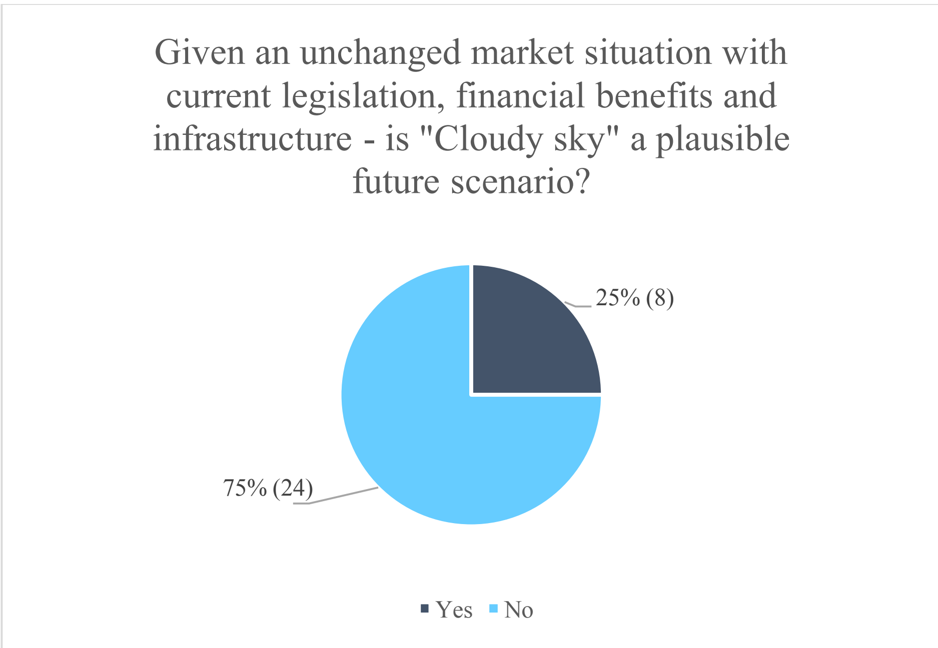

Figure 7.15. Distribution of answers regarding the plausibility of the future scenario "Cloudy sky" given current regulatory framework, financial benefits and infrastructure.

The second scenario being presented was "The public environmental hero". Here, follow-up questions focused on which stakeholders could be potential enablers and obstacles for the realization of this specific scenario. The respondents could select any number of stakeholders, as well as the alternative that no stakeholder was an enabler/obstacle.

The spread of the answers for enablers and obstacles can be found in figure 7.16. For “The public environmental hero”, 20 respondents pointed out regulators as enablers. The other six stakeholders were mentioned as enablers in a range 11 to 5 times. Three respondents saw no stakeholder as a specific enabler of this scenario. Regulators were also considered to be potentially holding back the realization of the scenario of “The public environmental hero”, in a range of 17 to 10 respondents each, together with DSOs and power suppliers. 7 people saw no stakeholder as potentially holding back the development towards the scenario.

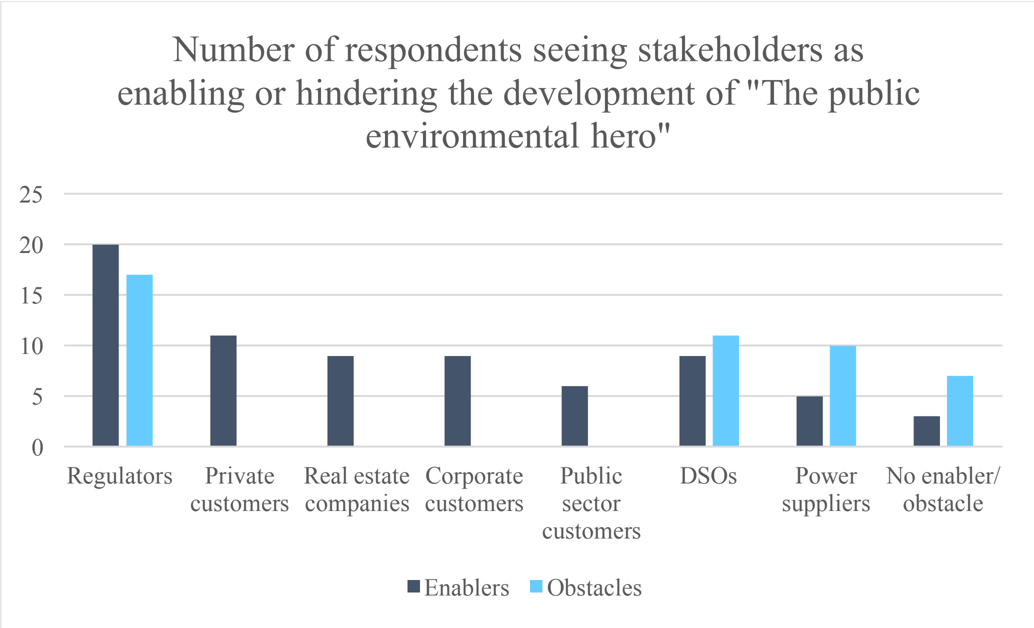

Figure 7.16. Distribution of answers regarding specific stakeholders as enablers or obstacles in the scenario “The public environmental hero”.

Following the scenario “The public environmental hero”, round 2 also asked if there was a shift in the distribution of roles and power connected to the realization of the scenario. The answers are displayed in figures 7.17. and 7.18. A majority of the respondents anticipated a change in the role distribution on the market in this scenario (63 %), while a slightly smaller majority also believed in a power shift (56 %).

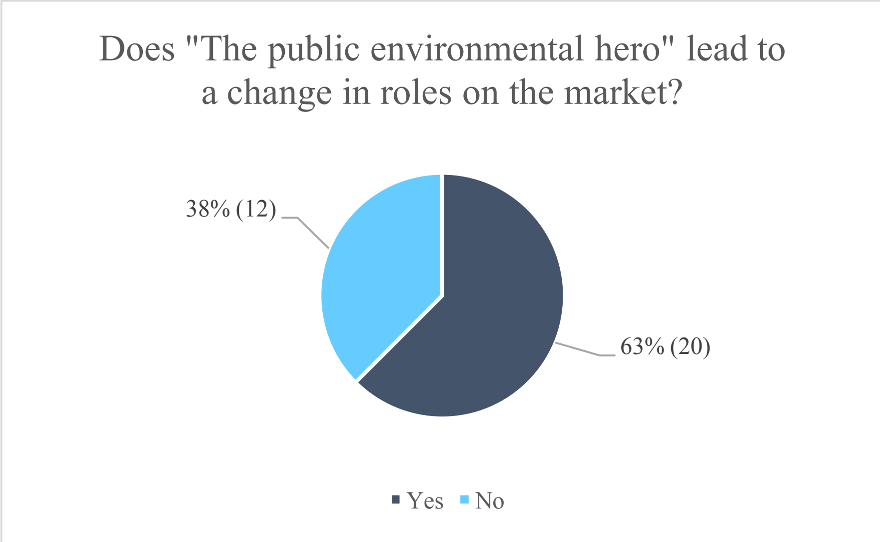

Figure 7.17 Respondents' answers for the question whether the scenario "The public environmental hero" leads to a change in the distribution of roles on the electricity market.

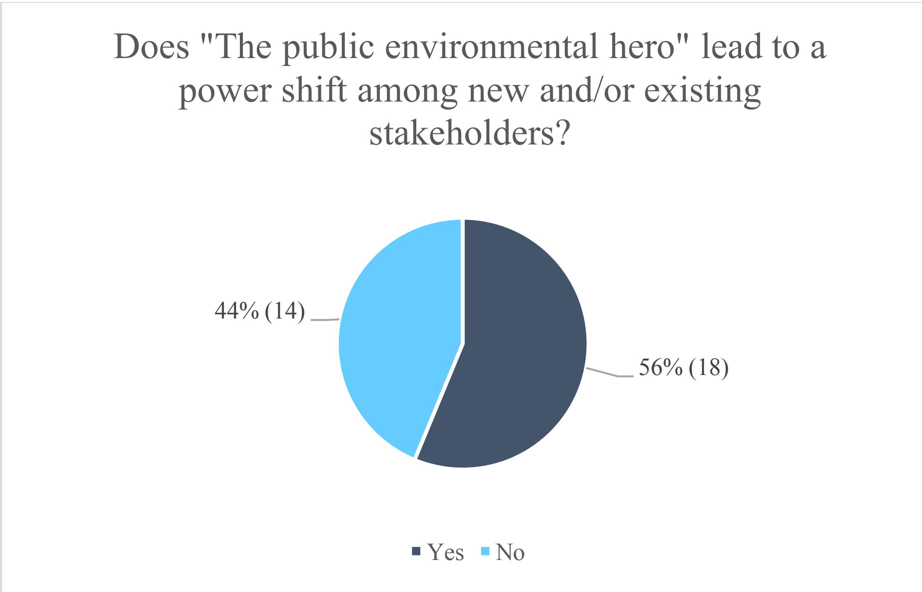

Figure 7.18. Respondents' answers for the question whether the scenario "The public environmental hero" leads to a change in power among the current and potential new stakeholders on the electricity market.

The third scenario was "The market game", with large financial benefits and small environmental concerns. As in "The public environmental hero", enablers and obstacles were asked upon. The distribution of answers can be found in figure 7.19. The perception of specific stakeholders as enablers were generally scattered among the stakeholders, ranging from 12 to 4 respondents seeing a specific stakeholder as an enabler. In the case of obstacles, 75 % of the respondents (25 people) pointed out regulators as potentially hindering the development of "The market game". Four respondents answered that no specific stakeholder functioned as an obstacle for this scenario.

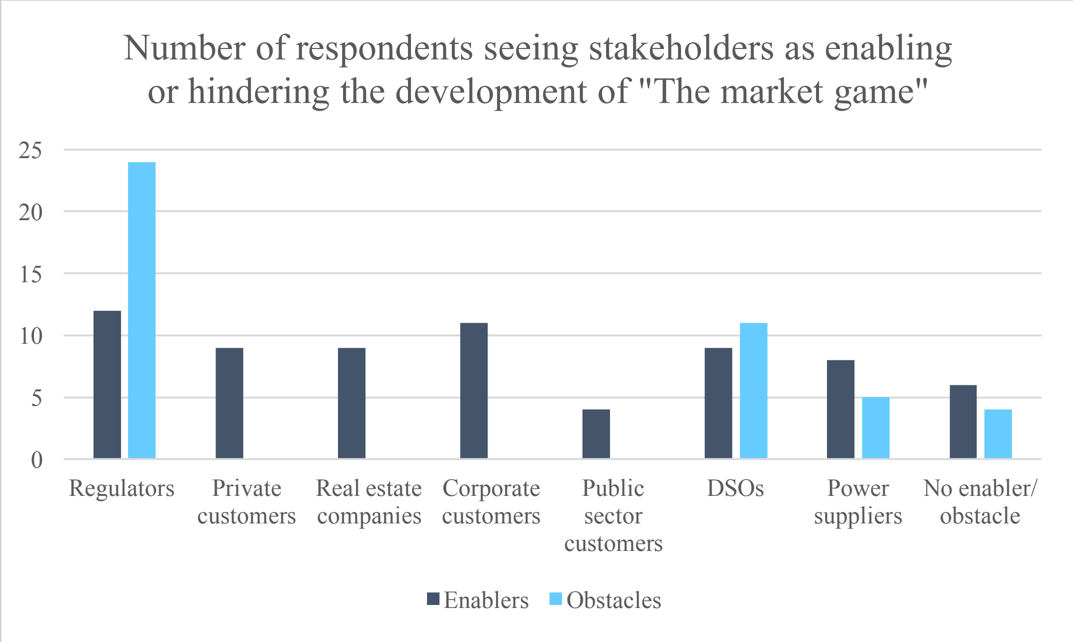

Figure 7.19. Distribution of answers regarding specific stakeholders as enablers or obstacles in the scenario "The market game".

In terms of roles, a majority (69 %) agreed that a realization of this scenario would lead to a change in the roles on the electricity market, as can be seen in figure 7.20.

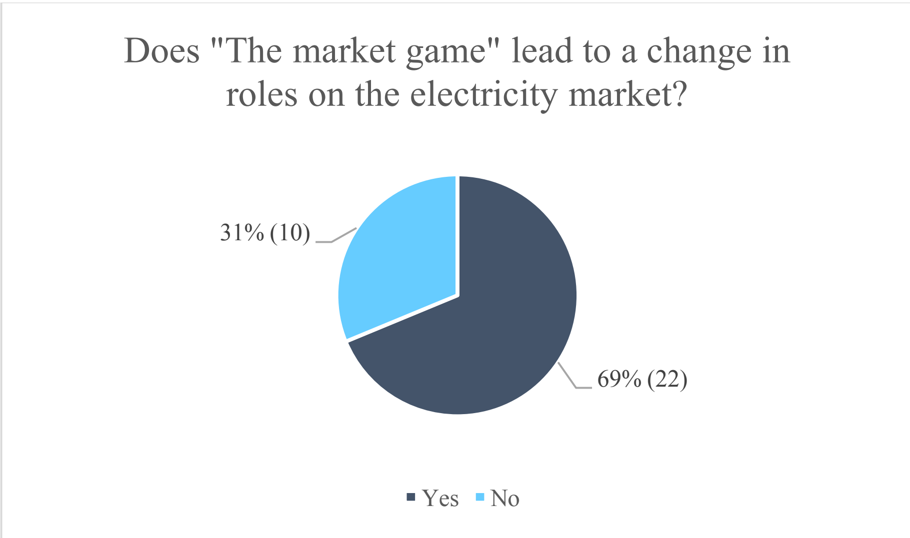

Figure 7.20. Respondents' answers for the question whether the scenario "The market game" leads to a change in the distribution of roles on the electricity market.

When looking at the findings per panel, there was some discrepancy in terms of changing roles connected with the scenario "The market game". In the panel *regulators/institutions,* only half of the respondents (6), agreed with the scenario resulting in changing roles. This stood in contrast to the other three groups, in which a strong majority did believe in a change of roles.

As for potential redistribution of power, 56 % of the complete sample answered that it would lead to a power shift towards existing or new market actors, as presented in figure 7.21.

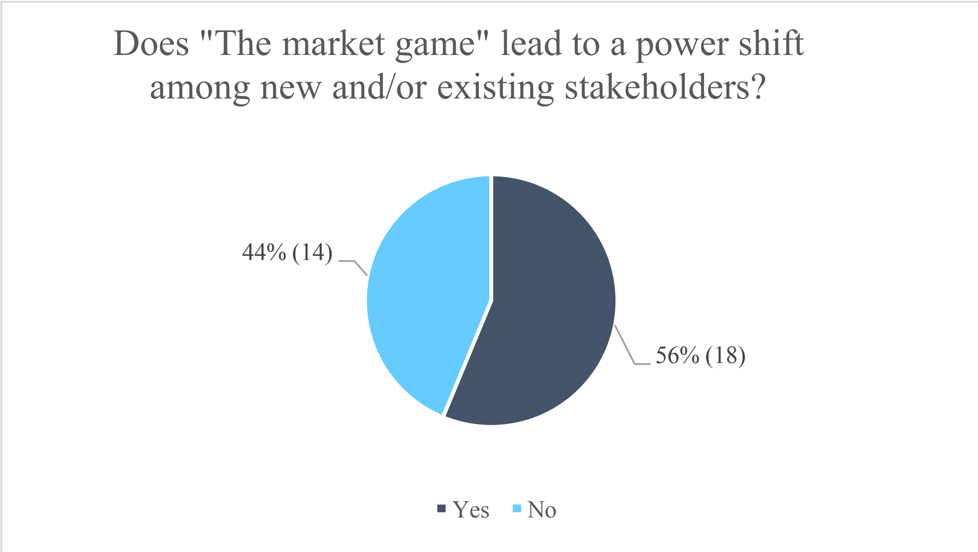

Figure 7.21. Respondents' answers for the question whether the scenario "The public environmental hero" leads to a change in power among the current and potential new stakeholders on the electricity market.

The final scenario, in which the two axes of the scenario cross were at their maximum, was "The solar revolution". The response rate for specific stakeholders as enablers were higher than in the previous scenarios; all stakeholders got between 8 and 19 responses. Five respondents saw no specific respondent as an enabler. There was further a higher rating of stakeholders potentially holding back the scenario, where the perception was that all stakeholders could potentially function as obstacles in the development. The answers are displayed in figure 7.22.

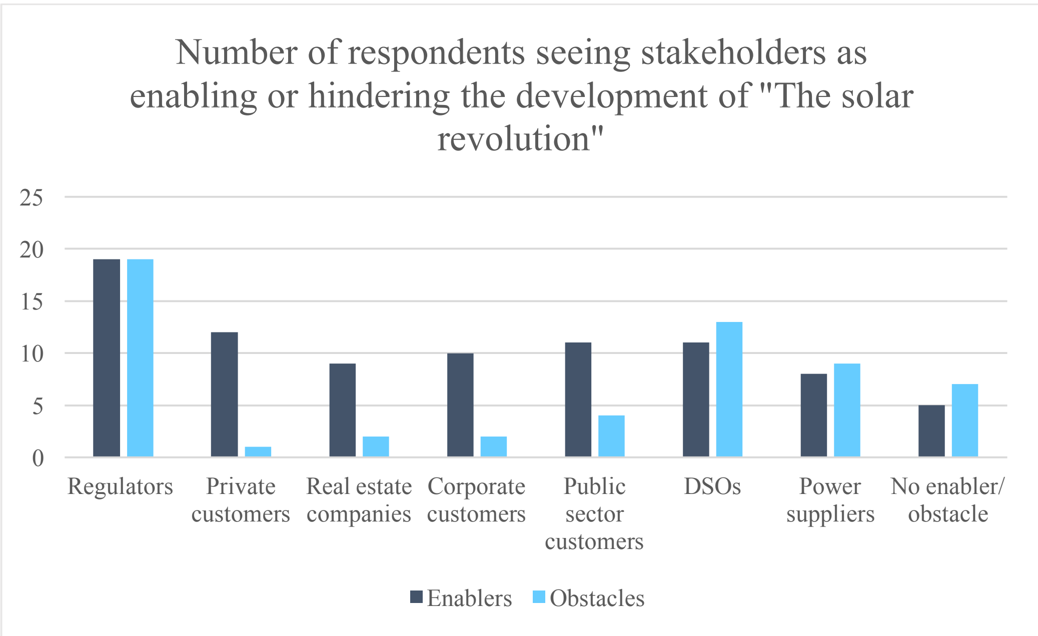

Figure 7.22. Distribution of answers regarding specific stakeholders as enablers or obstacles in the scenario "The solar revolution".

In the scenario "The solar revolution", a majority of the experts believed in a change of roles on the market, as displayed in figure 7.23. There was also a strong belief in the scenario resulting in a redistribution of power among new or existing stakeholders, with 75 % saying yes to the question of "The solar revolution" leading to a power shift. This is illustrated in figure 7.24.

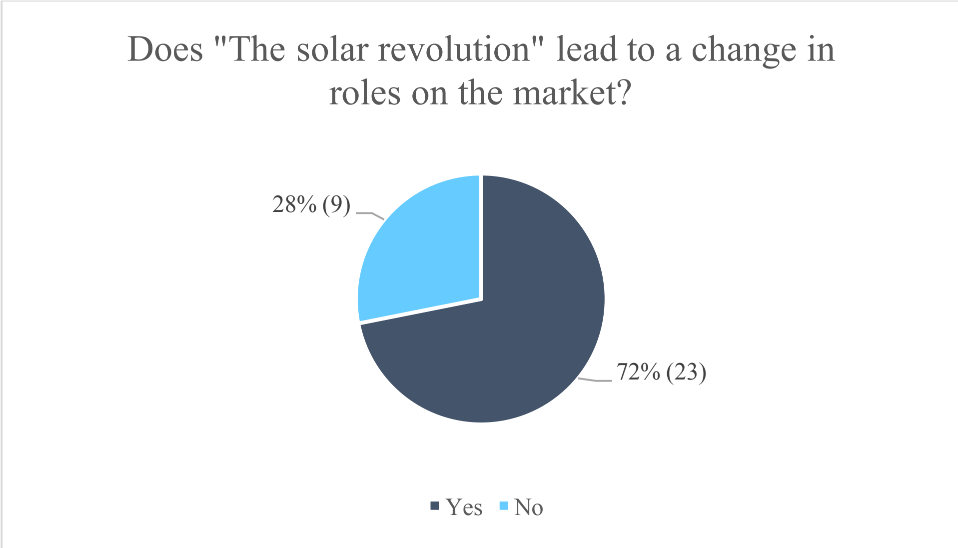

Figure 7.23. Respondents' answers for the question whether the scenario "The solar revolution" leads to a change in the distribution of roles on the electricity market.

