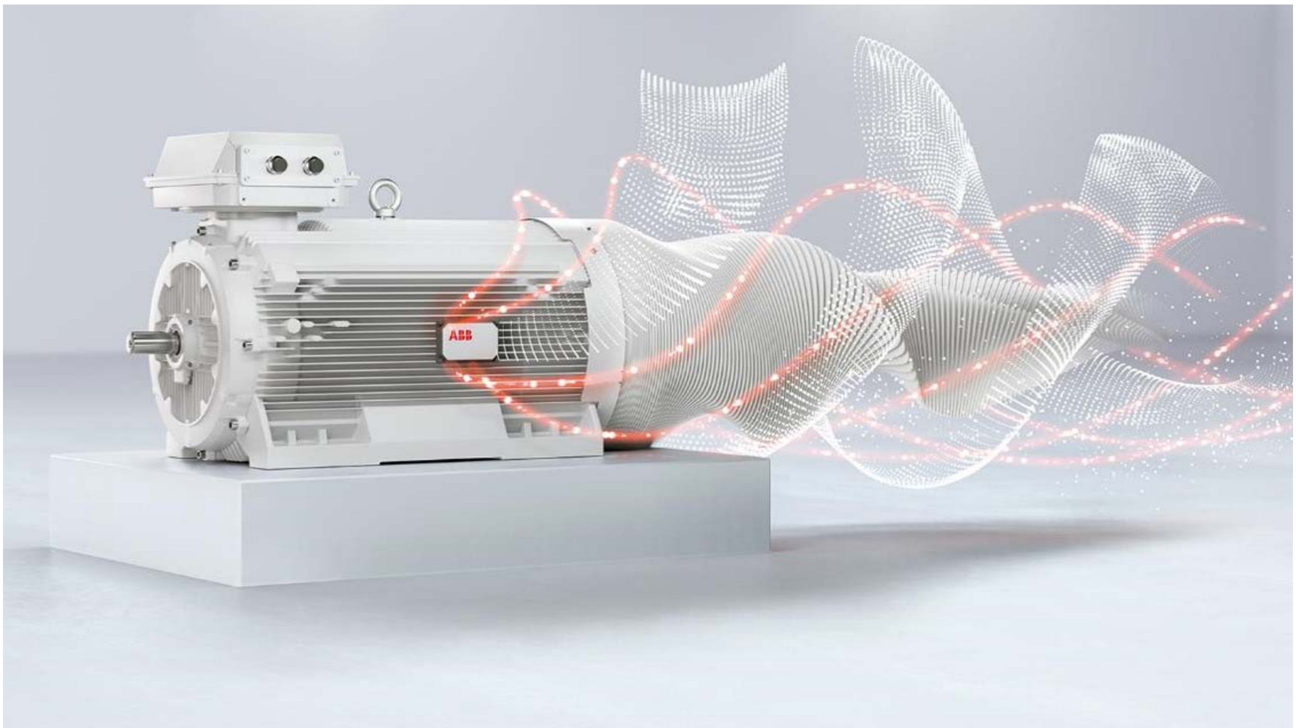

Sustainable Business for ABB Motors and Generators

Master's Thesis in the Master's Programme
Quality and Operations Management

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CHALMERS UNIVERSITY OF TECHNOLOGY

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Cover:
[an animated picture of an ABB Machine that is a part of the product line discussed in this thesis]

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Executive Summary

The market for large motors and generators has experienced a decreased demand during the last couple of years following the drop in oil prices in 2014. This follows significant investment in the sector by different actors in 2005-2014, which has resulted in an oversupply of large motors and generators on the market. ABB's division for Motors and Generators is a high quality, high cost supplier in these markets and has been challenged to keep demand high for its products. At the same time, renewable energy takes ever more market shares on the global energy market, incentivized by efforts like the Paris Agreement of 2016.

With the objective of finding new business applications for ABB Motors and Generators within sustainable energy production, this study has identified and analyzed a number of potential such applications. These applications have been evaluated in regard to ABB's resources and capabilities to compete in the prospected markets, and through an external perspective where market and technology forecasts have been taken into consideration. The analysis is based on a theoretical framework regarding business markets as networks, as well as resources in business relationships.