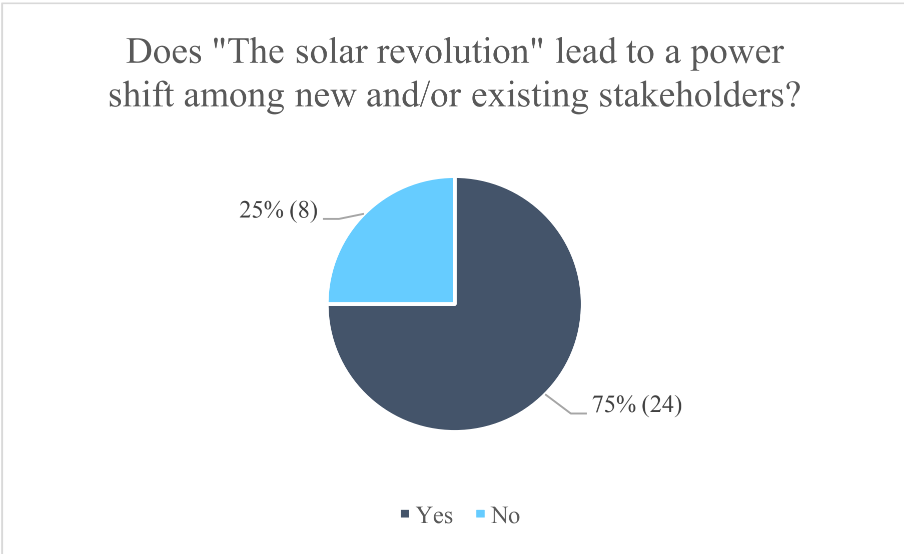

Figure 7.24. Respondents' answers for the question whether the scenario "The public environmental hero" leads to a change in power among the current and potential new stakeholders on the electricity market.

The experts were also asked to rank the probability of the scenarios occurring in two time frames, before or after 2026. The rankings conducted by the respondents both in the near time frame, before 2026, and the more distant future, after 2026, were plotted in the graphs seen in figures 7.25 and 7.26.

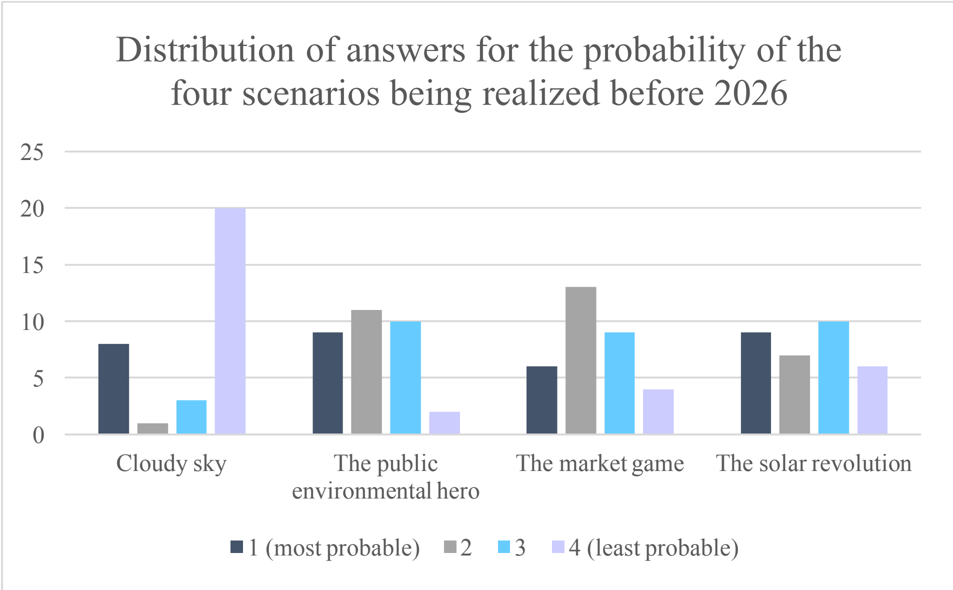

Figure 7.25. Distribution of answers when ranking the plausibility of the scenarios being realized before the year 2026 in Sweden on a decreasing scale (1 = most probable to be realized, 4 = least probable to be realized).

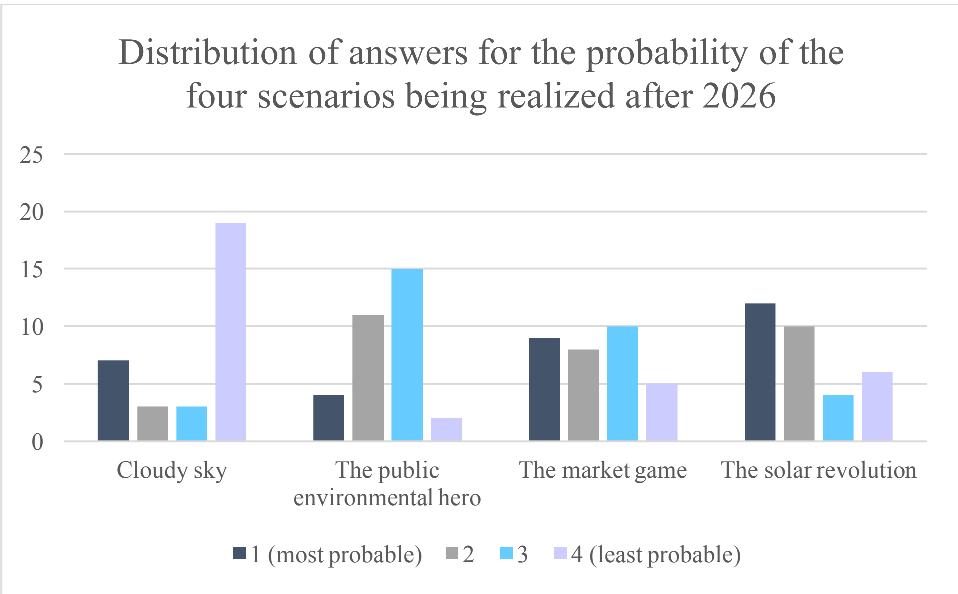

Figure 7.26. Distribution of answers when ranking the plausibility of the scenarios being realized after the year 2026 in Sweden on a decreasing scale (1 = most probable to be realized, 4 = least probable to be realized).

Similar to the procedures of round 1, analysis of the plausibility of the scenarios being realized was done using a point-based rating system. A ranking of 1 resulted in 2 points, rank 2 in 1 points, rank 3 in -1 points and rank 4 gave -2 points. These points were then added up for all four scenarios for the two time horizons before and after 2026. The resulting points can be found in table 7.4.

Table 7.4. Total rating of the probability of the different scenarios to be realized before and after 2026 (2 to -2 points, decreasing scale).

	"Cloudy sky"	"The public environmental hero"	"The market game"	"The solar revolution"
Before 2026	-26	15	8	3
After 2026	-24	0	6	18

In both the shorter and longer time perspective, "Cloudy sky" got the lowest total score, with -26 and -24 points respectively. "The public environmental hero" received the highest score in the near time frame (15), whereas "The solar revolution" scored highest in the long-term perspective (18).

Looking at the experts answers individually, the tendency was to rank the plausibility of the scenarios to be realized in the same way, especially for the scenario considered least probable and most probable to be realized. If "Cloudy sky" was ranked as least probable to be realized in the near time frame, then it was given the same rank for the distant time frame (and vice versa), with more variations in the two scenarios ranked second and third.

Continuing on the ranking of the scenarios, the questionnaire asked the respondents to which extent they believed in a change of roles in the four different scenarios. Frequency distributions can be found in figure 7.27. The tendency found in the distribution of answers was the ranking of "The solar revolution" seeing the biggest change in roles on the market, followed by "The market game", "The public environmental hero" and finally "Cloudy sky" seeing the least change in roles.

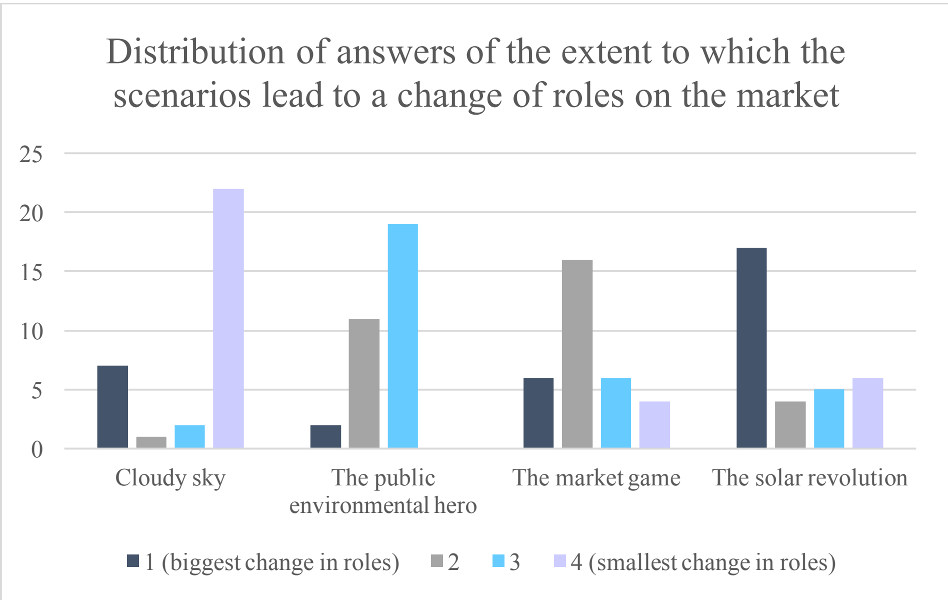

Figure 7.27. Distribution of answers when ranking the perceived change in roles within the four different scenarios compared to the current market (1 = biggest change in roles, 4 = smallest change in roles).

A point-based rating system was further applied for the changes in roles for the different scenarios, to display in which scenario the respondents saw biggest changes in roles compared to the current situation, with resulting points found in table 7.5.

Table 7.5. Total rating of the perceived change in roles for the different scenarios (2 to - 2 points, decreasing scale).

	"Cloudy sky"	"The public environmental hero"	"The market game"	"The solar revolution"
Change of roles	-31	-4	14	21

The ranking was consistent with the general tendency of ranking "The solar revolution" highest in terms of changing roles, followed by "The market game" and then "The public environmental hero", with "Cloudy sky" seeing the smallest role change.

Within the panels, some distinctions could be made. The panel of *regulators/institutions* had some respondents believing that "Cloudy sky", opposed to the general perception, entailed the biggest change in roles compared to the current market situation. Almost half of the respondents in this panel (42 %, 5) gave "Cloudy sky" the score of 1, biggest change in roles. The sample displayed a high discrepancy with the remaining half of the group ranking "Cloudy sky" as the scenario with the smallest change in roles.

In the ending part of the questionnaire, the respondents were asked what factor they saw as most important in enabling a so called "solar power boom" in Sweden, which is displayed in figure 7.28.

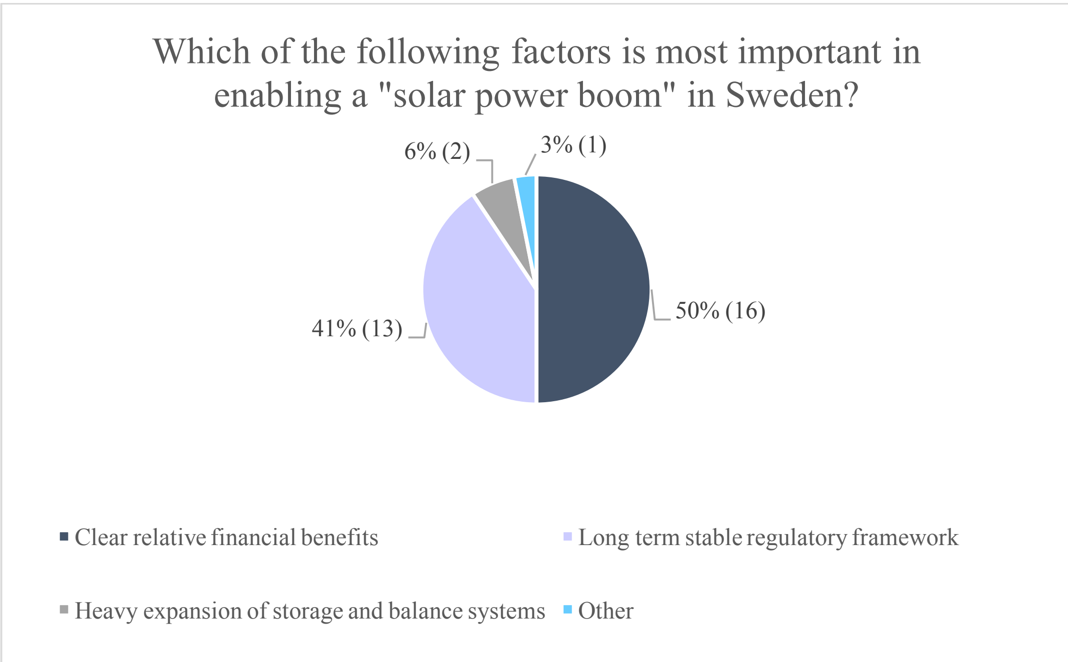

Figure 7.28 Distribution of answers regarding which factor was perceived as most important in enabling a "solar power boom" in Sweden.

Clear financial benefits for solar power compared to other technologies received 50 % of the respondents' answers. This was followed by the idea of a long-term stable regulatory framework, that 41 % believed was the most important factor. Two respondents chose a heavy expansion of storage and balance systems as the key enabler of a "solar power boom". A single respondent selected "other", proclaiming that the technical revolution would run over all factors holding back the development.

7.3.2.2 Qualitative analysis

As in the first questionnaire, the second one also provided space for comments. Since commenting was not mandatory, some questions were more frequently commented than others. The tendency for writing a comment decreased throughout the questionnaire, with more people commenting on the questions in the beginning than the end. On the first question, about whether private customers' desire for *self-sufficiency* was important for the development of solar power in Sweden, more than half of the respondents chose to comment. Two beliefs were recurring here; that the share of customers driven by a desire for *self-sufficiency* was relatively small, and that the desire for *self-sufficiency* could be connected to private customers' negative perception of both power suppliers and DSOs.

In comments connected to other questions, there was often no clear pattern in what the respondents chose to emphasize. This was for example the case when asked whether power is currently shifting from the public to the private sector. Twelve people left a comment, with diverse focus. While one person argued that the involvement of the private sector was crucial for the development of large-scale renewable electricity, another was of the opinion that the power shift has already peaked and that the market will now experience increased power for the public sector. Yet another respondent argued that the availability of new technological solutions would enhance the freedom of action for private shareholders. A fourth respondent thought the question was strangely phrased.

Regarding which characteristics of power possessed by the regulators were believed to be the most significant, the respondents could choose between *Financial incentives, Legally binding legislation* and *Incentives for technological development*, or provide his or her own answer in a separate space. Here, several respondents emphasized the importance of making it easier for customers to install solar systems, suggesting loosening of current regulations as a way of achieving this. When asked further whether a scenario would result in a power shift, involving existing or new shareholders, many comments focused on the latter, with several respondents naming aggregators and providers of new types of energy services as examples.

7.3.3 Synthesis of round 2

Out of the findings of round 2, a synthesizing summary was made in the same way as round 1.

7.3.3.1 Collective insights

The first part of round 2 presented the synthesis of round 1. In-depth questions regarding some topics found relevant in round 1 were asked. These topics were desire for self-sufficiency, power and obstacles.

1a. A total of 91 % agreed with the synthesis of round 1. The three respondents (9 %) who did not agree had individual reasons for doing this, such as being opposed to a desire for self-sufficiency becoming more important in the future.

1b. A majority of 63 % considered desire for *self-sufficiency* to be an important driving force for the development of solar in Sweden. All but three respondents, or 91 %, stated that increased importance of this force would lead to more personalized, small-scale solutions on the market.

1c. Concerning the characteristics of power possessed by regulators, *financial incentives* was considered the most important key factor by 69 % of the respondents. A majority of 75 % stated that there is no general feeling of powerlessness among any stakeholders. Looking at the different expert panels revealed nuances. While around half the experts in both *internal* and *external knowledgeable* acknowledged the existence of powerlessness (50 and 57 % respectively), almost all participants in *academia* and *regulators/institutions* did not (100 and 91 % respectively). Continuing to the issue of a power shift, 63 % out of the complete sample were of the opinion that the market is in fact experiencing a shift of power from the public to the private sector.

1d. No general consensus was reached regarding the reasons why regulators, DSOs and power suppliers were considered the most prominent obstacles, although a slight tendency towards "complicated bureaucracy" was visible (38 %). Having a "central role on the market" came in second place with 28 %, and "lack of long-term decisions came in third, with 22 %.

The second part of round 2 presented four scenarios generated from a scenario cross. These were followed by questions regarding the probability of these scenarios being realized, what stakeholders could be enablers or obstacles for the different scenarios and potential changes in role and power distribution entailed by them.

2a. Regarding the first scenario, "Cloudy sky", a majority of the respondents (75 %, or 24 people) did not believe that it was a probable scenario given current legislation, financial benefits of available solar power technologies and infrastructure.

2b. In "The public environmental hero", all seven stakeholders were pointed out by at least five respondents each as potential enablers of the realization of the scenario, with regulators being the most prominent (20). Regulators were considered a potential obstacle by 17 respondents, DSOs and power supplier*s* respectively scored 11 and 10 respondents. 7 participants did not want to name any obstacles at all. In terms of changes in roles, a majority of the experts (63 %) believed in a change if "The public environmental hero" was realized, with a slightly smaller majority (56 %) believing that the scenario also implied a power shift among existing or new market actors.

2c. For "The market game" all stakeholder were considered to be enablers, and were put forth by between four and twelve respondents each. Regulators were pointed out as a potential key obstacle in this scenario by 75 % of the experts. More respondents saw regulators as potential obstacles than as enablers. Agreeing with a change of roles was slightly more common for "The market game" than "The public environmental hero" with 69 % agreement, while it was equally common to believe in a power shift in both scenarios (56 %). When looking at the answers of the four expert panels individually, participants in the *regulators/institutions* panel had a different view of the change of roles than the other groups, with several respondents not seeing a change in roles connected to the realization of the scenario.

2d. For "The solar revolution" all stakeholders were pointed out as enablers in the realization of the scenario, ranging between 8 and 19 respondents identifying each stakeholder group as an enabler. All stakeholders were also mentioned as potential obstacles, with regulators being the most prominent, followed by DSOs and power suppliers. A majority expressed a belief in both a change in roles and a power shift connected with the scenario, with 72 and 75 % respectively.

2e. In ranking the probability of the four scenarios, "The public environmental hero" was seen as the most probable to be realized before 2026, while "The solar revolution" was ranked highest after 2026. "Cloudy sky" was deemed least probable in both time perspectives, but was subject to dispersion with some respondents also believing it to be the least probable. The respondents were quite consistent in their ranking of the scenarios in both time perspectives, especially if choosing "Cloudy sky" or "The solar revolution" as the most or least probable scenario. When ranking change in roles among the four scenarios, the responses were consistent with the questions following each scenario with most respondents agreeing to a change of roles in "The solar revolution", followed by "The market game", "The pubic environmental hero" and finally "Cloudy sky".

3a. Regarding what factor was the most crucial for a "solar power boom" in Sweden, *financial benefits* relative to other technologies and a *stable regulatory framework* were the two most prominent, with 50 and 41 % respectively.

7.4 Analysis of survey

7.4.1 General findings

In total, 42 of the invited experts responded to the first round of questions, and 32 of these participated once again in the second round. Generally, the respondents had varied perceptions of the future of solar power in Sweden. This was reflected in both the frequency distributions of the quantitative data and the comments of qualitative nature. The analysis was mainly performed on the entire sample group, but also included some exploration of trends and tendencies within the four different panels where some differences could be observed. These differences were more prominent in round 2, likely due to round 2 consisting of more distinct questions which often required answers such as "yes" or "no". No elements of feedback from round 1 on peer-level was given used in round 2. This was both due to the ranking of driving forces being indistinct, and the general frequency distribution being similar for the four panels. The separate panels could further be considered to be on the verge of being too small to allow any general conclusions on panel level.

7.4.2 Consensus and feedback

Out of round 1, a synthesis was made and sent to the respondents as part of round 2. 29 of the 32 respondents (91 %) agreed with the statements presented. A higher response rate of round 2 would have ensured greater validity in the degree of consensus reached. The three experts that did not agree all gave an individual reason for disagreement. The summary was intentionally comprehensive and limited to one page, avoiding too many details and comments, in order to limit the attention required for this section. The purpose of this was to allow for the dedication of sufficient time to the in-depth questions and scenario building of round 2. The synthesis was also made in order to determine the areas were consensus could be reached after only one round. More rounds with more iterations of the elements of feedback could have made it possible to provide clearer consensus, although a larger number of rounds also include a risk of decreasing response rate.

7.4.3 Financial incentives and benefits

Financial benefits or incentives was one aspect identified as significant in both rounds. *Financial benefits* was a consistent driving force for all the stakeholders in round one, both today and in the future, and even more obtrusive among the commercially driven stakeholders. This was not particularly surprising considered the profit-aim of these stakeholders. The emphasis of financial aspects was further highlighted in regulators' perceived characteristics of power. The provision of financial incentives in the form of policies was considered the number one characteristic of power in the development of the solar power market. Clear relative financial benefits for solar power technologies was also deemed the key enabler of a "solar power boom" in Sweden.