Three markets have been identified as having a high potential to constitute strong new business opportunities for ABB – Geothermal Power, Large Windmills, and Grid Stabilization Products. The increased share of renewable energy creates a less stable electrical grid that can be stabilized by counteracting short fluctuations with synchronous condensers. The demand for these condensers are expected to grow in the amount of uncontrollable power (i.e. sun, wind etc.) being added to the grid. Geothermal Power is an energy source that can provide sustainable and clean baseload power to the electrical grid which will be vital in counteracting longer fluctuations, particularly from uncontrollable energy sources on the grid and different power demand at different times during the day. Wind power is currently one of the cheapest forms of producing energy and the trend goes towards producing larger windmills, where the large generators can be used.

The changed business environment has also left ABB with a need to look over its sales channels, to further increase the effectiveness of its efforts to argue the value of its high-cost, high quality solutions. It is concluded focus should be on influencing end user customers to motivate the high quality and high cost of ABB's products.

Keywords
Industrial Marketing, Network Identity, Focal Startup, Network Context, Network Horizon, Sales Channels, Baseload Power, Geothermal Power, Smart Grids, Grid Stabilization, Electrical Machines, Wind Power

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To all our interviewees at Universities and Companies that took the time to help us understand things that few economists dare approach.

Table of Contents

1. Introduction

This chapter will provide a background and a structure for the reader to help visualize what the report is about.

1.1 Background

Environmental issues are gaining increased attention on the global stage. Steps have been taken towards minimizing the effects of global warming and climate change, the most recent ones being stated in the Paris Climate Agreement of 2016 (UNFCC, 2017). Global warming can in large parts be credited to emission from using fossil fuels in the production of energy, e.g. oil, gas and coal (Elliott, 2013). Fossil fuels are a finite resource and hence it is not a sustainable solution from a long term perspective. As a result of the efforts in recent years, renewable energy technologies are becoming increasingly common and today such technologies comprise a larger share of the source of produced energy in the world (Morgan Stanley, 2016). Additionally, the cost of such technologies is decreasing and applications such as wind power is currently one of the most cost-effective ways of producing energy (J.P. Morgan, 2017). According to Elliott (2013) renewable energy can be defined as the flow of energy that exists within the environment, such as sun, wind, and water. Although renewable energy often is seen as the only long term solution to keeping a sustainable climate on Earth, there can still be temporary solutions that slows climate change. An example of a temporary solution lifted by Elliott (2013) is Carbon Capture and Storage (CCS) where carbon is compressed and stored below the ground to keep it from going up in the atmosphere. The United Nations defines sustainable development as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*" (UN, 2017). In this report the definition is broadened to also include techniques and applications that slow climate change and decrease emissions.

Energy producers around the world are adapting and directing focus towards renewable energy production and their suppliers have to adapt accordingly (Elliott 2013). One of the suppliers to the energy sector is ABB Motors and Generators, that produces large electrical machines. In essence, a generator is supplied with something that drives the turbine, e.g. steam, wind, or gas from which electricity can be produced. The applications of these products have historically been in industries such as oil and gas, mining, and power supply. For a long time, these markets have been stable, with returning customers and high demand (J.P. Morgan, 2017). However, during the last couple of years, ABB and its competitors have experienced a decreasing demand as some previous customers have started producing their own products or switched to low-cost competitors, which has changed large parts of the business network in which ABB is located. On the one hand ABB seeks new market potential due to the decreasing demand in its existing networks and markets. On the other hand, they seek potential applications in the growing market of renewable energy production. This forms the background to this master's thesis.

1.2 Objectives

The main objective is to identify and analyze viable, i.e. economically profitable, new business opportunities for the motors and generators in relation to renewable and sustainable production of energy. A thorough analysis of the market they are operating in, as well as other potential markets, will be conducted in order to fulfill this objective. Part of the analysis will regard market demands, i.e. the technical and commercial requirements necessary to be competitive in the proposed market. Recommendations of how ABB can go about to benefit from the proposed business potential will conclude the project.

1.3 Problem Discussion

A large portion of the customers of ABB Motors and Generators are active in the oil and gas sector. The price of oil dropped substantially during 2014 and subsequently, demand from customers in this sector have been declining. Finding new business, particularly within oil and gas, is considered difficult and of low priority. ABB does, however, have clients within fields that could be considered more sustainable and with higher potential for new business. The drop in oil price have been mentioned as the main reason to the drop in revenue, but it's possible that other reason has driven the change as well, and finding out why is one of the first things effort must be put to clarify and review.