7.4.4 Time horizon

A recurring finding among the responses in both rounds was that the aspect of time was difficult to assess in evaluating and determining characteristics of the future market for solar power in Sweden. The period 2023-2026 was the most commonly selected in round 1 for both changes in driving forces and shift in power, closely followed by the upcoming years between 2019 and 2022. This made 2026 a natural starting point for ranking the scenarios' plausibility in a near or distant time frame. There was a tendency to believe in the same scenario both before and after 2026, specifically if believing in either "Cloudy sky" or "The solar revolution" at each end of the scenario cross. "The solar revolution" was believed to be the most realistic after 2026, while "The public environmental hero" was deemed plausible to be realized before 2026. Some commented that it was hard to determine the time frame of the scenarios, while some respondents emphasized that they believed the market would see changes long before 2026.

7.4.5 Self-sufficiency

In the first round, *self-sufficiency* was found to be the least important of the four driving forces, for all stakeholders. For private customers it was regarded as slightly more important, but for all groups a belief in an increase in importance was visible over time. In the second round, the desire for *self-sufficiency* was further explored. A majority (although small) believed that it will be important for the development of solar in Sweden, and almost everyone thought that *self-sufficiency* gaining in importance would lead to more customized, small-scale solar solutions. The idea of decentralization implied a greater change in the market characteristics compared to a development with greater centralization, but the trends of decentralization with more small-scale solutions and increasing amounts of people going off the grid was also perceived as developing along with more centralized systems of balance and storage and increased global and European interconnectedness.

7.4.6 Obstacles and enablers

Some respondents objected to the question regarding obstacles. When asked to point out three stakeholders that could potentially be holding back the development in round 1, some stated that they could only define one or two. Four participants did not point out any stakeholder at all. In the comment spaces, several respondents shared their opinions. Even though a stakeholder is said to be positively tuned to solar, its actions may not be - knowingly or unknowingly. This idea was repeatedly applied to regulators; the government has a goal for 100 % renewable energy but regulations were by several respondents regarded as lagging. In the second round, the alternative of "no stakeholders is perceived as an obstacle" was included in the questions regarding obstacles, with some respondents selecting this alternative. The phrasing of stakeholder as obstacles and potentially hindering the development was also used as an element of provocation. This was specifically considering the positive tendency among the respondents in the idea that all stakeholders want to accomplish a "solar power boom" in Sweden, which was considered to not necessarily be the case.

Different opinions of what lies in the word "obstacle" are likely to have had impact on the results. While some only considered a stakeholder an obstacle if it acted as such based on internal factors, others were of the opinion that a stakeholder could be holding back development due to external circumstances. This was emphasized by a few respondents to be the case for the DSOs. While a specific company may include a strive for renewable energy sources in its strategy, it may still be acting as an obstacle due to prevailing legislation.

This being said, three stakeholders were found to be the most noticeable potential obstacles for the development of solar in Sweden; regulators, DSOs and power suppliers. Regulators were the most prominent, with respondents from the panel *regulators/institutions* agreeing with the view of regulators hindering market development in certain ways. Although no consensus was visible when asking upon the reasons for why these particular stakeholders were considered obstacles, "complicated bureaucracy" was the most frequently chosen alternative, followed by having a "central role" and "lacking long-term decisions". Since the question was asked for all three stakeholders at once, it is likely that this made answering it difficult. This could have been avoided by using three separate questions, possibly with customized alternatives.

Connecting to the perception of stakeholders as obstacles, the respondents were also asked upon enablers of certain scenarios. This could also be traced back as an opportunity of power, where high levels of power could create the opportunity for a stakeholder to function as an enabler in realizing a scenario. There were no obvious stakeholders recurrently seen as key enablers of the different scenarios, although regulators had the most prominent role in enabling "The public environmental hero". The two other scenarios "The market game", and "The solar revolution" saw a more equal distribution of all stakeholders as potential enablers, which goes in line with the view of a power shift, with more new stakeholders entering the market with the private, profit driven actors in center of development.

7.4.8 Probability of scenarios

In general, the tendency found among the experts was a positive belief in the future. When asked upon if "Cloudy sky" was a probable scenario with an unchanged regulatory framework, infrastructure and technology, 24 respondents (75%) said no. It was also ranked lowest in probability of occurring both in the near and more distant time frame, and some participants mentioned their belief that "The public environmental hero" depicted the current market situation. Other factors contributing to the belief in positive assurance was some mentioning the time horizon as too short, and the discussion of no stakeholders as holding up development. In the more imminent future, before 2026, "The public environmental hero" was ranked as most probable. After 2026, the highest ranked scenario among the respondents was instead "The solar revolution".

In creating distinct scenarios, the goal was to identify trends that could be seen independently from each other, with the hope of seeing a potential roadmap to the future market. The final question of what the key factor of a "solar power boom" was, also tried to put these axes against each other. The synthesis out of the ranking of the scenarios indicated a belief in "The public environmental hero" as more probable than "The market game", but the axis of relative financial benefits, that was prominent in “The market game”, was deemed slightly more important compared to a stable regulatory framework in enabling a “solar power boom”. This ought to indicate that a development in line with “The public environmental hero” is plausible in a near future, but that it is not enough in enabling a solar revolution in Sweden. The technical development, or in other terms market development that makes solar power profitable “beyond policy regulations”, is a vital element of disruptive growth, and is expected to occur at a breaking point sometime between 2023 and 2026. A technical disruption could also be seen as a characteristic of the development worldwide. This is despite the fact that financial benefits can be motivated as originating from both technical development and from policy regulations, or a combination of the two.

7.4.9 Change of roles and power shift

The results from the Delphi study showed a general belief in changes concerning both roles and power on the future market for solar power. In the scenario that was intended to be most distinct from the present situation, “The solar revolution”, the ranking turned out accordingly, with a stronger belief in a power shift compared to the other scenarios. This was also the scenario for which most respondents foresaw a change in the distribution of roles. More solar power in the grid is expected to result in a greater change in roles. In second place, both regarding changes in roles and in power, came the “The market game”. Both “The market game” and “The solar revolution” entailed disruption in the financial profitability of solar power technologies, which could possibly result in many new stakeholders entering the market due to large opportunities.

A slight majority of the respondents (63 %) believed in a shift of power from the public to the private sector which could be connected to the growth of a more decentralized electricity market. When decentralization is becoming more common it is likely that the number of smaller actors, such as tech startups, will increase. With increased levels of solar power in the grid, “The solar revolution” also brought about new solutions for storage and balance. Considering that these are considered necessities for coping with the characteristics of solar, the implications of new roles could also be perceived as relating to this transformation. Roles in terms of activities and relationships in the stakeholder network could thereby be transferred to both new and existing actors. Aggregators was the most prominent new actor that was found in both rounds, but which actors and what roles could appear in a future scenario could be explored further.

7.4.10 Comment sections

The respondents’ comments were, as previously mentioned, qualitatively analyzed. The comment spaces were used to emphasize and elaborate on answers, to express opinions regarding both the development of the market and of the contents of the questionnaire, and to provide criticism. Through clustering the comments were grouped together, and themes were identified. Due to the rather small sample it was common that a cluster was made up of comments from 3 to 6 people. Several people commented on the electricity market and existing challenges in general, and many issues were only brought up by one or two individuals. To not give unproportionate weight to thoughts that were actually only expressed by very few people, the comments were not included in the collective insights of round 1.

8 DISCUSSION

This chapter presents the discussion of the project. The findings of each of the chapters 4 to 7 and their connections to the research questions of this report are discussed. These findings are also integrated in a general evaluation of answering the research questions.

8.1 Contributions of findings

8.1.1 Chapter 4 Setting the context: The electricity market

The fourth chapter of this research paper provided information on the Swedish electricity market and the characteristics of solar power. It also provided an exploratory overview of research covering stakeholder mapping and foresight studies on energy and electricity markets. The current regulatory framework relating to solar power in Sweden was found to be ambitious, with strong policy instruments aimed at foremost making it valuable for customers of all segments to use solar power. The legislation was also found to be complicated. Other stakeholders in the system - one being the DSO - was found to, to some extent, be held back by these legal boundaries.

The specific properties of on-grid solar power in terms of new requirements and demands on the grid was found to be a vital element of the market development. Solar power, mainly being small-scale and with high fluctuance in electricity production, places higher demands on new infrastructure of the national grid. Solutions in terms of increased flexibility, storage systems and increased interconnectedness between regions are factors that by many have been pointed out as becoming increasingly important if solar is to actually contribute to the Swedish energy mix.

8.1.2 Chapter 5 Case study

In the case study, the situation of the specific DSO was highlighted. The DSO was considered a central player in the area of on-grid solar power, with an ambitious strategy towards becoming completely renewable. Challenges in creating a sustainable business model relating to solar were however discovered, much of it connected to legislation, such as that regarding natural monopolies and unbundling. Building on this, the strategy of the company emphasized a greater orientation towards being "customer-centered", with many new collaborations with a range of stakeholders presented as an element of this. Internal collaborations were restricted by the rule of unbundling, but more collaboration among the subdivisions of the company ought to be both possible, and probably valuable. A range of key stakeholders were found to be forming the stakeholder network of the DSO. All were considered to influence the market of solar based electricity, with new ones potentially emerging as the market changes.

The identification and grouping of stakeholders in both chapter 5 and 6 could be conducted in a broader or narrower sense, and presented some challenges in the distinction of what a stakeholder actually was. Several examples found in literature were limited to only a few "stakeholder groups" such as public sector/private sector. The clustering of stakeholders was open to many interpretations, with stakeholder groups sharing common characteristics in some areas but in terms of e.g size, profitability focus or other underlying driving forces could be perceived as too heterogeneous. The aim of the case study was to identify stakeholders with direct connection to the DSO at hand, that could be captured through different driving forces. To enable a comprehensive analysis, it was important to not move forward with too many stakeholders.

8.1.3 Chapter 6 From case to market

Chapter 6 captured general stakeholder identification, drivers of change, framework settings and mega trends relating to the area of solar power. In general, the market was found to be imprinted by uncertainties, with a large number of different trends identified in literature. Some trends that at first seemed to be representing opposite directions of development, were found to not necessarily do so. This was the case with decentralization and increased interconnectedness, two trends that actually are likely to develop in parallel. Regions are expected to become more interconnected through investment in transmission grids, but at the same time, decentralization and small-scale development with more customers going “off the grid” and regions becoming self-sufficient, was also a plausible development. Despite the different opinions concerning the price development for electricity, there is a trend of increasing variation with the intermittent characteristics of solar power and renewable energy in general. Therefore, both these trends can be ways of hedging for the fluctuant characteristics of renewables.

The themes identified in the literature review could be boiled down to four framework conditions that together formed the setting of the market, capturing the influences of the market. The broad scope of the factors was a way of being deliberately inclusive and of capturing what was considered vital in examining the stakeholder network on the market. Many underlying forces were found to be potentially driving the actions of the stakeholders. The four intrinsic driving forces, which importance were investigated further, were identified in the context of solar power, but can to some extent be applicable for the overall electricity market.

8.1.4 Chapter 7 Survey

Chapter 7 of this thesis project treated the two-round Delphi study applied in the context of solar power in Sweden. Much of the findings from the previous chapters were validated through the survey, with driving forces of importance and some stakeholders as holding back or enabling development due to current situation, opportunities and boundaries. In general, the chapter contributed a lot of findings, thanks to the possibility to assess a lot of areas through the questionnaires. Consensus among the experts was reached on some of the topics, while others would need a more thorough investigation with more rounds or more limited questions.

In terms of the individual panels, the findings mainly showed insignificant differences between them. Some interesting tendencies were found, however, foremost in round 2 which asked more distinct questions (often yes or no) than round 1. The perception of powerlessness among the actors was more prominent among the market-based participants (*internal* and *external knowledgeable*), and the respondents in the panel *regulators/institutions* were less inclined to believe in a powershift from public to private market actors than the other panels. Larger groups or more rounds would have provided more credibility to these findings.

8.1.5 General discussion

Several driving forces, intrinsic and external, were found to influence the roadmap to the future. The realization of the green transition of the Swedish energy system depends on many factors - both enabling and hindering factors are currently affecting the situation of the stakeholders. Major uncertainties involve long-term stable regulations for involved parties, financial incentives that make solar technologies competitive to other sources and efficient solutions for storage of electricity. The driving force of *self-sufficiency* was not perceived as influencing the stakeholders as much as financial and environmental interests. *Self-sufficiency* was highlighted in various reports in the literature review, which emphasized its importance to the growth of renewable energy due to private customers wanting to take control of their own energy supply. Despite being rated low in the Delphi study, its importance was expected to grow with time, and it is perhaps the most interesting driving force relating to solar power in particular, whilst financial and environmental considerations are more general interests on the electricity market. If it origins from a desire to disconnect from the grid, or if it is just a way of securing supply, is a dimension to consider further.

Praising of solar as the savior of the climate seems to be common among the parties of the energy sector, with few voices claiming otherwise. This was articulated in primary sources at the case study company and the main body of documentary sources in the literature review. Still, in the anonymous setting of the Delphi study, the vast majority of the respondents identified certain stakeholders as obstacles that are potentially holding back development. Complicated bureaucracy, instability in decisions and difficulties in modifying existing structures, together with the specific characteristics of solar being intermittent and small scale, make for a demanding future for the established actors on the market. Some people objected against stakeholders being obstacles, stating that no one was hindering development since all the actors involved were striving towards the “solar boom”. This can be considered a rather bold statement, and by objecting to the existence of obstacles there is also a risk of diminishing the possibility of addressing problems and challenges properly. Although solar, in the form of the ruling PV technology, is likely to be an important part of the future Swedish energy mix, it is not evident to what extent.

While it can be easy to point fingers and set hopes to individual stakeholders and their responsibilities, such as regulators and legislation, the issue of solar based electricity is very complex. It is possible that solar could keep growing in the current pace and, with time, provide a considerable chunk of the power demand. Considering the need for a quick reduction of greenhouse gas emission, and the goal of a renewable energy system by 2040 in Sweden, it is however probable that more direct action is needed to speed up the process. Since all stakeholders interplay and affect each other, directly or indirectly, it is crucial (albeit difficult) to see to the system as a whole and not limit the perspective to a single actor. Several examples have however been found of the opposite, and advocates for different directions preach their own solution. Direct policy instruments favoring certain technologies is also subject to a debate on technology neutrality. Even if a need for support instruments for solar is identified, it can be argued to be economically inefficient since its aim may be too specific, favoring only solar. Increased investment support for customers may be the wrong way to achieve more solar in the grid if it coincides with for example DSOs or electricity suppliers unintentionally holding back infrastructural investments due to regulations, or if the process of joining the system is overly complicated.

The roles of the current stakeholders are expected to change with the introduction of more solar in the Swedish grid, but in what way is still uncertain. Changing roles implies changing business models, and creating businesses that are both financially and environmentally sustainable is a challenge for some of the existing players on the market. In order to survive in the new technological paradigm, adaptations and adjustments are needed. New actors are on the rise, and integration between different industry sectors (when digitalization and technology become incorporated in various products and services) is likely to enable collaborations beyond solely the stakeholders of the energy market. To enable a bright future, such as that portrayed in "The solar revolution", deeper understanding and collaboration will be needed between various actors. While a widely spread feeling of powerlessness among market actors is likely to have negative influence over the market development, the opposite can be a prerequisite for successful collaborations.

9 CONCLUSIONS

This chapter presents the conclusions of this thesis project. First, a summary of the conclusions is presented. Then, the research questions are answered. This is followed by the project's contributions to theory and practice, along with reflections upon methodology, theory and trustworthiness. Finally, areas for future research within the field are suggested.

9.1 Summary

The purpose of this project was to examine driving forces for different stakeholders on the current Swedish market for solar power. It also aimed to study if and why the roles of different stakeholders will change over the years ahead, as well as to explore driving forces and potential scenarios on the future market. The project identified a range of stakeholders on the current market, along with both intrinsic and external driving forces that influence the development towards more solar power in the grid. It also resulted in four distinct scenarios that could depict possible pathways into the future, constructed using the two axes *relative financial benefits of solar power* and *prioritization of environmental concerns*. Different stakeholders were identified as enablers for, and obstacles of, the different pathways for development, along with other elements of vitality for more solar in the grid. The results implied that the rise of solar as a prominent energy source in Sweden is closely connected to changes in roles of the current stakeholders. In general, the study revealed a bright perception of the future of solar power in Sweden, but some changes and adaptations are needed if the market is to disrupt and solar is to become a significant part of the Swedish energy mix.

9.2 Answering the research questions

What driving forces and distribution of roles could characterize the future market for solar power in Sweden?

The general research question is considered fully met through the answering of each of the three sub-questions used in this thesis project.

9.2.1 RQ1

What stakeholders can be identified that are connected to increased levels of solar power in the Swedish distribution network?

The stakeholders identified as most prominent connected to increased levels of solar based electricity in the Swedish distribution network were the following: (1) Regulators, (2) Private customers, (3) Real estate companies, (4) Corporate customers, (5) Public sector customers, (6) Distribution system operators, and (7) Power suppliers.

9.2.2 RQ2

What drives the different stakeholders, today and in the future?

When acting in the context of more solar based electricity in the Swedish national distribution network, the identified stakeholders were found to be influenced by four central intrinsic driving forces:

- Financial benefits
- Environmental concerns
- Sustainable profile
- Self-sufficiency

The different stakeholders could be seen as operating according to these intrinsic forces to varying degree, with some similarities shared by the collective group of private actors compared to the public actors. *Financial benefits* was recurrently important, with *sustainable profile* as a key element for the private stakeholders. Regulators and private customers were regarded as valuing *environmental concerns* highly. The driving forces today were found to be similar to the future, with a general increase of all driving forces for all stakeholders with time. *Self-sufficiency* was ranked lowest out of the four, but saw the biggest increase into the future.

The identified stakeholders could further be seen as operating within a certain framework of setting conditions that influence their behavior. The identified conditions were:

- External environment
- Technology
- Institutional governance
- Market structure

The institutional setting along with the actions of regulators were commonly regarded as dominant in shaping the future market. The regulators were by the respondents considered to have the most power out of the stakeholders, by providing legislation and policies to support solar power technologies. This included creating possibilities for all stakeholders, specifically DSOs and power suppliers, to operate without holding back the development. Suitable infrastructure was also a key element in enabling the growth of solar power.

The external driving forces on the market were captured in a set of “mega trends” that shape the development of solar power. These were:

- Changing electricity needs (energy efficiency and electrification)
- Fluctuating electricity prices
- Increased technology development and digitalization
- Increased global interconnectedness
- Increased decentralization in electricity production
- Increased flexibility (usage and supply)
- Increased environmental awareness

The characteristics of solar power pave the way for a disruptive transformation of the market, specifically if self-sufficiency becomes a driving force in the development. With this, roles of stakeholders are generally expected to change. This entails new activities for the existing stakeholders, as well as the entrance of new actors. It also indicates a power shift on the market.

9.2.3 RQ3

What potential scenarios could depict the future market for solar power?
Two prominent driving forces involving uncertainties were selected for creating future scenarios for solar in Sweden in line with the scenario cross methodology: *financial benefits for solar power compared to other technologies*, and *prioritization of environmental concerns*. Relative financial benefits were crucial for all stakeholders to pursue more solar power solutions. A long-term stable regulatory framework that enables all stakeholders to operate towards increased solar power in the distribution network in a financially sustainable and simple way was also deemed vital for the realization of a so called "solar power boom" in Sweden.

Rating high or low on the two axes relative *financial benefits* and importance of *environmental concerns* produced four scenarios in the context of more solar based electricity in the distribution network: "Cloudy sky", "The public environmental hero", "The market game" and "The solar revolution", as depicted in figure 9.1.

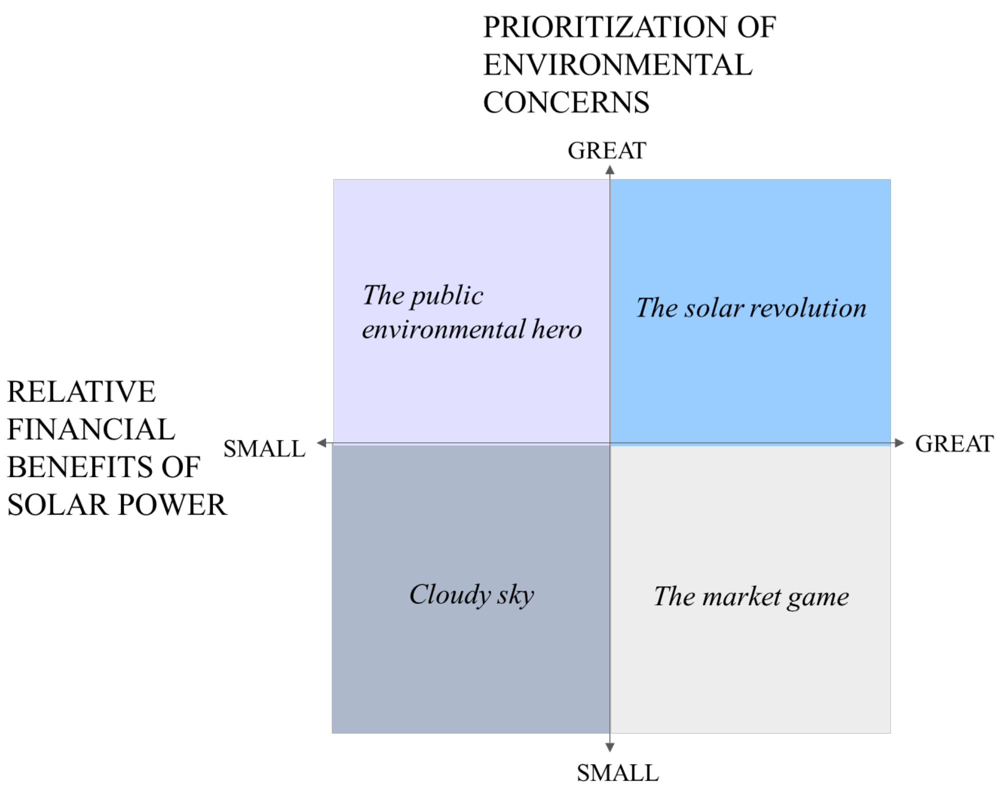

Figure 9.1 Scenario cross of the four scenarios constructed in this thesis project.

Scenario 1: Cloudy sky

- Lack of relative financial benefits of solar power.
- Environmental concerns are lowly prioritized among decision makers and customers.
- The development of the market for solar power has stalled, and solar remains an insignificant part of the Swedish energy mix.
- The few users of solar power that do exist are to a large extent driven by philanthropy.

The "solar power boom" that many people thought was just around the corner has not yet occurred, and solar represents only 1 % of the Swedish electricity consumption. Some blame the uncertain regulatory framework, while others claim it is due to that the environment and climate change issue has fallen out of the political spotlight. The solar power in production originates from small facilities, and among private customers solar power is mostly something for enthusiasts interested in technology and the environment. The lack of relative financial benefits has led to a stall in market development, and despite solar technologies remaining cheap since the large price drop in the beginning of the 21th century, the financial outcome still presents some shortcomings.

Scenario 2: The public environmental hero

- Environmental concerns are highly prioritized among decision makers and customers.
- Relative financial benefits of solar power are small.
- Regulators, public sector and private customers dominate the market development.
- The regulatory framework benefitting renewable energy is ambitious and long-term stable.
- Private customers influence the public opinion through consumer power.
- Desire for self-sufficiency is experiencing a positive trend.

After the US declared its exit out of the Paris Agreement, the rest of the world has done its best to limit global climate change. The Swedish government has placed large emphasis on ambitious policies promoting renewable energy. This sends clear signals to all market actors to steer activities towards sustainable infrastructure, where for example changes in revenue cap and other legislation benefit sustainable investments from all stakeholders. Environmental concerns are at the top of the public agenda. Although small-scale off-grid solutions are also growing, thanks to a widespread desire towards self-sufficiency, there are other renewable energy solutions, such as wind power, that really grow on the Swedish market.

Scenario 3: The market game

- Great relative financial benefits for solar power.
- Environmental concerns are neglected by regulators and customers in favor of other issues.
- The regulatory environment is characterized by large insecurities and instability.
- Commercial actors drive the market development, while new stakeholders enter the market.

Disruptive innovation leads to an extreme price decrease for solar compared to other energy sources. The business of solar power can now sustain itself without heavy policy instruments, and the commercial actors of the market are active in the transformation towards a partly solar driven Sweden. Despite the thriving market, the politicians are lagging behind, with unreliable and fluctuating policy instruments, where DSOs, real estate companies and other actors still lack a stable, long-term regulatory framework to rely on in order to invest in solar power on a large scale.

Scenario 4: The solar revolution

- Great financial benefits of solar power compared to other energy sources.
- Environmental concerns are highly prioritized among regulators and customers.
- The market for solar power has exploded.
- Both companies and regulators are investing in technical development and infrastructure.
- Solar stands for a considerable share of the Swedish energy mix.
- The growth of storage systems is large, and the flexibility in the grid is increasing.

Roofs and walls of many buildings are covered in solar power solutions. On the countryside, land has been dedicated to solar farms. Technology has developed quickly due to a combination of relative financial benefits and an ambitious and stable policy regime. In line with the explosive development, balancing and storage systems such as batteries have improved over the recent years. The electrification of industries and the transport sector makes Sweden a prominent leader of a sustainable society.

In evaluating the four scenarios, "The public environmental hero" was deemed most probable in a near time frame, before 2026, with a strong long-term policy framework for renewable energy benefitting all stakeholders, but with low relative financial benefits of solar power. After 2026, it was instead "The solar revolution" with high rating of both axes, that was most plausible out of the four scenarios.

The positive view of the experts participating in the Delphi study indicate that there is a general belief in the future of solar in Sweden. In the near time frame, an ambitious and long-term stable regulatory framework concerning renewable energy is believed to become reality, which is found to be essential for the creation of opportunities for solar power. Nonetheless, it is not until the element of relative financial benefits for solar power is established, that a true "solar power boom" can realized.

9.3 Contributions to theory and practice

The contributions of the project were twofold and consisted of the findings and results on one hand, and the specific method used on the other.

The project produced a number of tendencies, trends and projections on the future market for solar power in Sweden. Despite sources of error, the findings can be seen in light of both the current market and stakeholder network, as well as depicting some plausible pathways, enablers and obstacles in the development of the market. The report provided an overview of a range of research conducted within foresight, scenario building and Delphi applications within the specific context of electricity markets and the area of solar power. The scenario building using the scenario cross model also produced four novel and distinct scenarios illustrating pathways into the future, not found in previous research. Although the clear-cut development of the scenarios may not become realized, they can be used to prepare for the future, for example by functioning as a backdrop for discussion.

The method combination can be useful for other research projects, especially (but not limiting to) such including elements of foresight studies. By first performing a case study the researcher can build on the gained knowledge when beginning the survey building, which makes it easier to construct suitable questions concerning truly relevant topics. Thus, the number of iterative rounds needed to achieve results can be limited compared to when less resources are dedicated to the foundation of the survey. The study has also made contributions to the application of the Delphi study, by providing a thorough description of the work process. Specifically, it provides an example of how the Delphi technique can be used in connection with scenario building and the scenario cross.

9.4 Further reflections

A general reflection upon the thesis project was that foresight studies is a complex research area, and that perceptions of what are prominent characteristics of the future vary. Trends, roles and stakeholders cannot be isolated, but have to be regarded in the larger system within which the actors operate and where many different factors influence the roadmap to the future.

If one was to reexamine the area and scope of this project, other attempts of answering the research questions could have been made. A narrower scope in the Delphi study could have made it possible to conduct more rounds, potentially being able to provide more detailed feedback and arriving closer towards consensus. The questionnaires could also have been replaced with workshops or interviews, with the drawback of making it difficult to create a sample group of sufficient size. More experts, perhaps knowledgeable within the larger context of energy markets or expanding from looking at the Swedish market, could have been included in other variations of the Delphi. The scope of only exploring the market for solar power could also be discussed, considering the driving forces could in some ways be general for the overall electricity market.

9.4.1 Reflections on methodology

The study had an abductive approach and used a method combination to answer the research questions. The case study proved useful to answer question 1 and to form a strong knowledge base for the survey, while the survey provided answers for research questions 2 and 3. A literature review also provided information in answering all three questions by setting the context and recollecting findings of other studies within this specific research area. A single method approach could have given stronger reliability in one or a few aspects of the project, enabling stronger focus on a selected scope. Another method approach could for example have been to only focus on the case study and go further into the situation of the DSO. Limiting the method to the Delphi study could have been another method adaptation, even if the methodology of Delphi has been emphasized as needing a strong foundation or pre-study in creating questionnaires of high quality. Although time consuming, the method proved suitable for the holistic purpose of the project.

The case study, focusing on a specific DSO, provided valuable insights into the current market situation. It also provided a basis for the continuous research, where “more solar in the grid” functioned as a focal point. The findings of the case were based on partly primary sources, and subsequently generalized from the case to the market. The perception of power, obstacles and interest of the stakeholders was also developed from parts of the case study. The transferability of the case into the market perspective ought to be subject to some criticism. In an attempt to cope with this, the questionnaire included questions regarding whether any other stakeholders should be included in the key stakeholder network, and space for comments on the content of the survey rounds. It was also somewhat accounted for in considering the context of the study being on-grid solar power, were DSOs have a central role, but could also have been further established in a primary step if more resources had been available.

The Delphi technique entailed both benefits and difficulties. The iterative process took many different perspectives into account, which allowed for a deeper and more nuanced understanding. Gathering a sufficient number of experts willing to participate was an important step to assimilate the benefits of the Delphi technique, but also proved time consuming since a large number of people had to be identified in order to hedge for decline in answers throughout the process.

9.4.2 Reflections on theory

The theoretical framework placed large emphasis on stakeholder theory and analysis. The research area was found to be broad, with many different applications depending on its origin being management literature, R&D or social science. The description of a stakeholder followed the definition used by Freeman (2010), but distinguishing between different stakeholders was a complex task. The clustering included different types of customers, including real estate as a specific case of corporate customers. Despite this division into a range of key stakeholders, some of the types could be considered to be heterogeneous stakeholder groups, if accounting for size and interest. Stakeholder groups were unified through sharing similar activities, and the aim of the specific division was to explore what driving forces impacted the actions of each stakeholder on the market for solar power. An even more distinct definition of stakeholders could have made it clearer what drives each specific stakeholder, but was not further considered due to the limited time frame of the project.

One of the most established ways of stakeholder analysis, and specifically stakeholder mapping, was found to be the power/interest matrix. A focal firm was also the starting point of mainly all stakeholder analysis. This thesis project, however, chose to further do a generalized mapping of the stakeholder network connected to more solar power in the national grid. Power and interest were deemed vital elements in determining the development of the market, but was difficult to assess in a general way through a hands-on stakeholder mapping as presented in theory. The issues of power and interest were instead incorporated in the survey, as the axes used for the scenario building. Adding to the stakeholder analysis, ANT was used to expand from a focal firm in the center of analysis. Considering non-physical objects as “actors” was not deemed applicable for portraying the key stakeholders on the market for solar power in Sweden, but did help to capture the framework factors and the mega trends that helped identify the driving forces impacting the market development.

The theory on foresight studies gave insight in the application of the Delphi technique and qualitative scenario building, illustrating strengths and weaknesses within established theory. Available theory on the Delphi method placed large emphasis on building a strong base for the questionnaires, selection of qualified experts and on elements of feedback which were all incorporated in the utilization of the technique. The scenario cross was useful in creating four distinct, plausible scenarios, but other applications of scenario building e.g. by placing one specific stakeholder in the center of development could have been other ways of displaying the future. Much literature on scenario building illustrate how the aim of creating scenarios is not to find the most probable future, but to show tendencies that can be put under consideration today.

9.4.3 Reflections on trustworthiness

Much of the conclusions of this thesis project rely on the findings of the conducted Delphi study. In measuring the quality and validity of the results of the present Delphi study, several sources of influence need to be considered. The selection of the experts within the different segments and their response rate affected the outcome of the findings. Out of the 42 experts participating in round 1, 32 answered round 2. No respondent gave any specific reasons for not participating in round 2, making it difficult to determine whether these respondents had anything in particular in common. If they, for example, decided not to participate in round 2 due to not agreeing with the questions of round 1, it is likely that the degree of agreement with the summary of round 1 (91 %) would have been very different had they chosen to participate. The groups were further not equal in size, and the participants had varying knowledge and experience of the electricity market and the field of solar power. The allocation of membership of the groups was also subject to some ambiguity due to possible overlaps where for example previous researchers in academia currently worked in institutions or where a respondent had changed position recently. Although all calculations were performed with caution, the human factor and the mistakes it may have caused should not be ignored.

Considering the fixed-form questionnaires and the limited room for elaboration, precise and clearly phrased questions were important for the validity of the results. In light of the experts coming from diverse backgrounds, there was also a need to consider the respondents' interpretation of some phrases or definitions, for example the perception of stakeholders functioning as obstacles. All experts had knowledge and experience within solar power, and were willing to participate in the survey. This could indicate a bias in believing in the market for solar power in Sweden, thus providing positive assurance in the development of solar power in the Swedish grid. A sample which included only experts on the general energy market, might have resulted in another depiction of the future.

9.5 Suggestions for future research

During the course of this project, many potential areas were found interesting to explore but were due to limited resources left for further research. Some interesting tendencies were identified when evaluating the answers of the questionnaires separately for each expert panel. It was however not possible to generate any far-reaching conclusions based on this, due to the small group sizes. Future research could investigate the differences of the panels on a higher level, for example by inviting a greater number of experts from each group to participate or by only focusing on one group at a time. This research could, as a suggestion, focus on the issues where the discrepancy was found to be large.

The case study focused on one single DSO. Future research could focus on a different DSO, or several ones through multiple case studies, in order to validate the findings of this specific report. Capturing the perception of power and interest through a common stakeholder map, within the framework of Johnson and Scholes (1999), could been another attempt to provide a clear mapping of the stakeholders surrounding the specific DSO. Building on the insights of stakeholders as obstacles, their perceived power and force of interest ought to be able to supply further research with a foundation of a mapping of this kind.

Another research domain that could be explored, but that lies outside of the scope of this project, is what specific roles could characterize the future market. A shift in roles was identified to occur, but investigation into what it actually implies for the different stakeholders and what new business models the change may entail could provide more information on how the stakeholders can position themselves on the market. Here, a concrete mapping of the current roles and the changes both among current stakeholders and new ones emerging could complement the findings of this project.

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A APPENDIX

A.1 Questionnaire round 1

Delphistudie: Roller kring solbaserad el - omgång 1

Denna enkät är en del av ett examensarbete som utförs på avdelningen för produktionsekonomi vid Lunds tekniska högskola våren 2018.

Det talas om en "solcellsboom" i Sverige, där solenergi väntas stå inför sitt stora genombrott. Trots att detta varit på gång i flera år står solen för blott 0,09 % av den svenska elproduktionen. Hur solenergi ska bli en etablerad energiform i ett förnybart energisystem är oklart. Vår frågeställning är vilka drivkrafter som påverkar hur marknaden för solel utformas, och vilka aktörer som reellt kan påverka andelen solbaserad elektricitet i nätet.

Vi har under projektet identifierat möjliga drivkrafter som påverkar olika aktörers beteenden. Genom en Delphistudie vill vi förstå deras inverkan på andelen solbaserad el i det svenska elnätet. Med hjälp av experter på området - däribland dig själv - vill vi få en djupare förståelse för vilka av dessa drivkrafter som är mer tongivande än andra, samt hur de kan komma att påverka rollfördelningen på elmarknaden.

Som deltagare i studien svarar du på två formulär, där det andra formuläret baseras på resultaten från det första. Deltagande i båda omgångarna väntas inte ta mer än 2 x 15 min. All data från den här studien kommer att behandlas konfidentiellt och svaren hanteras endast av oss. Den färdiga rapporten kommer du att få i digitalt format i slutet av juni.

Var vänlig besvara detta formulär senast **den 28 mars**.

Vid några oklarheter eller frågor, tveka inte att höra av dig.

Tack för ditt deltagande!

Rebecka Marklund & Carolina Ramberg

Om dig
Denna information används för uppföljning till runda två.

Namn
Svar:

E-postadress
Svar:

Hur många års erfarenhet har du av energibranschen?
Svar:

Hur kunnig anser du dig vara inom energimarknaden?

Inte så kunnig 1 2 3 4 5 6 Väldigt kunnig

Hur kunnig anser du dig vara inom området för solbaserad el?

Inte så kunnig 1 2 3 4 5 6 Väldigt kunnig

Bakgrund
Ett antal aktörer (stakeholders) har identifierats som betydande för marknaden kring mer solbaserad el. Dessa är följande:

(1) regulatorer/beslutsfattare
(2) privatkunder
(3) fastighetsbolag
(4) företagskunder
(5) kunder inom offentlig sektor
(6) eldistributör/nätägare
(7) elhandelsbolag*

*Även andra aktörer anses ha betydelse, såsom exempelvis solcellsproducenter, media, miljöorganisationer och internationella marknader, men dessa anses ej ha direkt inverkan på energimarknaden och exkluderas därför i denna studie.

Dessa aktörers beteende kan sägas påverkas av en rad faktorer. De enligt oss främsta drivkrafterna i kontexten av solenergins framväxt i Sverige är:

- **Ekonomiska incitament** (aktören arbetar enligt direkta ekonomiska intressen för sig själv eller samhället i stort inom marknaden för solenergi)
- **Miljömedvetenhet** (aktören drivs av en vilja och omsorg för klimat, miljö och en hållbar samhällsutveckling)
- **Varumärkesbyggande kring en hållbar profil** (aktören har en vilja att visa upp en hållbar profil genom att agera förebild eller ta del av ekonomiska fördelar genom ett hållbart varumärke)
- **Självförsörjning** (aktören drivs av en strävan mot oberoende energiförsörjning, antingen för aktören i sig, för dess kunder eller för Sverige som land)

Kommentar:

DEL 1. DRIVKRAFTER

Nedan följer frågor som kartlägger respektive aktörs drivkrafter i frågan kring solenergi. För varje aktör ställs frågan till vilken grad aktören drivs av en specifik drivkraft, samt hur denna drivkraft förväntas utvecklas i framtiden. Vänligen svara på frågorna som rör alla aktörerna utifrån din yrkeserfarenhet, även om du inte direkt har arbetat med alla specifika segment.

(1) Regulatorer/beslutsfattare

Regulatorer/beslutsfattare styr och lagstiftar det ramverk inom vilket de andra aktörerna agerar.

1a. Till vilken grad drivs regulatorer **i dagsläget** av följande drivkrafter på elmarknaden?

	Inte alls				Väldigt hög grad	
Ekonomiska incitament	1	2	3	4	5	6
Miljömedvetenhet	1	2	3	4	5	6
Hållbar profil (för Sverige som land)	1	2	3	4	5	6
Självförsörjning (för Sverige som land)	1	2	3	4	5	6

1b.Till vilken grad tror du regulatorer **i framtiden** kommer drivas av följande drivkrafter på elmarknaden?

	Inte alls				Väldigt hög grad	
Ekonomiska incitament	1	2	3	4	5	6
Miljömedvetenhet	1	2	3	4	5	6
Hållbar profil (för Sverige som land)	1	2	3	4	5	6
Självförsörjning (för Sverige som land)	1	2	3	4	5	6

1c Om du svarat olika på fråga a och b, under vilken tidsperiod tror du att förändringen sker?

[2019-2022] [2023-2026] [2027-2030] [efter 2030]

Kommentarer:

(2) Privatkunder

Privatkunder definieras som privatpersoner och hushåll.

2a. Till vilken grad drivs privatkunder **i dagsläget** av följande drivkrafter på elmarknaden?

	Inte alls					Väldigt hög grad
Ekonomiska incitament	1	2	3	4	5	6
Miljömedvetenhet	1	2	3	4	5	6
Hållbar profil	1	2	3	4	5	6
Självförsörjning	1	2	3	4	5	6

2b. Till vilken grad tror du privatkunder **i framtiden** kommer drivas av följande drivkrafter på elmarknaden?

	Inte alls					Väldigt hög grad
Ekonomiska incitament	1	2	3	4	5	6
Miljömedvetenhet	1	2	3	4	5	6
Hållbar profil	1	2	3	4	5	6
Självförsörjning	1	2	3	4	5	6

2c. Om du svarat olika på fråga a och b, under vilken tidsperiod tror du att förändringen sker?

[2019-2022] [2023-2026] [2027-2030] [efter 2030]

Kommentarer:

(3) Fastighetsbolag

Fastighetsbolag inkluderar icke-vinstdrivande kommunalt eller statligt ägda bostadsföretag, privata vinstdrivande bolag som äger eller förvaltar fastigheter samt bostadsrättsföreningar.

3a. Till vilken grad drivs fastighetsbolag **i dagsläget** av följande drivkrafter på elmarknaden?

	Inte alls					Väldigt hög grad
Ekonomiska incitament	1	2	3	4	5	6
Miljömedvetenhet	1	2	3	4	5	6
Hållbar profil	1	2	3	4	5	6
Självförsörjning	1	2	3	4	5	6

Kommentar:

3b. Till vilken grad tror du fastighetsbolag **i framtiden** kommer drivas av följande drivkrafter på elmarknaden?

	Inte alls					Väldigt hög grad
Ekonomiska incitament	1	2	3	4	5	6
Miljömedvetenhet	1	2	3	4	5	6
Hållbar profil	1	2	3	4	5	6
Självförsörjning	1	2	3	4	5	6

Kommentar:

3c. Om du svarat olika på fråga a och b, under vilken tidsperiod tror du att förändringen sker?

[2019-2022] [2023-2026] [2027-2030] [efter 2030]

Kommentarer:

(4) Företagskunder

Företagskunder definieras som företag och organisationer som driver någon form av affärsmodell med vinstintresse, ej fastighetsbolag.

4a. Till vilken grad drivs företagskunder **i dagsläget** av följande drivkrafter på elmarknaden?