When new business opportunities within sustainable energy are reviewed, two things need to be kept close in mind. First, there must be a financial relevance in the applications for them to be relevant at all, and so financial analysis must in some terms follow in parallel to the technical and ESG evaluation. There might also be necessary to decide how to relate to applications in the gray zone of sustainability. Should applications that can be argued to have sustainable impact be touched more than briefly, and if so, how much?

In order to propose a future direction for ABB it is necessary to conduct an internal and external analysis to understand the company's capabilities and requisites (Hayes et al. 1996). The internal analysis will ensure that any suggestions are connected to ABB's current strategy. The purpose of the internal analysis is to pinpoint ABB's strengths and competitive areas as well as to examine possible synergy effects between divisions that ABB can benefit from when expanding their market and target group. The external analysis will focus on the firm's external environment. As the network ABB is operating in is changing, they need to adapt and maybe reform relationships, if they should follow established network strategies. (Håkansson and Ford, 2002).

Figure 1 - Scope of the project.

The scope of the project is divided into three areas. First of all, the internal point of view. In order to understand ABB’s capabilities and limitations it is necessary to conduct an internal analysis to be able to give reasonable suggestions. Second, the customer relationships. In this area the requirements within the market are of importance, as well as the identification of possible customers and attractive new markets. ABB’s current customer relationships as well as potential new relationships will be analyzed. The external point of view will have two levels of analysis. The first one is the customer relationship level (Håkanson & Snehota, 1995) and the second one is the network level The positive externality of customers using ABB’s products. In this area the view will be broadened to further explore potential opportunities. A sustainability-mindset will be a common theme throughout the analyzes within these areas.

This leads to the following four research questions:

- How can ABB utilize its current resources and product portfolio in new sustainable business applications?
- What does potential customers within sustainable energy production value and require from a supplier?
- What does ABB's network look like and how can ABB utilize it to find new viable and sustainable business?
- What changes within ABB would facilitate the process of attracting new customers?

1.4 Disposition

The disposition of this thesis follows the method of systematic combining (see 3.3) hence the traditional structure has not been followed. Analyses have been conducted throughout the study thus also in the report, where the latter chapters (5,6,7,8, and 9) consist of a combination of theory, empirics, and analysis.

The initial chapter gives the reader a brief introduction to the background of the thesis as well as to the research questions that will be investigated in this report. It also contains a description of the focal company (ABB) and the demarcations to the scope of the study. Chapter 2 contains a description of the products of ABB Motors and Generators and some basic theory behind the technologies. This is followed by chapter 3 which aims at providing the reader with a thorough description of the method used in this study, i.e. data collection, research strategy & design, and research quality.

Chapter 4 contains the theoretical framework of the report focusing on business markets as networks, resources in business networks, and relationships between actors in a network. This chapter lays the foundation for part of the analysis conducted in the latter chapters. Chapter 5 gives the reader an explanation of the different entities in ABB's business context and how they are related to each other. This is followed by a chapter that describes the market ABB is operating in and the opportunities & challenges surrounding it.

As the focus of this report is within renewable energy chapter 7 provides the reader with an explanation of the implications on the electrical grid when the share of renewable energy sources increases. This is followed by chapter 8 which describes and analyses the applications that has been considered in this study following the funnel approach (see chapter 3.4.2). Chapter 9 describes ABB in relation to the most promising applications and how ABB can go about to take advantage of the business opportunities that the applications provide. A recommendations chapter concludes the study which summarizes the recommended course of action for ABB in the near future.

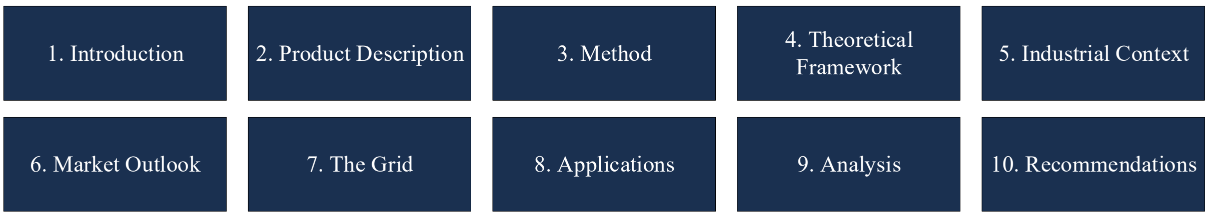

Figure 2 – Disposition

1.5 Demarcations

The project will use a funnel approach to regard different new applications for the products. In the beginning, many different applications will be considered and then continually be prioritized until 2-3 applications are left to be considered on a more detailed level. Disregarded applications will not specifically be lifted or further viewed by the study.

The study will cover the exploration of potential business possibilities for ABB, leaving the implementation and entry strategy outside the scope of this project.

1.6 ABB Motors and Generators

ABB is a global industrial technology company that works with utility, industry, transport and infrastructure customers in roughly 100 countries with 132 000 employees and approximately 35 billion USD in annual revenue. It is the merged product of the Swedish company ASEA and the Swiss company Brown Boveri, that were both founded in the late nineteenth century to create electrical products. ABB has worked with digitalization for more than four decades and has a vision to be the leader in digitally connected and enabled industrial equipment and systems. It currently has an installed base of more than 70,000 digital control systems connecting 70 million devices.

This study focuses on ABB Motors and Generators and its factory in Västerås, Sweden. The Västerås factory is one of several factories in ABB Motors and Generators that in turn is one of three business units under ABB Robotics and Motion, one of the four divisions of ABB, see below.

The Västerås factory acts independently from the other units, but is a part of a larger internal network with similar business units inside ABB and ABB Motors and Generators. The Västerås factory has 310 employees. The factory has a long history dating back to the nineteenth century and has a long-serving specialized staff with a strong brand distinction, derived from thousands of successful installations and a high level of technical competence.

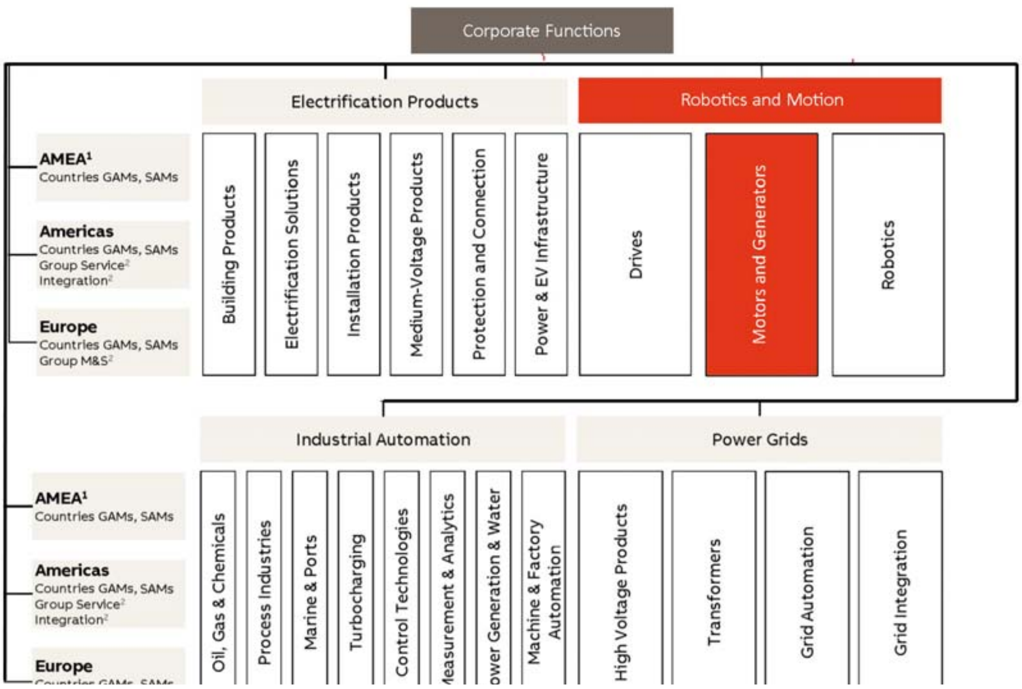

Figure 3 - ABB Organizational Chart

2. Product Description and Technical Framework

ABB Motors and Generators has a broad range of different products and accessories. The Västerås factory produces units within three product areas: Synchronous Machines, Induction Machines and VHV - Very High Voltage Units. The machines can be configured to be either generators or motors. The machines come in many different sizes and configurations, but all machines have in common the basic design of having a Rotor, (that rotates) inside a Stator (that is static).

A generator is a machine that converts kinetic power to electric power, i.e. generates electric power. An electric motor is a machine that creates kinetic power from electric power, i.e. generates torque.

In the case of generators, kinetic energy rotates the rotor inside the stator, thus creating an electromagnetic field between the copper winding in the rotor and stator that spawns an electric current.

In the case of a motor, current is lead through the copper winding in the stator, creating an electromagnetic field that makes the rotor rotate. This creates kinetic energy from the electric (AC) current and is as such a motor.