	Inte alls					Väldigt hög grad
Ekonomiska incitament	1	2	3	4	5	6
Miljömedvetenhet	1	2	3	4	5	6
Hållbar profil	1	2	3	4	5	6
Självförsörjning	1	2	3	4	5	6

4b. Till vilken grad tror du företagskunder **i framtiden** kommer drivas av följande drivkrafter på elmarknaden?

	Inte alls					Väldigt hög grad
Ekonomiska incitament	1	2	3	4	5	6
Miljömedvetenhet	1	2	3	4	5	6
Hållbar profil	1	2	3	4	5	6
Självförsörjning	1	2	3	4	5	6

4c. Om du svarat olika på fråga a och b, under vilken tidsperiod tror du att förändringen sker?

[2019-2022] [2023-2026] [2027-2030] [efter 2030]

Kommentarer:

(5) Kunder inom offentlig sektor

Kunder inom offentlig sektor definieras som skattefinansierade organisationer som verkar åt det allmänna.

5a. Till vilken grad drivs kunder inom offentlig sektor **i dagsläget** av följande drivkrafter på elmarknaden?

	Inte alls					Väldigt hög grad
Ekonomiska incitament	1	2	3	4	5	6
Miljömedvetenhet	1	2	3	4	5	6
Hållbar profil	1	2	3	4	5	6
Självförsörjning	1	2	3	4	5	6

5b. Till vilken grad tror du kunder inom offentlig sektor **i framtiden** kommer drivas av följande drivkrafter på elmarknaden?

	Inte alls					Väldigt hög grad
Ekonomiska incitament	1	2	3	4	5	6
Miljömedvetenhet	1	2	3	4	5	6
Hållbar profil	1	2	3	4	5	6
Självförsörjning	1	2	3	4	5	6

Kommentar:

5c. Om du svarat olika på fråga a och b, under vilken tidsperiod tror du att förändringen sker?

[2019-2022] [2023-2026] [2027-2030] [efter 2030]

Kommentarer:

(6) Eldistributör/nätägare

Eldistributörer är den som är ansvarig för att upprätthålla god spänningskvalitet i elnätet och ansluta nya produktionsanläggningar.

6a. Till vilken grad drivs eldistributörer **i dagsläget** av följande drivkrafter på elmarknaden?

	Inte alls					Väldigt hög grad
Ekonomiska incitament	1	2	3	4	5	6
Miljömedvetenhet	1	2	3	4	5	6
Hållbar profil	1	2	3	4	5	6
Kunderas strävan efter självförsörjning	1	2	3	4	5	6

6b. Till vilken grad tror du att eldistributörer **i framtiden** kommer drivas av följande drivkrafter på elmarknaden?

	Inte alls					Väldigt hög grad
Ekonomiska incitament	1	2	3	4	5	6
Miljömedvetenhet	1	2	3	4	5	6
Hållbar profil	1	2	3	4	5	6
Kundernas strävan efter självförsörjning	1	2	3	4	5	6

Kommentar:

6c. Om du svarat olika på fråga a och b, under vilken tidsperiod tror du att förändringen sker?

[2019-2022] [2023-2026] [2027-2030] [efter 2030]

Kommentarer:

(7) Elhandelsbolag

Elhandelsbolaget är den som är ansvarig för elleverans, och som förser konsumenter med elavtal.

7a. Till vilken grad drivs elhandelsbolag **i dagsläget** av följande drivkrafter på elmarknaden?

	Inte alls					Väldigt hög grad
Ekonomiska incitament	1	2	3	4	5	6
Miljömedvetenhet	1	2	3	4	5	6
Hållbar profil	1	2	3	4	5	6
Kundernas strävan efter självförsörjning	1	2	3	4	5	6

7b. Till vilken grad tror du elhandelsbolag **i framtiden** kommer drivas av följande drivkrafter på elmarknaden?

	Inte alls					Väldigt hög grad
Ekonomiska incitament	1	2	3	4	5	6
Miljömedvetenhet	1	2	3	4	5	6
Hållbar profil	1	2	3	4	5	6
Kundernas strävan efter självförsörjning	1	2	3	4	5	6

7c. Om du svarat olika på fråga a och b, under vilken tidsperiod tror du att förändringen sker?

[2019-2022]   [2023-2026]   [2027-2030]   [efter 2030]

Kommentarer:

DEL 2 MAKT OCH HINDER

Efter att ha granskat drivkrafterna för respektive aktör följer nu frågor som behandlar makt och hinder kopplat till tillväxten av solbaserad el i Sveriges elnät.

(8) Makt

8a. Vänligen rangordna de tre aktörer som du anser har mest makt att påverka ökad tillväxt av andelen solbaserad el **i dagsläget**, där plats 1 innebär mest makt (*placera 1, 2 resp. 3 vid de tre aktörer som du anser har mest makt).*

Regulatorer
Privatkunder
Fastighetsbolag
Företagskunder (ej fastighetsbolag)
Kunder inom offentlig sektor
Eldistributörer
Elhandelsbolag

8b. Vänligen rangordna de tre aktörer som du tror kommer ha mest makt att påverka ökad tillväxt av andelen solbaserad el i **framtiden**, där plats 1 innebär mest makt (*placera 1, 2 resp. 3 vid de tre aktörer du tror har mest makt).*

Regulatorer
Privatkunder
Fastighetsbolag
Företagskunder (ej fastighetsbolag)
Kunder inom offentlig sektor
Eldistributörer
Elhandelsbolag

8c. Om du svarat olika på maktbalansen idag och i framtiden, under vilken tidsperiod tror du att förändringen sker?
[2019-2022] [2023-2026] [2027-2030] [efter 2030]

Kommentarer:

(9) Hinder

9a. Vänligen rangordna de tre aktörer som du anser utgör hinder för ökad tillväxt på marknaden för solel **i dagsläget**, där plats 1 innebär störst hinder.

Regulatorer
Privatkunder
Fastighetsbolag (ej fastighetsaktörer)
Företagskunder
Kunder inom offentlig sektor
Eldistributörer
Elhandelsbolag

9b. Vänligen rangordna de tre aktörer som du tror utgör hinder för ökad tillväxt på marknaden för solel **i framtiden**, där plats 1 innebär störst hinder.

Regulatorer
Privatkunder
Fastighetsbolag (ej fastighetsaktörer)
Företagskunder
Kunder inom offentlig sektor
Eldistributörer
Elhandelsbolag

9c. Om du svarat olika på störst hinder idag och i framtiden, under vilken tidsperiod tror du att förändringen sker?
[2019-2022] [2023-2026] [2027-2030] [efter 2030]

Kommentarer:

Till sist
Om du saknade någon aktör eller drivkraft; vilken/vilka?
Svar:

Om du har några kommentarer eller tankar kring studien får du gärna lämna dem här:
Svar:

Tack för din medverkan!

Ditt deltagande betyder mycket för oss. Nästa runda, som skickas till dig om ett par veckor, kommer innehålla en sammanfattning av alla deltagares svar samt hur dina svar förhåller sig till resten av gruppen. Slutrapporten kommer skickas till dig i slutet av juni.

A.2 Questionnaire round 2

Delphistudie: Roller kring solbaserad el - omgång 2

Detta är den andra rundan av en Delphistudie som utförs som en del av ett examensarbete vid Lunds Universitet under våren 2018. Utifrån deltagarnas svar i omgång 1 har en sammanfattande analys formulerats vilken presenteras i detta frågeformulär. Runda 2 innehåller några fördjupande frågor samt frågor som berör fyra framtidsscenarier för solel som har utvecklats ur analysen.

Var vänlig svara på detta formulär senast den 27 april.

Tack för ditt deltagande!

Rebecka Marklund & Carolina Ramberg

Om dig
För- och efternamn:

Sammanfattande analys av runda 1

Första delen av runda 1 berörde till vilken grad olika aktörer som verkar på elmarknaden i dagsläget drivs av de fyra drivkrafterna:

- **Ekonomiska incitament** (aktören arbetar enligt direkta ekonomiska intressen för sig själv eller samhället i stort inom marknaden för solenergi)
- **Miljömedvetenhet** (aktören drivs av en vilja och omsorg för klimat, miljö och en hållbar samhällsutveckling)
- **Varumärkesbyggande kring en hållbar profil** (aktören har en vilja att visa upp en hållbar profil genom att agera förebild eller ta del av ekonomiska fördelar genom ett hållbart varumärke)
- **Självförsörjning** (aktören drivs av en strävan mot oberoende energiförsörjning, antingen för aktören i sig, för dess kunder eller för Sverige som land)

Respondenterna kunde även definiera en tidshorisont då graderingen av drivkrafterna väntades förändras, samt hade möjlighet att lämna kommentarer.

1a. Resultatet visar tendenser på att samtliga drivkrafter anses bli viktigare i framtiden än idag, för alla aktörer. Självförsörjning är den drivkraft som återkommande värderas lägst för varje aktör, även om den för privatkunder är något mer betydande. Självförsörjning väntas dock bli viktigare i framtiden för alla aktörer, och såg en relativt hög ökning vid jämförelse med de andra drivkrafterna.

1b. För kommersiella aktörer (företagskunder, eldistributörer och elhandelsbolag och vissa fastighetsbolag) anses ekonomiska incitament återkommande vara den viktigaste drivkraften, följt av hållbar profil, både idag och i framtiden. För offentliga aktörer (regulatorer och kunder inom offentlig sektor) är hållbar profil och miljömedvetenhet de mest framträdande drivkrafterna. Privatkunder drivs främst av ekonomiska incitament samt miljömedvetenhet.

1c. Avseende tidsperspektiv anses förändringar på marknaden ske inom en nära (men ej direkt) framtid. Det råder en generell överenskommelse om att tidsperioden 2023-2026 och även perioden 2019-2022 kan ses som en brytpunkt inom området för solbaserad elektricitet i Sverige, både gällande drivkrafter och maktfördelning.

Andra delen av runda 1 berörde aktörers makt och deras möjlighet att utgöra hinder för mer solbaserad el i det svenska elnätet.

2a. Bland experterna råder det idag en allmän uppfattning om att regulatorer och beslutsfattare har mest makt, både idag och i framtiden, även om deras betydelse anses minska något framöver. Avseende vilka andra aktörer som har makt inom området för solel finns ingen större konsensus.

2b. Även i fallet att agera hinder på marknaden håller de flesta med om att regulatorer och beslutsfattare är mest framträdande, bland annat på grund av brist på kontinuitet och förutsägbarhet av regleringar. Därefter följer eldistributörer och elhandelsbolag som de aktörer som främst anses kunna hindra framväxten av mer solbaserad el.

Avslutningsvis frågades det om det fanns några andra aktörer av vikt som ej framkommit i studien.

3a. Ett antal deltagare nämnde solcellsinstallatörer och andra entreprenörer som arbetar med solcellslösningar. Andra respondenter tog upp batteriproducenter, investerare, oljeindustrin och klimatpolitiska rörelser, men det var ingen större konsensus kring andra aktörer av betydelse.

Håller du med om det som framkommit i analysen eller finns det något du vill lyfta fram som du ej håller med om?

Ja, jag håller med. Nej, jag håller inte med.

Om nej, vad är det du inte håller med om?

Kommentar:

DEL 1 FÖRDJUPNINGSFRÅGOR

Nu följer ett antal fördjupande frågor avseende drivkrafter, makt och hinder.

DRIVKRAFTER

Självförsörjning får högre ranking i framtiden för alla aktörer, men värderas återkommande lågt i förhållande till de andra drivkrafterna. Privatkunder är den aktör som värderar självförsörjning högst.

1.1 Är privatkunders vilja till självförsörjning en viktig drivkraft för hur marknaden för solenergi i Sverige utvecklar sig?

Ja Nej

Kommentar:

1.2 Om självförsörjning blir en allt viktigare drivkraft för privatkunder, leder då detta till en mer decentraliserad elmarknad, med allt fler småskaliga, kundanpassade lösningar?

Ja Nej

Kommentar:

Aktörerna definierades i runda 1 enligt följande:

- Regulatorer - beslutsfattare vilka styr och lagstiftar det ramverk inom vilket de andra aktörerna agerar, ex regering, riksdag, Svenska kraftnät och myndigheter.

- Privatkunder - definieras som privatpersoner och hushåll.

- Fastighetsbolag - inkluderar icke-vinstdrivande kommunalt eller statligt ägda bostadsföretag, privata vinstdrivande bolag som äger eller förvaltar fastigheter samt bostadsrättsföreningar.

- Företagskunder - definieras som företag och organisationer som driver någon form av affärsmodell med vinstintresse, ej fastighetsbolag.

- Kunder inom offentlig sektor - definieras som skattefinansierade organisationer som verkar åt det allmänna.

- Eldistributörer - den som är ansvarig för att upprätthålla god spänningskvalitet i elnätet och ansluta nya produktionsanläggningar.

- Elhandelsbolag - den som är ansvarig för elleverans, och som förser konsumenter med elavtal.

MAKT

Det rådde från runda 1 konsensus om att regulatorer har mest makt idag. Denna väntas minska i framtiden, men till vilken aktör denna maktförskjutning sker råder det ej konsensus om. Fastighetsbolag, eldistributörer och privatkunder är några av aktörerna som väntas få mer makt i framtiden.

1.3 Vilken typ av maktfaktor som regulatorer besitter tror du är viktigast för att öka andelen solbaserad elektricitet i elnätet?

- Ekonomiska incitament - Gör det fördelaktigt att producera och nyttja solbaserad el genom bidrag och andra ekonomiska styrmedel.
- Tvingande lagstiftning - Reglerar elnätsavgifter, klimatutsläpp, kvotplikt och andra juridiska regleringar.
- Incitament för teknisk utveckling - Skapar infrastrukturinvesteringar samt stöd till forskning och utveckling:
- Annan faktor:

Kommentar:

1.4 Upplever du att det i dagsläget finns en känsla av maktlöshet hos de andra aktörerna?

Ja Nej

Kommentar:

1.5 Går marknaden mot en generell maktförskjutning från offentliga till privata aktörer?

Ja Nej

Kommentar:

HINDER
Generellt rankas regulatorer, eldistributörer och elhandelsbolag som de tre största hindren för ökad tillväxt av solbaserad el, både idag och i framtiden.

1.6 Vilken är den främsta faktorn som gör att dessa aktörer utgör ett potentiellt hinder för tillväxten av solel i Sverige?

- Aktören upplevs agera enligt krånglig byråkrati och försvårar tillväxt av solel.
- Aktören har en viktig, central roll på elmarknaden med relationer till flera andra aktörer.
- Aktören saknar vilja och verkliga, långsiktiga initiativ till att arbeta mot mer solbaserad el.
- Annat:

Kommentar:

DEL 2 FRAMTIDSSCENARIER

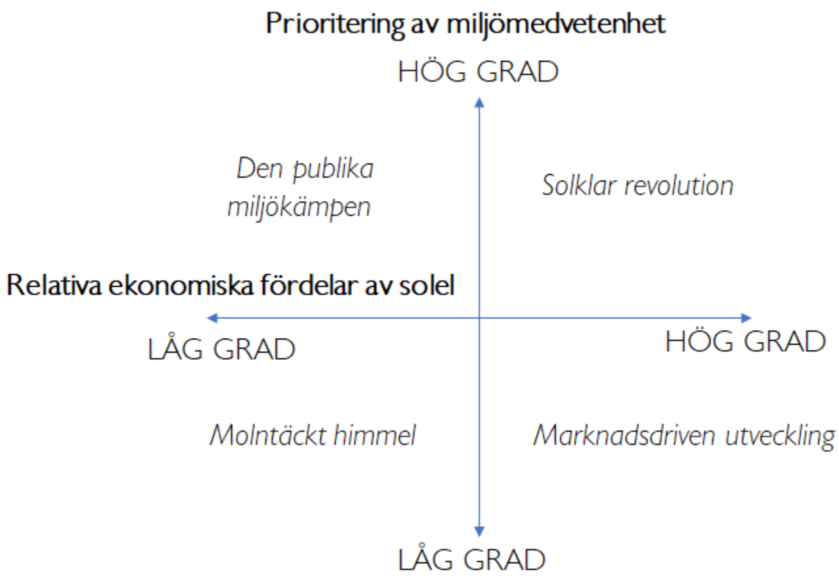
Baserat på resultatet av runda 1 och den litteraturstudie som utförts under detta examensarbete har ett antal framtidsscenarier över den framtida marknaden för solbaserad elektricitet konstruerats. Två osäkerheter på varsin axel skapar ett så kallat scenariokors som ger upphov till fyra scenarier. Även om vissa karaktärsdrag delas av flera scenarier så har varje scenario säregenheter. På nästföljande sida följer djupare beskrivningar av de fyra scenarierna samt några frågor som berör respektive.

Scenariobyggandet i denna studie bygger på två osäkerhetsfaktorer kring utvecklingen av marknaden för solel.

- Grad av relativ ekonomisk fördel (X-axel)
X-axeln representerar de ekonomiska fördelar som solbaserad el medför relativt alternativa tekniker för elproduktion. Stora relativa ekonomiska fördelar innebär att är lönsamt ur en renodlad ekonomisk synvinkel att nyttja solceller (PV) för aktörerna på marknaden. Om eller när marknadens aktörer kan åtnjuta ekonomiska fördelar för solel kontra andra produktionsslag är idag oklart.

- Prioritering av miljömedvetenhet (Y-axel)
Y-axeln visar till vilken grad miljömedvetenhet prioriteras och påverkar marknadsutvecklingen. En hög prioritering av miljömedvetenhet från framför allt beslutsfattare och privatkunder innebär tydliga och långsiktiga beslut mot en hållbar utveckling med en ambitiös, grön styrmedelspolitik som möjliggör infrastrukturella investeringar. Prioriteringen av miljömedvetenhet och viljan att driva en hållbar agenda är också en drivkraft där det råder osäkerheter i dagsläget.

Dessa två osäkerheter formar tillsammans fyra olika scenarier, vilka återges nedan.



Scenario 1 Molntäckt himmel
Karaktärsdrag:
- Relativa ekonomiska fördelar för solel saknas.
- Miljömedvetenhet är lågt prioriterat av beslutsfattare och kunder.
- Utvecklingen går trögt, sol förblir en liten del av Sveriges energimix.
- De få aktörer som nyttjar solel drivs till stor del av en filantropisk tanke om hållbarhet.

"Solcellsboomen, som många trodde var precis runt hörnet, har inte inträffat och sol står bara för runt 1 % av Sveriges elkonsumtion. En del skyller detta på att marknadens reglering varit så oförutsägbar, andra på att miljö och klimat glidit ned från toppen av den politiska agendan. Den solel som produceras kommer från små anläggningar och bland privatpersoner är solceller mest något för entusiaster, som förenas i ett intresse för teknik och miljö. Bristen på ekonomiska incitament att lett till att utvecklingen i princip stannat av, och även om solceller är ganska billiga sen priserna gick ned i början på 2000-talet så brister ändå lönsamheten eftersom tekniken inte förbättrats sedan dess."

1.1 Givet att situationen på den svenska marknaden även fortsättningsvis ser ut så som du uppfattar den idag, med avseende på infrastruktur, politiska styrmedel samt ekonomiska incitament - är detta scenario en trolig framtid?

Ja Nej

Kommentar:

Scenario 2 Den publika miljöhjälten
Karaktärsdrag:
- Miljömedvetenhet är högt prioriterat av beslutsfattare och kunder.
- Relativa ekonomiska fördelar för solel saknas.
- Regulatorer, offentlig sektor och privatkunder driver på utvecklingen.
- Styrmedelspolitiken till fördel för förnybar energi är ambitiös och långsiktigt stabil.
- Privatpersoner påverkar opinionen genom kundmakt.
- Självförsörjning har blivit en allt viktigare drivkraft.

"Efter att USA drog sig ur Parisavtalet har resten av världen gjort sitt bästa för att begränsa den globala uppvärmningen. Detta innebär att den svenska regeringen satsat stort på styrmedel för att öka tillväxten av förnybar energi. Detta skickar tydliga signaler till marknadens aktörer att satsa på miljövänlig infrastruktur, där t ex förändringar av intäktsreglering och anslutningskrav för eldistributörer gynnar hållbara investeringar. Miljömedvetenheten är hög och central i samhällsdebatten. Även om småskaliga off-grid-lösningar för sol växer ur en ökad vilja till självförsörjning, är det andra förnybara energislag som exempelvis vindkraft som verkligen är på frammarsch."

2.1 Finns det någon aktör som kan ses som en specifik möjliggörare för att åstadkomma detta scenario?

- Regulatorer
- Privatkunder
- Fastighetsbolag
- Företagskunder
- Kunder inom offentlig sektor
- Eldistributörer
- Elhandelsbolag
- Jag anser inte att någon specifik aktör är en möjliggörare för detta scenario

Kommentar:

2.2 Vilken eller vilka aktörer utgör möjliga hinder för att åstadkomma detta scenario?

- Regulatorer
- Privatkunder
- Fastighetsbolag
- Företagskunder
- Kunder inom offentlig sektor
- Eldistributörer
- Elhandelsbolag
- Jag anser inte att någon aktör utgör ett hinder för detta scenario

Kommentar:

2.3 Leder detta scenario till en förändring av roller på marknaden för solbaserad el?

- Roller definieras här som de aktiviteter som aktörerna i dagsläget utför på marknaden och det samspel och de relationer som finns i dagsläget på elmarknaden, och en rollförändring kan innebära både att nya aktörer tillkommer men också att existerande aktörer kan få förändrade aktiviteter.