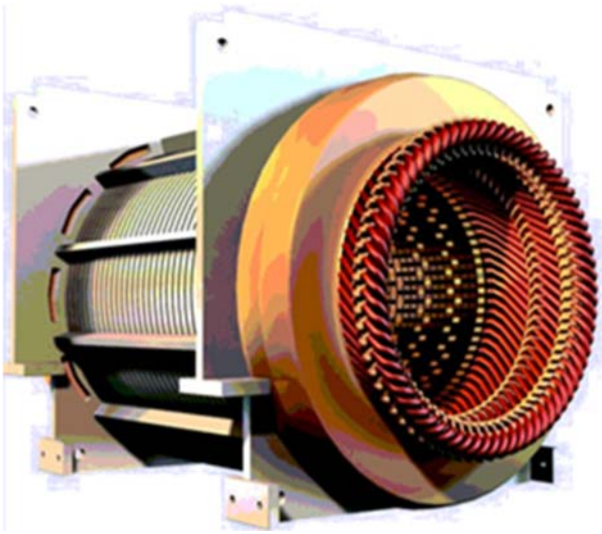

Figure 4 - A Stator

Very similar machines can therefore be either setup as a motor or a generator, depending on whether current or kinetic energy is the input or output. Some products can act as hybrids, being both motors and generators at the same time, varying input and output.

The output of the products currently produced in Västerås ranges from 0,5 megawatts to 80 megawatts. It would be possible to create up to 250MW with current technology, but that would require significant investment in production equipment.

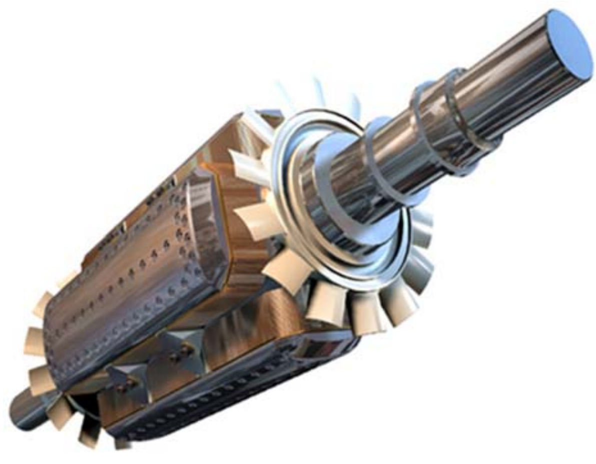

Figure 5 - A Rotor with Four Salient Poles

The products can be made either as synchronous or induction (asynchronous) motors/generators. A synchronous motor has one set speed, or Rotations-Per-Minute frequency, that exactly matches the frequency of the input current. An inductive motor can have different speeds that does not match the input current frequency. A synchronous generator must have a steady kinetic input, and are therefore limited to controllable inputs like water, diesel, gas and steam.

In addition to the rotor and stator, synchronous units also have an exciter, a small permanent-magnet dynamo that produces the field current for the larger generator. All units have bearings that makes it possible for the rotors to rotate, cooling systems and a machine casing. All parts vary depending on applications and environment.

2.1 Alternating Current (AC) Induction Motors and Generators

Induction Machines are characterized by they having inductive alternating current in the rotor that gets a magnetizing effect from the stator. The rotors in an Induction Machine are laminated, cylindrical, and have more poles than a synchronous machine. The Induction Motors produced in Västerås are available in two product series: Modular design and slip ring-design, with frame sizes ranging from 710mm to 1120mm and a rotation frequency of 50 or 60hz.

The modular induction motors AMI have a base unit and a broad range of accessories that are added to the base unit in a made-by-order modularity, each device being customized to fit the customers' needs. The modular design is said to have an optimal weight to power ratio in comparison to other products. They are available in sizes up to about 20mw.

The Slip Ring design has an external slip ring to allow for easier maintenance. It is more suitable for drives with adjustable speed. They are made with an output ranging between 1 and 18MW, and can be fitted with 4-24 poles (more poles on request).

The main applications of the induction machines are pump motors for power stations, water supply and sewage plants, compressor motors for Chemical, Oil, Gas and Air Separation, Fan motors for power stations etc.