Ja Nej

Kommentar:

2.4 Innebär detta scenario en förskjutning av makt till existerande eller helt nya aktörer?

Ja Nej

Kommentar:

Scenario 3 Marknadsdriven utveckling
Karaktärsdrag:
- Stora relativa ekonomiska fördelar för solel.
- Miljömedvetenhet är lågt prioriterat av beslutsfattare och kunder.
- Styrmedelspolitiken präglas av osäkerhet och instabilitet.
- Kommersiella aktörer driver på marknadens utveckling, och nya aktörer etableras.

"Disruptiv innovation leder till en extrem prissänkning av solceller relativt andra energislag. Solelsaffären kan nu bära sig själv ekonomiskt, bortom styrmedel, och marknadens kommersiella aktörer är aktiva i transformationen mot ett delvis soldrivet Sverige. Trots den blomstrande marknaden ligger politikerna efter, med en instabil och inkonsekvent styrmedelspolitik, där eldistributörer och fastighetsbolag fortfarande saknar tydlig reglering och incitament för att investera i solenergi på stor skala."

3.1 Finns det någon aktör som kan ses som en specifik möjliggörare för att åstadkomma detta scenario?

- Regulatorer
- Privatkunder
- Fastighetsbolag
- Företagskunder
- Kunder inom offentlig sektor
- Eldistributörer
- Elhandelsbolag
- Jag anser inte att någon specifik aktör är en möjliggörare för detta scenario

Kommentar:

3.2 Vilken eller vilka aktörer utgör möjliga hinder för att åstadkomma detta scenario?

- Regulatorer
- Privatkunder
- Fastighetsbolag
- Företagskunder
- Kunder inom offentlig sektor
- Eldistributörer
- Elhandelsbolag
- Jag anser inte att någon aktör utgör ett hinder för detta scenario

Kommentar:

3.3 Leder detta scenario till en förändring av roller på marknaden för solbaserad el?

- Roller definieras här som de aktiviteter som aktörerna i dagsläget utför på marknaden och det samspel och de relationer som finns i dagsläget på elmarknaden, och en rollförändring kan innebära både att nya aktörer tillkommer men också att existerande aktörer kan få förändrade aktiviteter.

Ja Nej

Kommentar:

3.4 Innebär detta scenario en förskjutning av makt till existerande eller helt nya aktörer?

Ja Nej

Kommentar:

Scenario 4 Solklar revolution
Karaktärsdrag:
- Stora ekonomiska fördelar av solel kontra andra energislag.
- Miljömedvetenhet är högt prioriterat av beslutsfattare och kunder.
- Solcellsmarknaden i Sverige har exploderat.
- Såväl företag som beslutsfattare har investerat i teknisk utveckling och infrastruktur.
- Hög andel av den svenska energimixen består av solenergi.
- Tillväxten av lagring och batterier är stor och flexibiliteten i elnätet är stor.

"Tak och väggar på skånelängor i söder till timmerhus i norr och fabriker från väst till öst, täcks av solcellslösningar. På landsbygden har en stor mängd mark dedikerats till solfarmar. Den tekniska utvecklingen har gått snabbt tack vare kombinationen av ekonomisk lönsamhet och en stabil och ambitiös styrmedelspolitik. I takt med den explosiva utvecklingen har även lagringslösningar för både industri och privatkunder gått snabbt de senaste åren, och elektrifieringen av industri och transportsektor gör att Sverige ligger i framkant för ett hållbart samhälle."

4.1 Vilka aktörer utgör möjliga hinder för att åstadkomma detta scenario?

- Regulatorer
- Privatkunder
- Fastighetsbolag
- Företagskunder
- Kunder inom offentlig sektor
- Eldistributörer
- Elhandelsbolag
- Jag anser inte att någon aktör utgör ett hinder för detta scenario

Kommentar:

4.2 Finns det någon aktör som kan ses som en specifik möjliggörare för att åstadkomma detta scenario?

- Regulatorer
- Privatkunder
- Fastighetsbolag
- Företagskunder
- Kunder inom offentlig sektor
- Eldistributörer
- Elhandelsbolag
- Jag anser inte att någon specifik aktör är en möjliggörare för detta scenario

Kommentar:

4.3 Leder detta scenario till en förändring av roller på marknaden för solbaserad el?

- Roller definieras här som de aktiviteter som aktörerna i dagsläget utför på marknaden och det samspel och de relationer som finns i dagsläget på elmarknaden, och en rollförändring kan innebära både att nya aktörer tillkommer men också att existerande aktörer kan få förändrade aktiviteter.

Ja Nej

Kommentar:

4.4 Innebär detta scenario en förskjutning av makt till existerande eller helt nya aktörer?

Ja Nej

Kommentar:

Generella frågeställningar om de fyra scenarierna

5.1 Vänligen rangordna scenarierna efter hur troligt det är att de blir verklighet på den svenska marknaden för solenergi innan år 2026 (1=mest troligt, 4=minst troligt):

- Molntäckt himmel
- Den publika miljöhjälten
- Marknadsdriven utveckling
- Solklar revolution

Kommentar:

5.2 Vänligen rangordna scenarierna efter hur troligt det är att de blir verklighet på den svenska marknaden för solenergi efter år 2026 (1=mest troligt, 4=minst troligt):

- Molntäckt himmel
- Den publika miljöhjälten
- Marknadsdriven utveckling
- Solklar revolution

Kommentar:

5.3 Vänligen rangordna scenarierna efter hur stor rollförändringen på elmarknaden kan tänkas bli (1=störst rollförändring, 4=minst rollförändring):

- Molntäckt himmel
- Den publika miljöhjälten
- Marknadsdriven utveckling
- Solklar revolution

Kommentar:

5.4 Vilken av följande faktorer är viktigast för att möjliggöra en s.k "solcellsboom" i Sverige?

- Långsiktigt stabil styrmedelspolitik som gynnar alla aktörer
- Tydliga ekonomiska fördelar för solbaserad el för alla aktörer
- Kraftig utbyggnad av lagring- och balans i elnätet

Kommentar:

Om du har några övriga kommentarer eller tankar kring studien och vilka frågor och aspekter vi valt att inkludera får du gärna lämna dem här.

Kommentar:

Stort tack för ditt deltagande! Den slutgiltiga rapporten beräknas skickas ut via mail i slutet av juni.
Vänligen,
Rebecka Marklund & Carolina Ramberg

A.3 Anonymized list of participants in Delphi study

The participants market in bold participated in both rounds.

Academia

PhD Student, Energy Technology, Chalmers University of Technology.

Electricity net and distribution researcher, Energiforsk.

Energy systems and market researcher, Energiforsk.

Associate Professor, Technical Design, KTH Royal Institute of Technology.

Senior lecturer, Energy and Building Design, Faculty of Engineering, Lund University.

Senior lecturer, Environmental and Energy Systems Studies, Faculty of Engineering, Lund University.

Assistant Professor, Energy Science, Faculty of Engineering, Lund University.

Solar energy research engineer, RISE.

Regulators/institutions

Former Senior advisor, Ministry of the Environment and Energy, Energy Unit.

Manager, Ministry of the Environment and Energy, Energy Unit.

Project manager, Ministry of the Environment and Energy, Energy Unit.

Municipal Energy and Climate Advisor, Southern Sweden.

Municipal Energy and Climate Advisor, Northern Sweden.

Energy and Climate Strategist, Municipal Administrative Board, Energy Unit, Southern Sweden. Energy and Climate Strategist, Municipal Administrative Board, Energy Unit, Central Sweden.

Project manager solar energy, Regional Energy Agency.

Regional development manager, Regional Energy Agency.

Manager, Department of Energy Analysis, Swedish Energy Agency.

Senior advisor, Swedish Energy Agency.

Manager, Department of Renewable Energy, Swedish Energy Agency.

Analyst, Consumer rights, Swedish Energy Markets Inspectorate.

Analyst, Net regulations, Swedish Energy Markets Inspectorate.

Internal knowledgeable

Manager, Energy supply, Arvika Kraft.

Manager, Local energy production, Ellevio.

Manager, Local energy production, E.ON Energy Networks.

Business Developer, Local energy production, E.ON Energy Networks.

Sales, Solar energy, E.ON Energy Solutions.

Sales, Solar energy, E.ON Energy Solutions.

Business Developer, Strategy, E.ON Energy Networks.

Project manager, Fortum.

Manager, Electricity network, Karlstad El och Stadsnät.

Regional supervisor, Save by Solar.

External knowledgeable

Journalist, Aktuell Hållbarhet.

Journalist, ETC.

Environmental coordinator, Skanska.

Manager, Skanska.

Journalist, Supermiljöbloggen.

Consultant, Environment and Energy, WSP.

Project manager, ÅF Consulting.

Freelance journalist and author.

Freelance energy consultant.

A.4 Interview guide

Intervjuguide för semistrukturerade intervjuer med intern personal E.ON Energidistribution. Februari 2018

Ämne: Ökad andel solbaserad el i elnätet
Syfte: Validera identifierade stakeholders (direkta och indirekta)

Frågor

- Identifierade aktörer
  - Saknas någon aktör?
  - Är indelningen av aktörer lämplig?
  - Vilka aktörer kan betraktas som direkta?
  - Vilka aktörer kan betraktas som indirekta?

- Drivkrafter
  - Vad påverkar aktörernas beteende?

- Relationer
  - Är någon aktör mer tongivande än andra?
  - Vad styr om en aktör har mer makt eller intresse för att påverka mängden solel?

- Identifierade trender (t ex decentralisering, miljömedvetenhet, elektrifiering, kundmakt)
  - Hur ser du på utvecklingen av de trenderna som ges som exempel?
  - Finns det några andra specifika trender som märks av på marknaden?

A.5 Results from round 1 - Frequency distributions

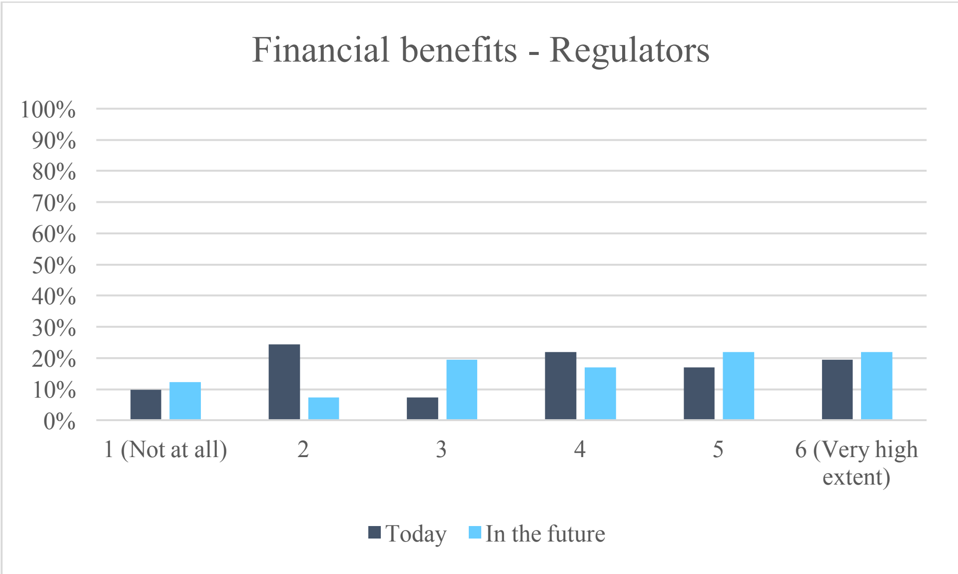


Figure A.5.1. Distribution of respondents' answers to the question "To what extent are regulators driven by financial benefits?"

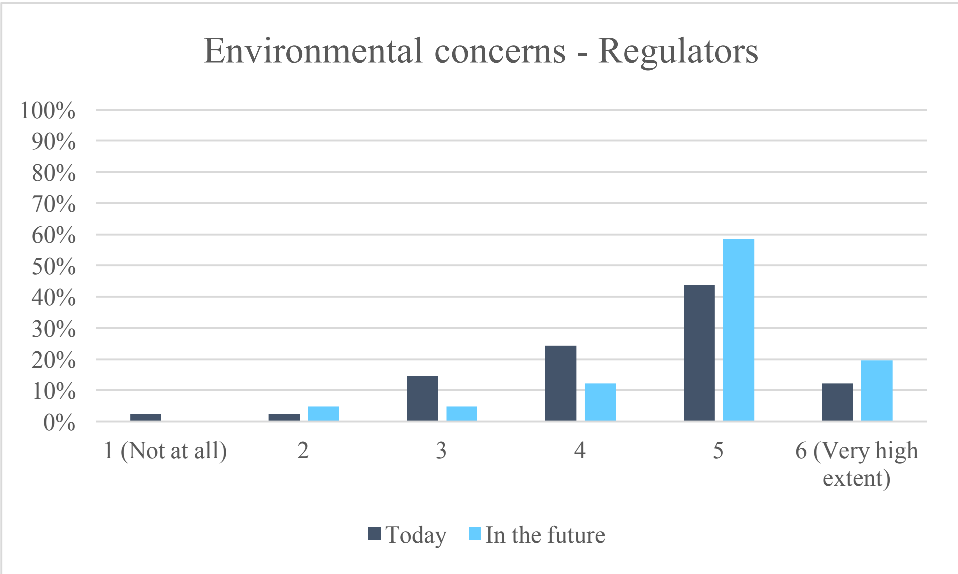


Figure A.5.2. Distribution of respondents' answers to the question "To what extent are regulators driven by environmental concerns?"

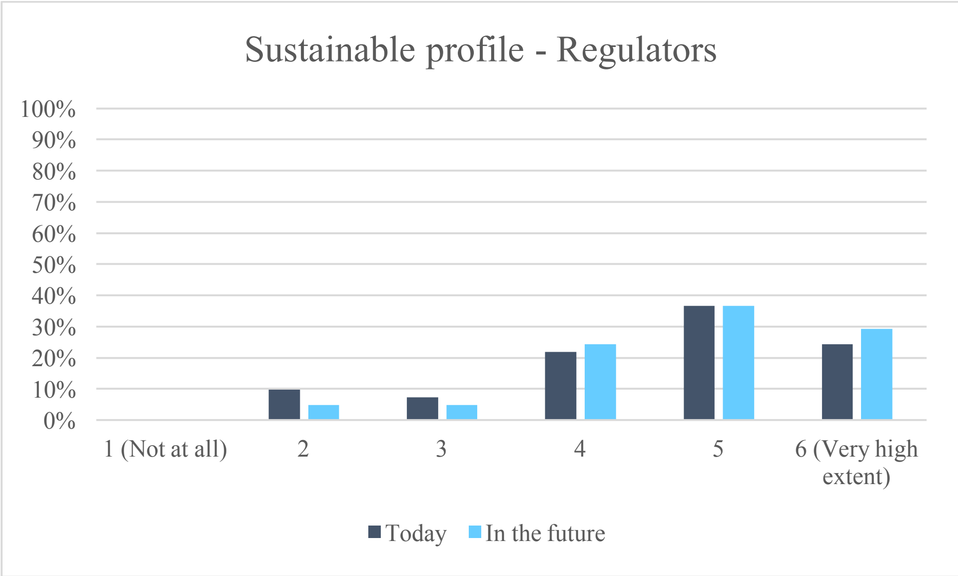


Figure A.5.3. Distribution of respondents' answers to the question "To what extent are regulators driven by a sustainable profile?"

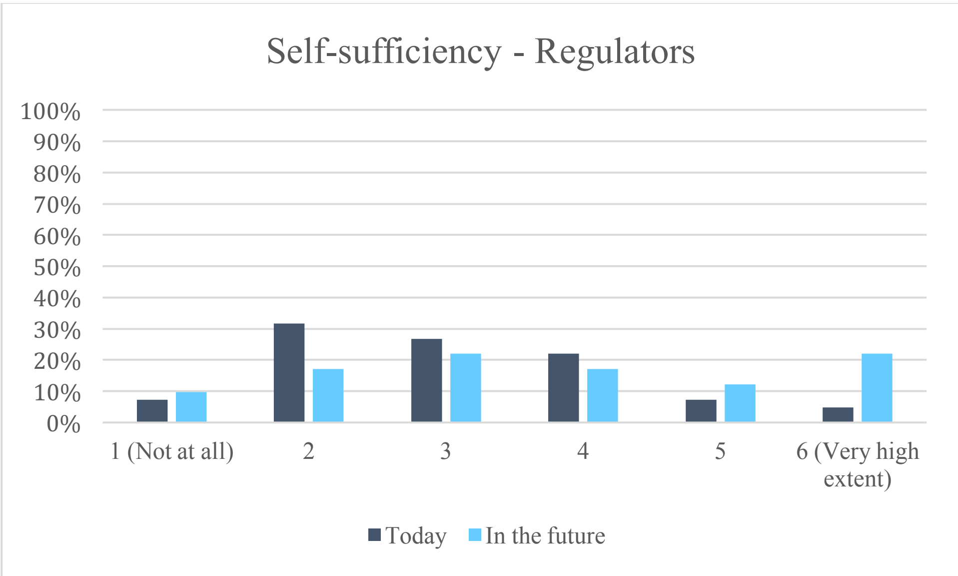


Figure A.5.4. Distribution of respondents' answers to the question "To what extent are regulators driven by self-sufficiency (for Sweden as a country)?"

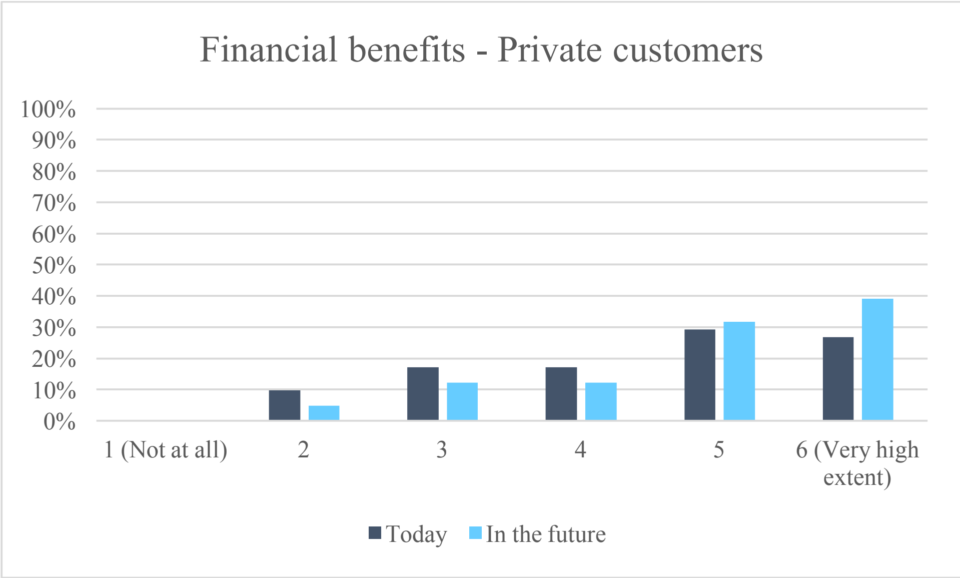


Figure A.5.5. Distribution of respondents' answers to the question "To what extent are private customers driven by financial benefits?"

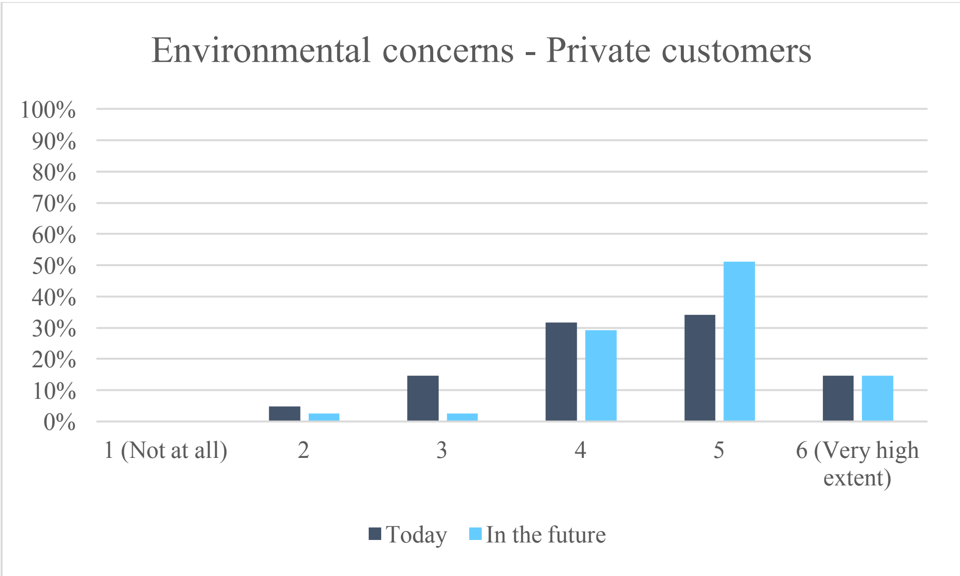


Figure A.5.6. Distribution of respondents' answers to the question "To what extent are private customers driven by environmental concerns?"