2.2 Synchronous Motors and Generators

Synchronous Machines are characterized by having a set rotation frequency that matches the Electrical Frequency that it is connected to, by the relation

$$Rotations\ per\ Minute\ =\ (Electrical\ Frequency * 2 * 60) \div Number\ of\ Poles$$

Instead of feeling a magnetizing effect from the stator, the rotor is magnetized by an external exciter, which is a dynamo with the sole purpose of feeding a set Direct Current (DC) to the rotor. Further, the rotors in synchronous machines have salient poles, usually 2-6.

Synchronous machines produced in Västerås has either 4 or 6 poles, frame sizes between 710-1400mm and has an output ranging between by 2-80.

The primary uses of Synchronous Motors can be found powering refiners, compressors, fans, extruders, etc. Many are often installed on offshore platforms. The generators - that need a controllable kinetic input - are driven by gas- and steam turbines or in combined-cycle setups.

Some versions can be equipped with Variable Speed Drives (VSD) that makes it possible to switch the output/input frequency with the help of a gearbox. This increases process controllability, which is useful when the process requires flow or pressure control according to the specific conditions. VSD gearboxes also reduces total energy consumption, releases capacity in electrical supply system and increases life of equipment lifetime, since the machines does not always need to operate at full power.

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2.3 Very High Voltage Synchronous Motors and Generators

VHV Machines are sized and prepared to be connected directly to a High Voltage Direct Current (HVDC) power grid, that are usually found in international or national power grids, transmitting large amounts of power over long distances. By sizing the machines for direct connection to HVDC grids, the need for transformers - that changes the characteristics of a current - is eliminated.

3. Method

This chapter will describe the method and approach used in this study. Initially the strategy and design will be discussed followed by the method for collecting and analyzing the data. The next section will describe and elaborate on aspects related to quality of the research and how this study has taken these aspects into consideration. The chapter will be concluded with a section describing the interviews that has been conducted in this research and the purpose behind these.

3.1 Research Strategy

Research strategy is divided into two separate approaches, qualitative and quantitative (Bryman & Bell, 2015). Quantitative research focuses on proving, or explaining, a hypothesis based on quantitative facts. Hence, the researcher believes that there is one single answer to the phenomena in question. Qualitative research on the other hand is more exploratory by nature. In line with this, the existence of several answers to a phenomenon is accepted hence context and interpretation becomes an important element. As the project by definition is looking into new market areas, an exploratory and qualitative research strategy is considered appropriate.

3.2 Research Design

There are five commonly used research designs according to Bryman & Bell (2015). The first one being an experimental design. As experiments can be difficult to conduct in a business setting it is rarely used in these kind of studies. Instead, it is used in e.g. the medical industry when testing drugs. Second, the cross-sectional design - Data is collected from multiple cases in order to find patterns between them. Commonly used tools are questionnaires and structured interviews. Third, the longitudinal design. This design takes time into account as the same sample is examined on multiple occasions hence e.g. trends can be detected. Fourth, the case study design where one single case is the focus of the study and analysis. This design is highly applicable in a business setting. Fifth, the comparative design - The same method is used in multiple cases in order to be able to compare between them.

As ABB is the main focus of this project the natural choice of research design is a case study, i.e. one single case is closely examined (Bryman & Bell, 2015).

3.3 Research Method

In other words, research method can be described as a plan for collecting data (Bryman & Bell, 2015). There are multiple ways of collecting data such as questionnaires, interviews, observations, experiments etc. The most common method in a qualitative approach is interviews. There is a distinction between structured interviews and semi-structured interviews, where the first method follows an interview guide with prepared questions to the letter while a semi-structured interview follows a guide but encourage the interviewee to go off in other directions. As a qualitative approach is reliant on context description and interpretation it is oftentimes appropriate with semi-structured interviews.

Dubois & Gadde (2002) suggest a research method of systematic combining in a case study, an approach that this study will follow. The systematic combining develops the theoretical framework in parallel with the empirical framework instead of viewing it as a linear process (ibid.). Two concepts are important in the approach - matching and direction & redirection. Matching refers to the process of matching the phenomena discovered in the case with theory. Once new aspects or discoveries has been found in the case a matching effort is done to find relevant theories supporting the empirical findings. Hence, the researcher goes back and forth between the theoretical and empirical framework. An implication of this is that the study can change direction dependent on what is explored in the case and in the theory. This aspect is referred to as direction & redirection. The theory can guide the empirical research and the empirics can guide the theoretical research. The approach is illustrated in figure 6.

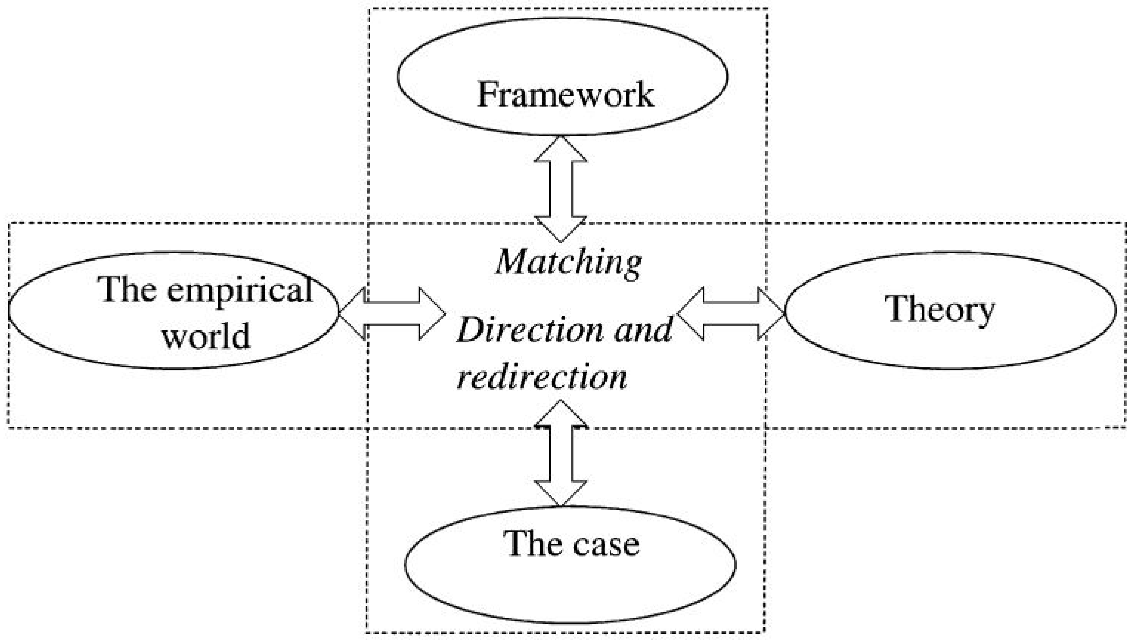


Figure 6 - Systematic combining (Dubois & Gadde, 2002)

3.4 Data Collection and Analysis

In general, qualitative research generates a large amount of data that can be difficult to analyze due to the nature of qualitative data (Bryman & Bell, 2015). The data gathering in this study is mainly comprised of semi-structured interviews where context and situational descriptions are of great importance. In order to analyze the data in a way that is sufficient the interviews will be conducted with several individuals covering the same topic to avoid misunderstandings and misjudgments. Additionally, the interviewees will belong to different positions within ABB as well as from other sources such as experts on the topic from the academia. In this way, it is possible to secure the quality of the data.

3.4.1 Literature Search

Besides the empirical data collection, from interviews, a thorough literature search has also been conducted. The literature search can be divided into two areas. First of all literature connected to theory behind networks, customer relationships, and resources were examined. This literature was found using the databases of Chalmers library and Google Scholar. The aim with this literature study was to get a deep understanding of ABB's network and its relationships from a theoretical point of view. The study strived to find theory from different authors to be able to compare the literature and give a more nuanced picture of the phenomenon.

Second, literature regarding the applications and technologies were examined. This literature was more focused on finding market reports and forecasts that could facilitate the evaluation of potential applications. In this area, it was important that the reports were up to date and contained the latest information regarding the markets. ABB's internal business intelligence portal was utilized to find sources of this nature. Forecasts and market reports were found from well reputed organizations such as Morgan Stanley and J.P. Morgan. Internal reports from ABB has also been considered although some information from these had to be left out of the report due to confidentiality issues.

3.4.2 Funnel Approach for the Empirical Study

In order to analyze and review the data a funnel approach will be used. Input from different sources will comprise the data needed to assess the phenomena. The funnel approach will be mainly used when analyzing the considered applications and its business opportunities, see below.