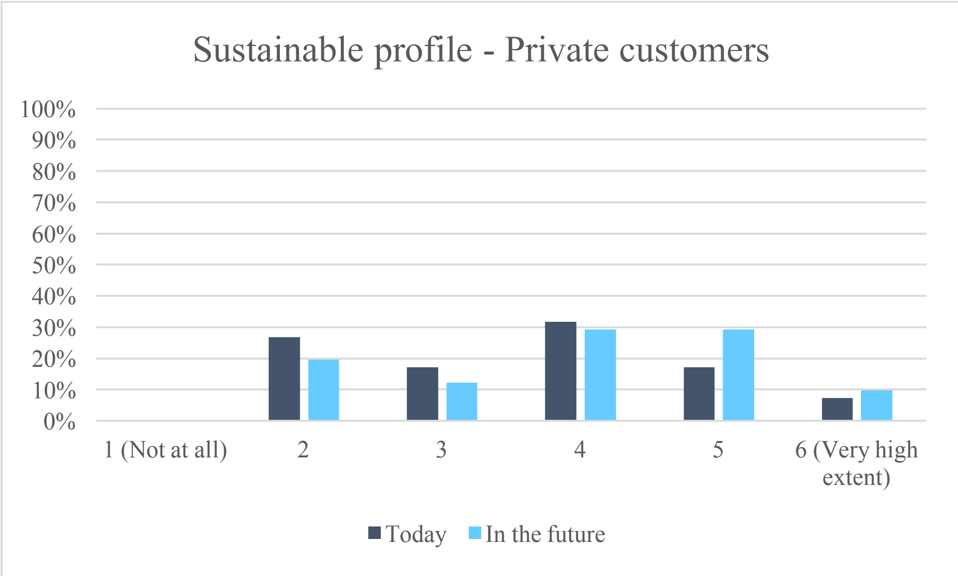


Figure A.5.7. Distribution of respondents' answers to the question "To what extent are private customers driven by sustainable profile?"

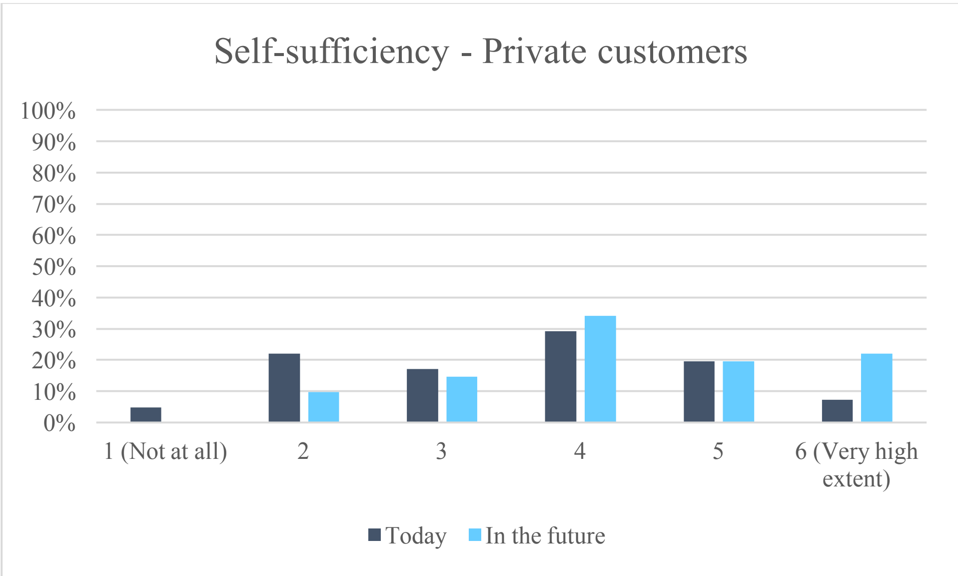


Figure A.5.8. Distribution of respondents' answers to the question "To what extent are private customers driven by self-sufficiency?"

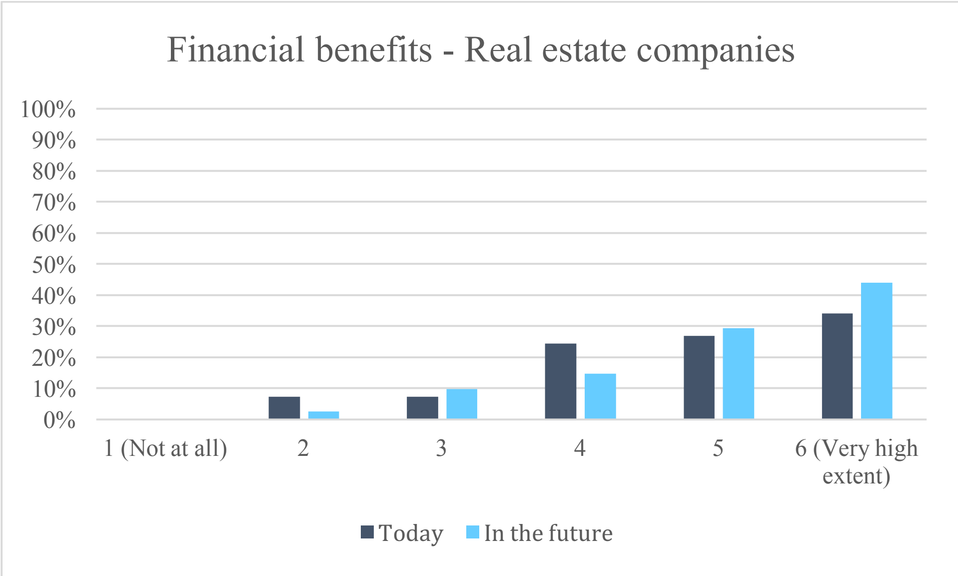


Figure A.5.9. Distribution of respondents' answers to the question "To what extent are real estate companies driven by financial benefits?"

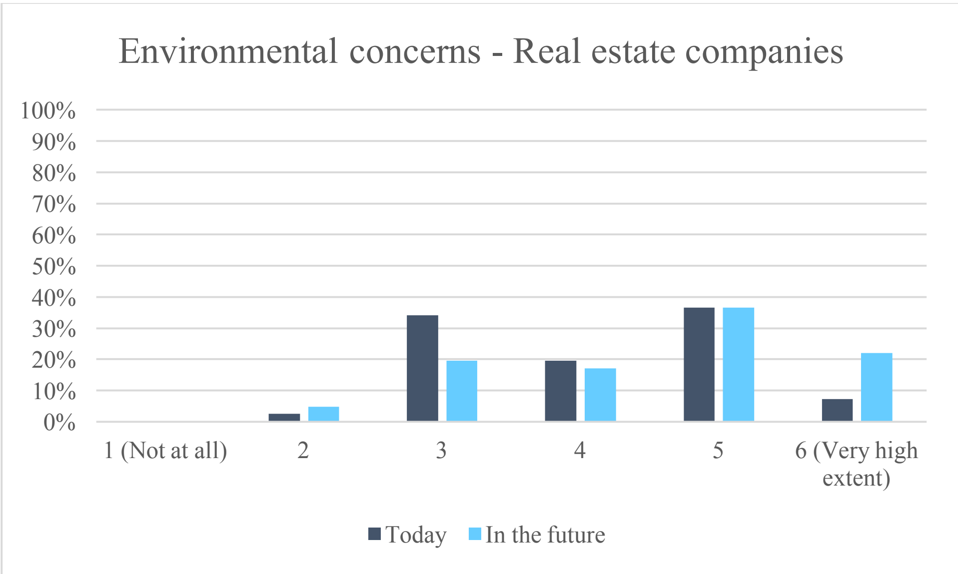


Figure A.5.10. Distribution of respondents' answers to the question "To what extent are real estate companies driven by environmental concerns?"

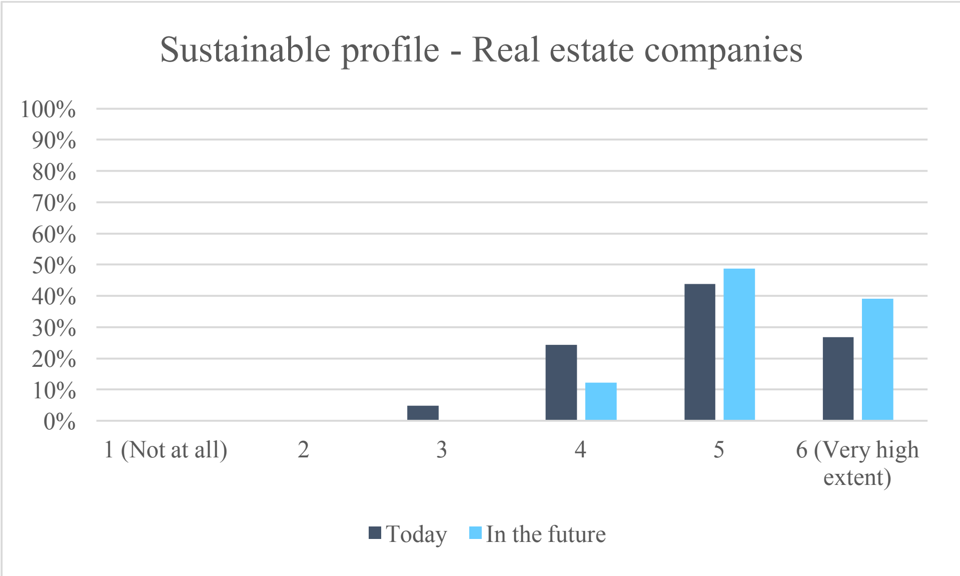


Figure A.5.11. Distribution of respondents' answers to the question "To what extent are real estate companies driven by a sustainable profile?"

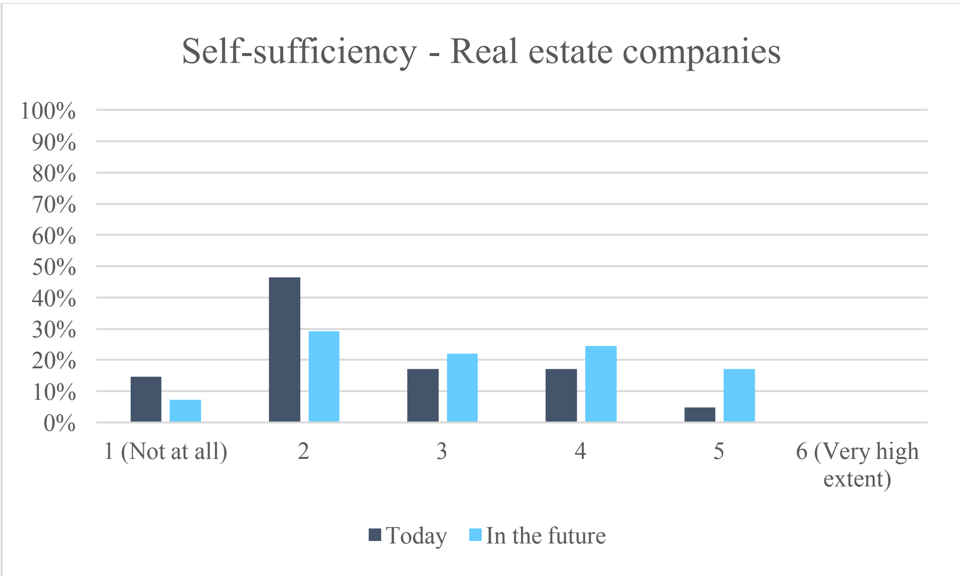


Figure A.5.12. Distribution of respondents' answers to the question "To what extent are real estate companies driven by self-sufficiency?"

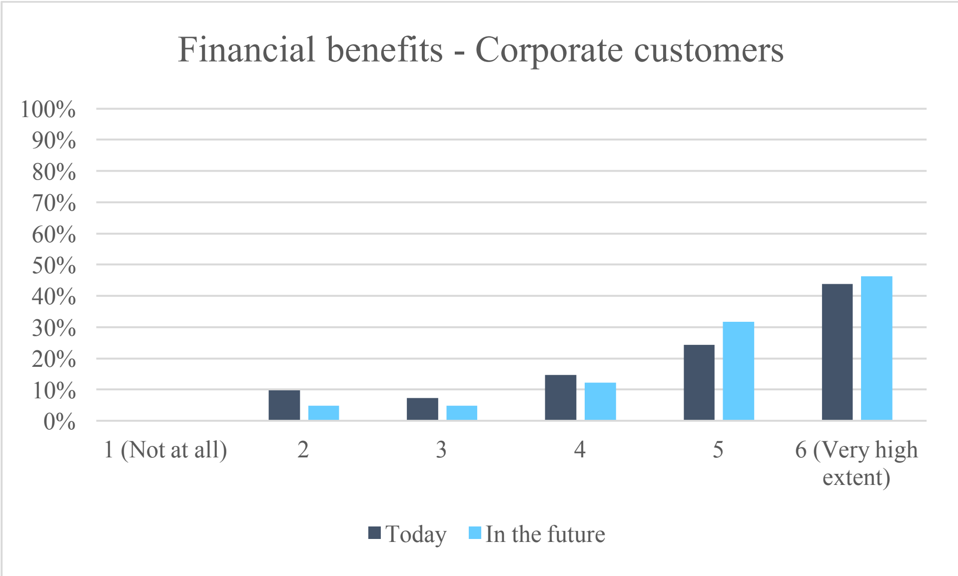


Figure A.5.13. Distribution of respondents' answers to the question "To what extent are corporate customers driven by financial benefits?"

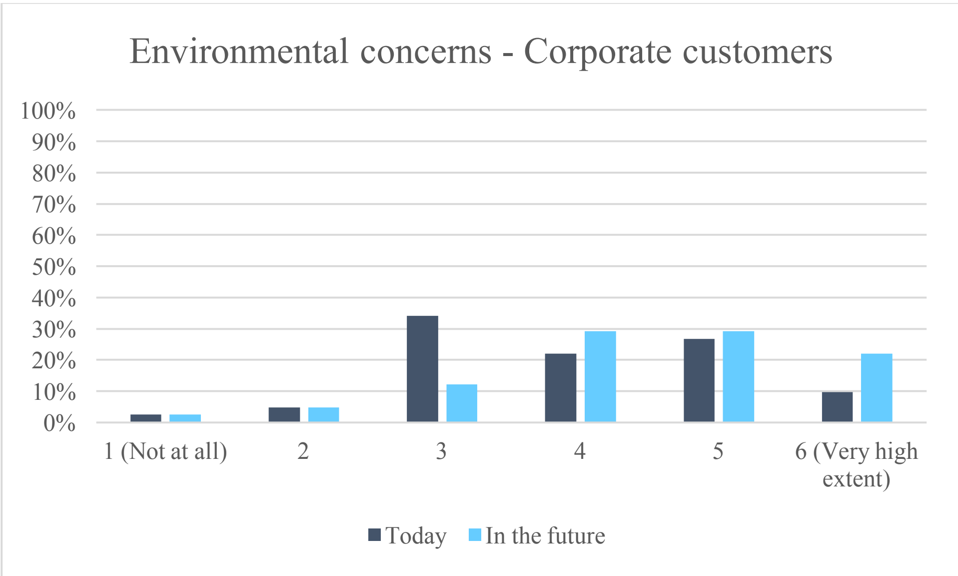


Figure A.5.14. Distribution of respondents' answers to the question "To what extent are corporate customers driven by environmental concerns?"

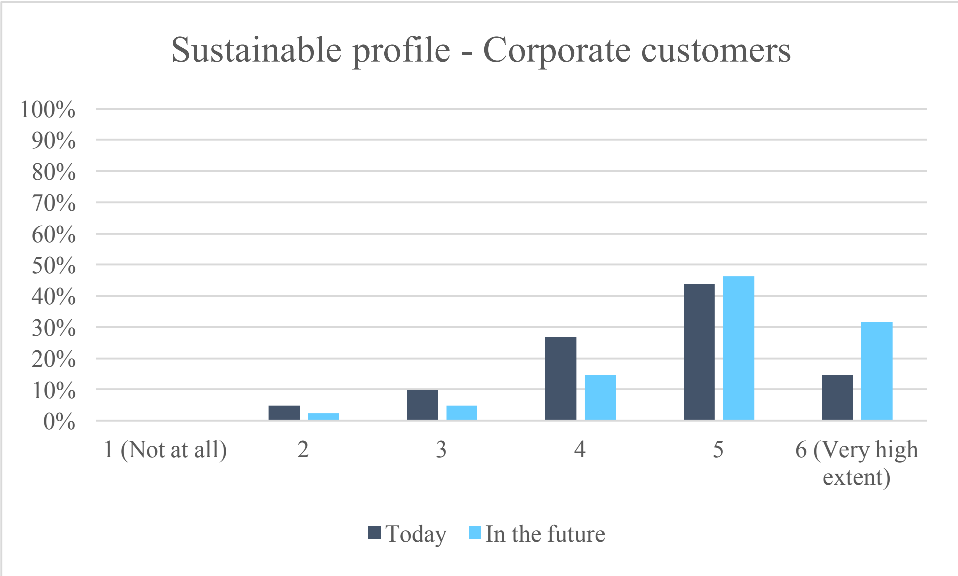


Figure A.5.15. Distribution of respondents' answers to the question "To what extent are corporate customers driven by a sustainable profile?"

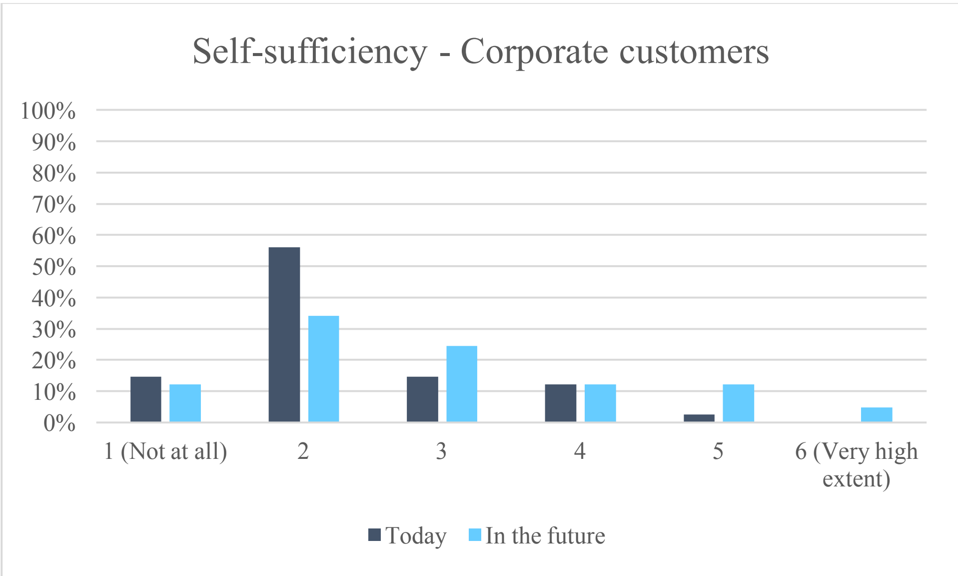


Figure A.5.16. Distribution of respondents' answers to the question "To what extent are corporate customers driven by self-sufficiency?"

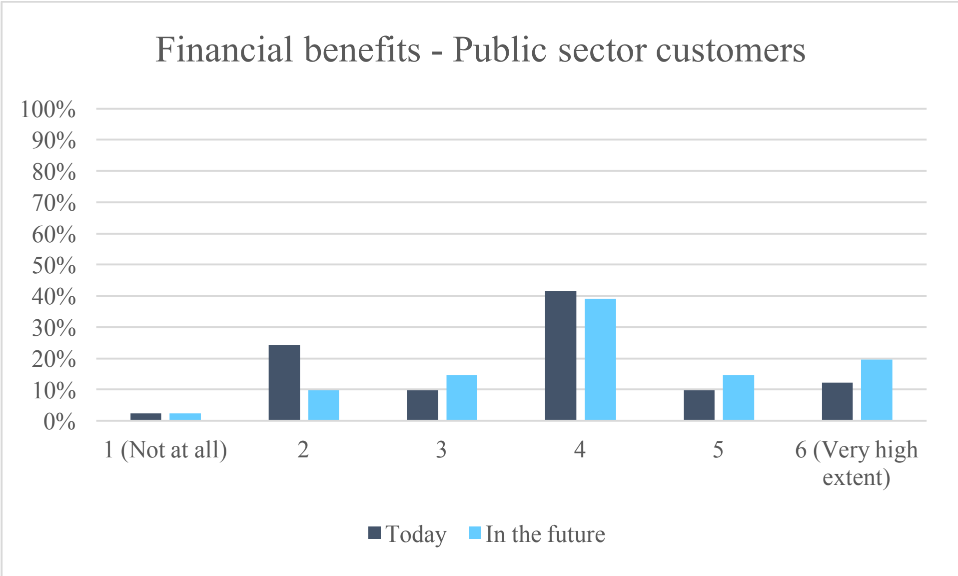


Figure A.5.17. Distribution of respondents' answers to the question "To what extent are public sector customers driven by financial benefits?"

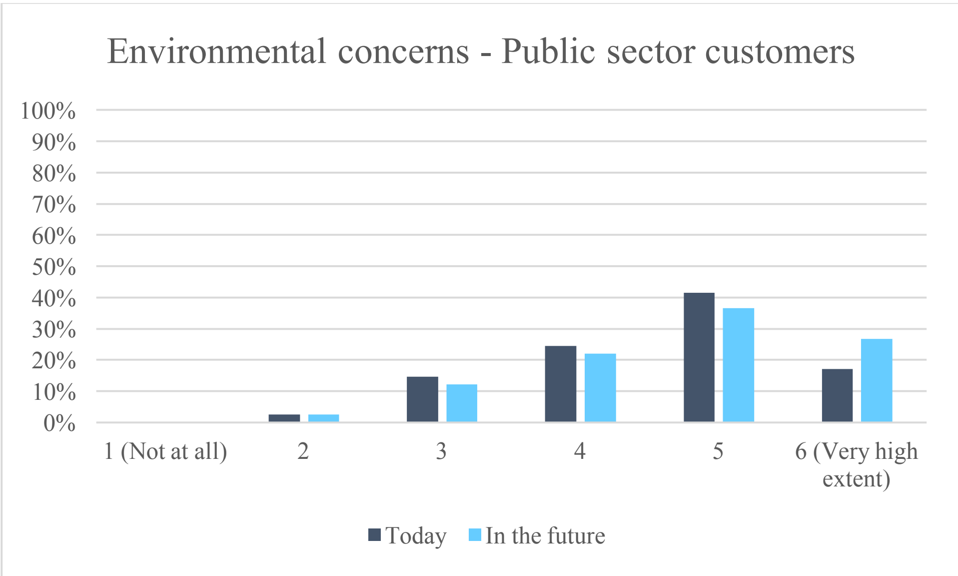


Figure A.5.18. Distribution of respondents' answers to the question "To what extent are public sector customers driven by environmental concerns?"

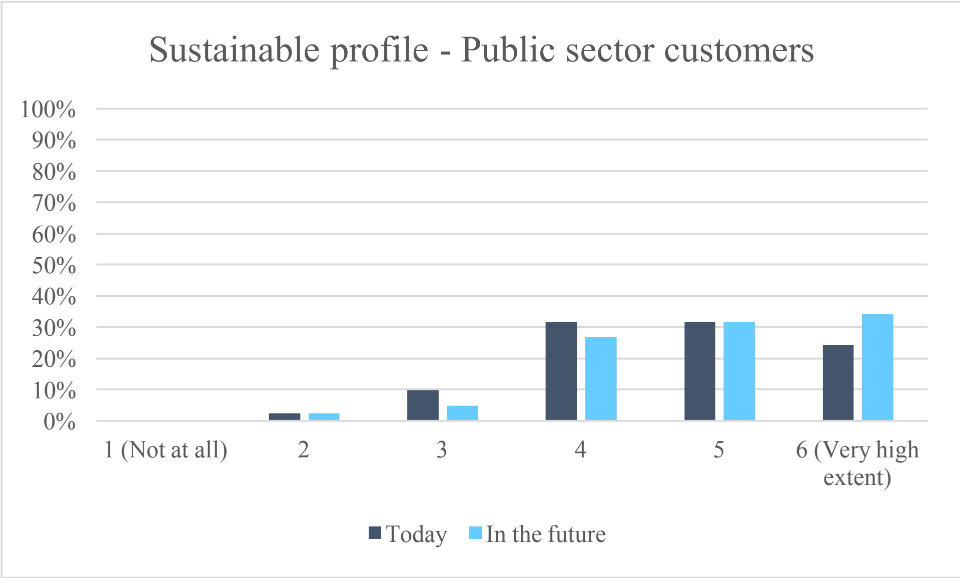


Figure A.5.19. Distribution of respondents' answers to the question "To what extent are public sector customers driven by a sustainable profile?"

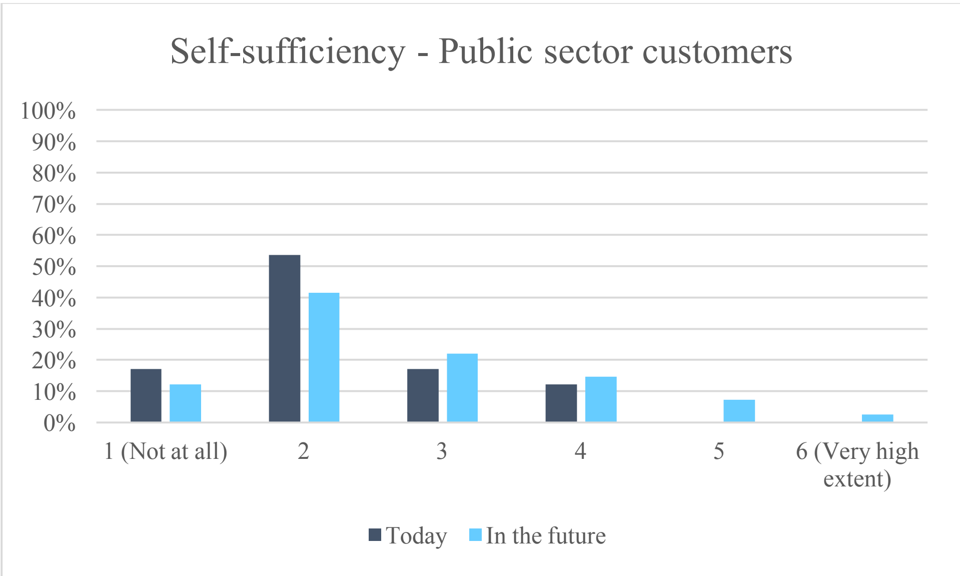


Figure A.5.20. Distribution of respondents' answers to the question "To what extent are public sector customers driven by self-sufficiency?"

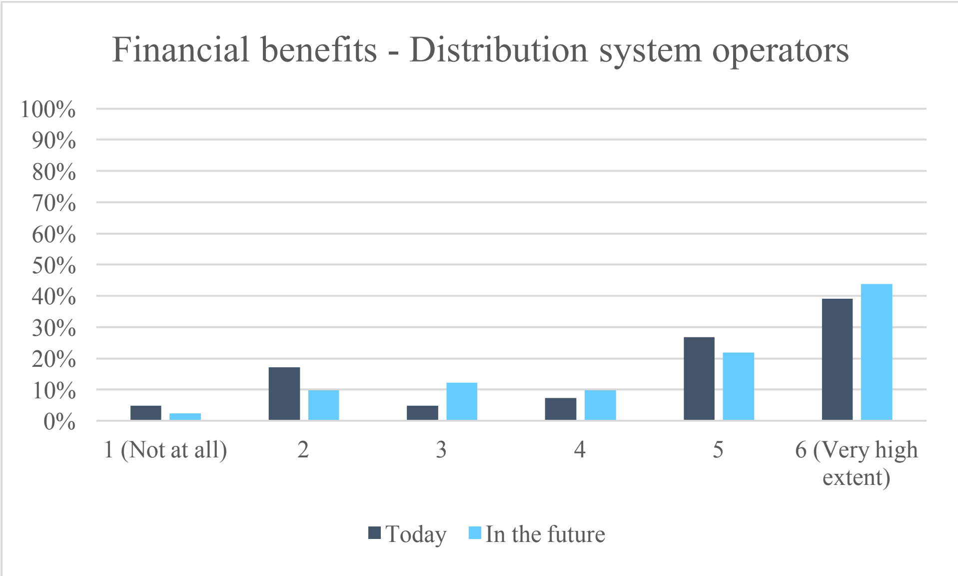


Figure A.5.21. Distribution of respondents' answers to the question "To what extent are distribution system operators driven by financial benefits?"

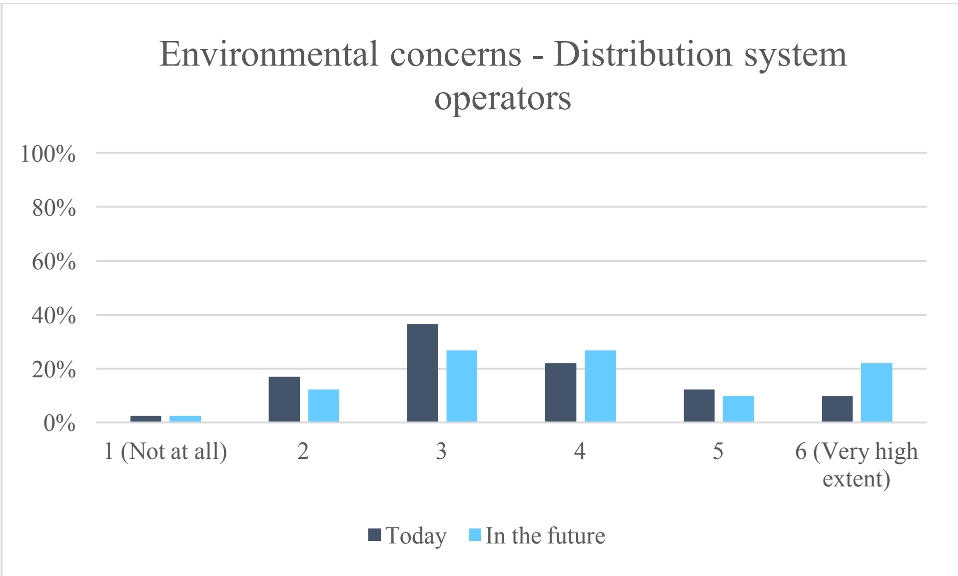


Figure A.5.22. Distribution of respondents' answers to the question "To what extent are distribution system operators driven by environmental concerns?"

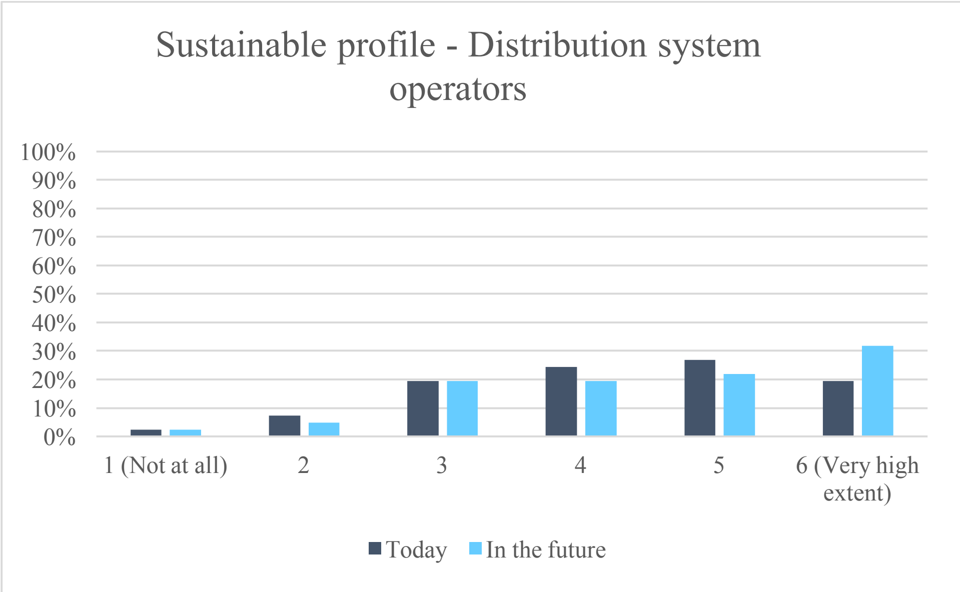


Figure A.5.23. Distribution of respondents' answers to the question "To what extent are distribution system operators driven by a sustainable profile?"

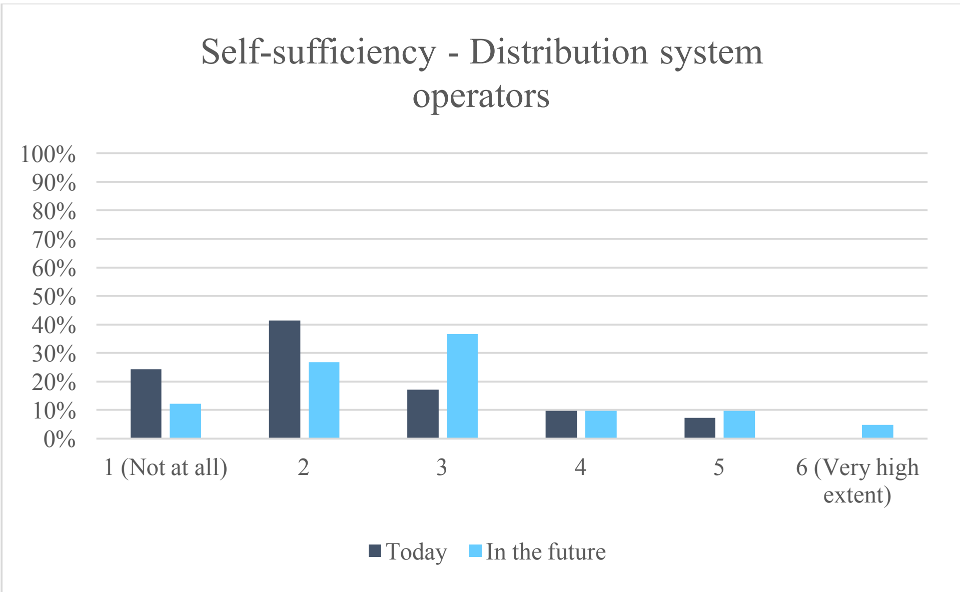


Figure A.5.24. Distribution of respondents' answers to the question "To what extent are distribution system operators driven by self-sufficiency?"

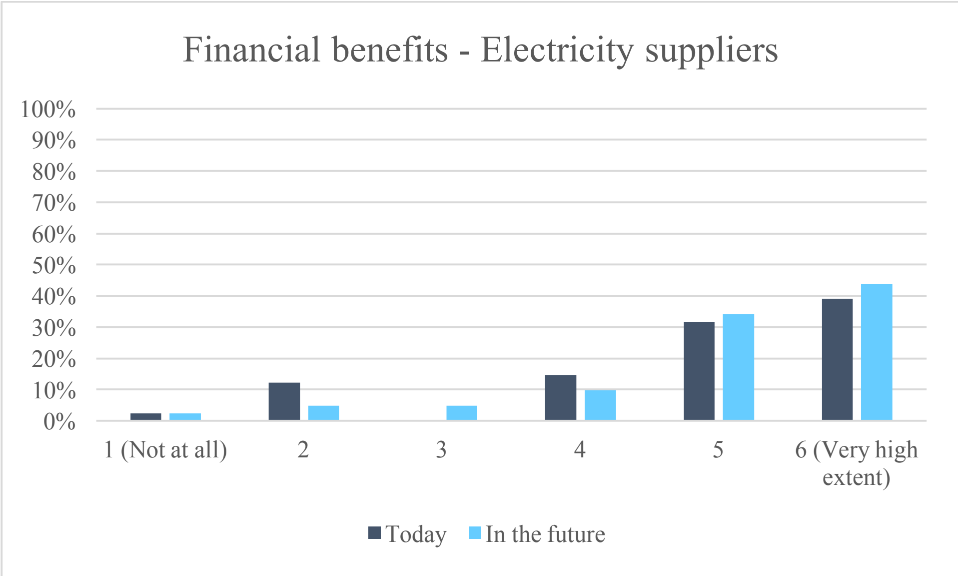


Figure A.5.25. Distribution of respondents' answers to the question "To what extent are electricity suppliers driven by financial benefits?"

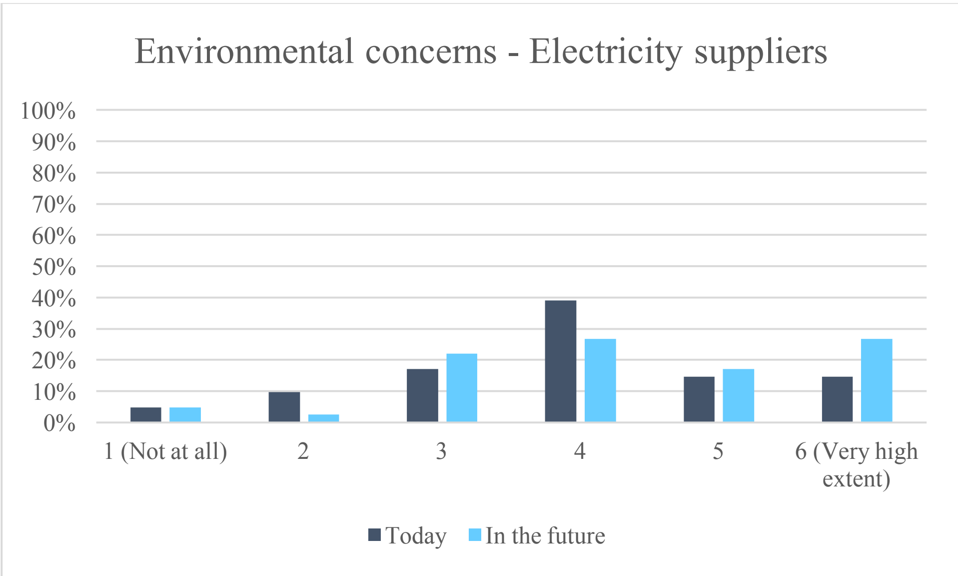


Figure A.5.26. Distribution of respondents' answers to the question "To what extent are electricity suppliers driven by environmental concerns?"

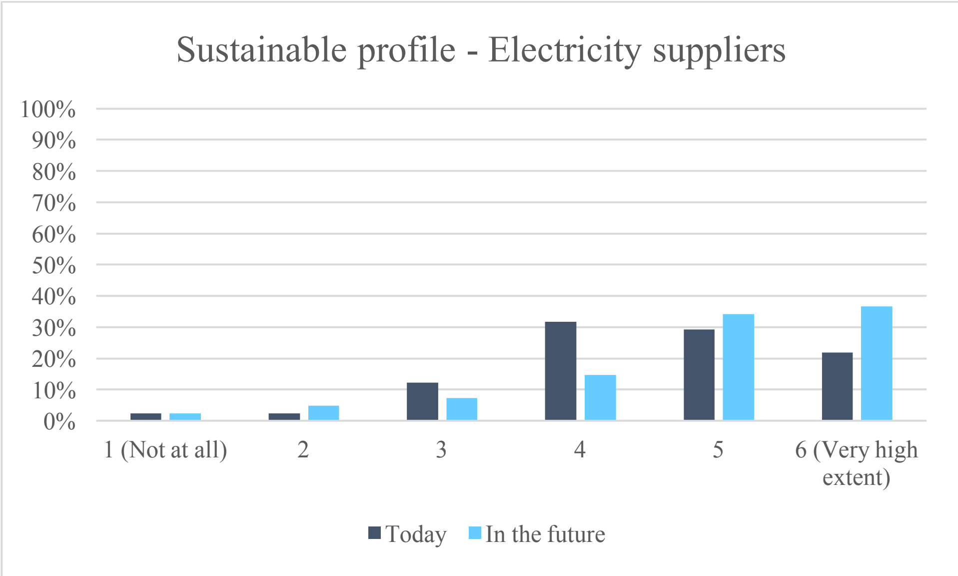


Figure A.5.27. Distribution of respondents' answers to the question "To what extent are electricity suppliers driven by a sustainable profile?"

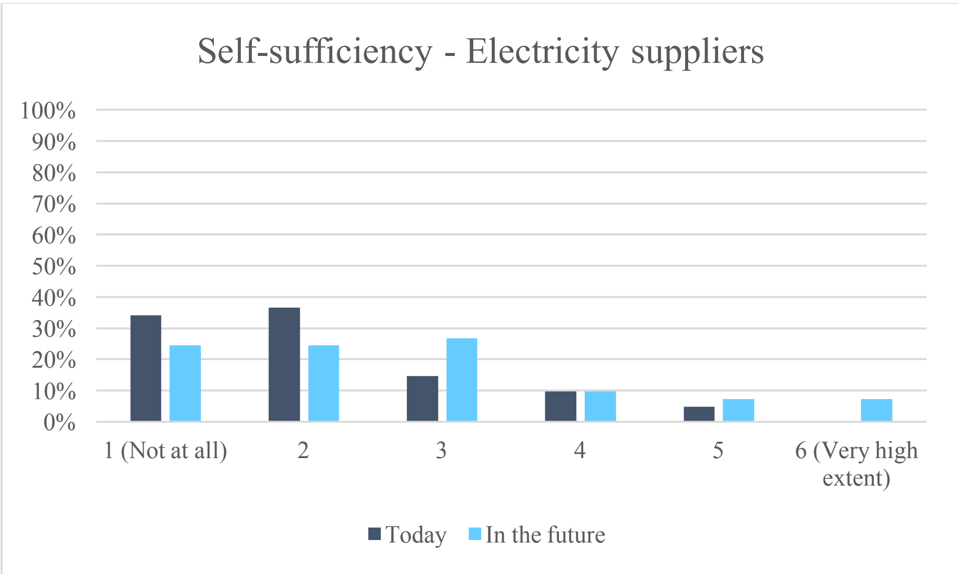


Figure A.5.28. Distribution of respondents' answers to the question "To what extent are electricity suppliers driven by self-sufficiency?"