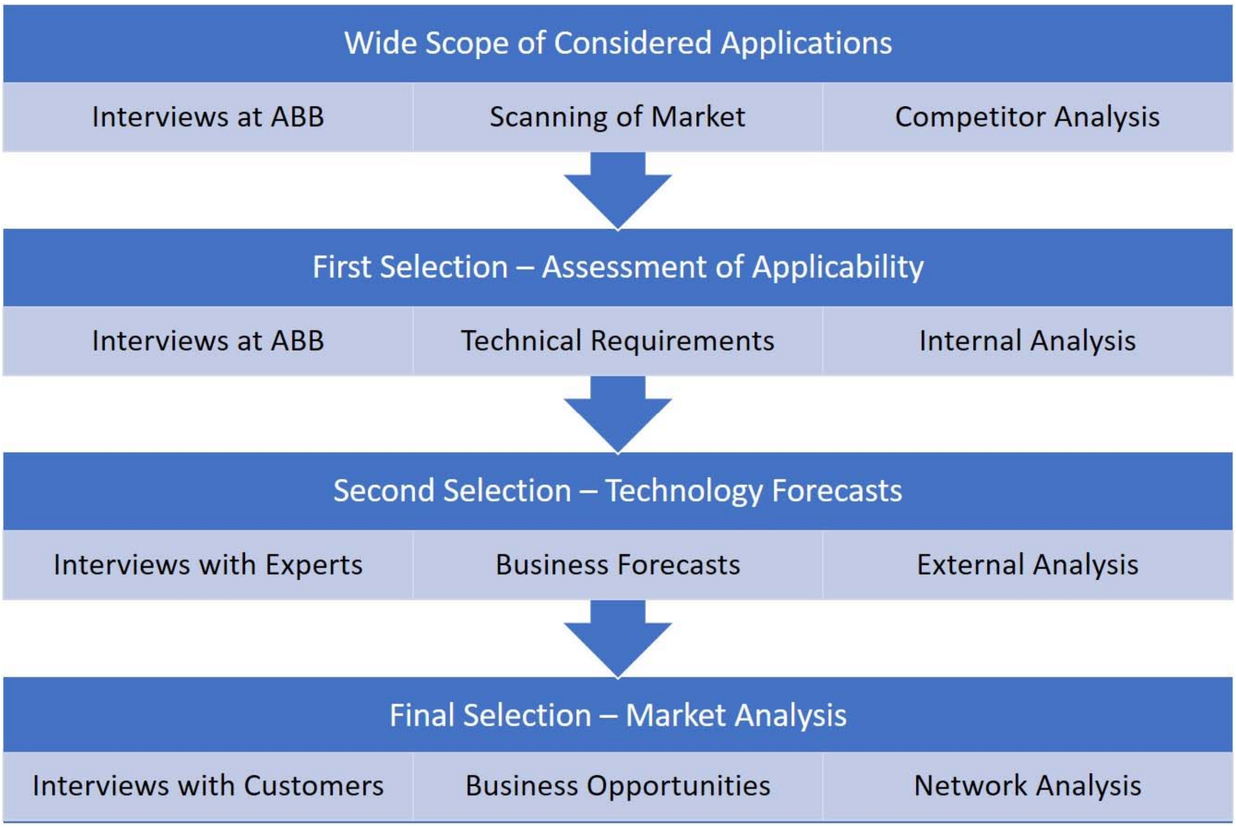


Figure 7 - The Funnel approach.

The funnel approach consists of four steps. In the beginning a wide scope of applications will be collected through different sources such as interviews at ABB and by scanning the market for potential applications. Once a variety of applications has been collected they will be assessed to ensure that the product portfolio of ABB Motors and Generators fit the requirements from the specific market. It will also be assessed whether there is a potential to develop a new product that can fit the requirements. Third, the forecasts of the technology will be analyzed to determine the state of it, i.e. is the market declining or increasing? This step is done to limit the risk of ABB making investments in a market that is obsolete or in the end of the life cycle. Finally, the market as such will be analyzed. This is done to determine the possibilities for ABB to enter the market. An internal analysis alongside an external analysis will be done where ABB's channels to the market as well as the competitive climate will be analyzed to assess the business opportunities for ABB in the near future. The funnel approach will limit the recommendations to a few well examined applications with strategies to exploit the market.

3.4.3 Conducting Interviews

The empirical data in this study derives from semi-structured interviews conducted with 1. Internal Staff at ABB Västerås factory, 2. Clients of ABB Motors and Generators Västerås Factory and 3. Research Staff at Chalmers. At ABB we interviewed all sales staff at the Västerås Factory, the heads of the product departments, global product marketing staff and electrical design staff. The names of the interviewees are withheld, but total internal staff that were interviewed at ABB Motors and Generators in Västerås numbers to 17 people. There are three main areas that has been addressed through these interviews - ABB's internal resources, Market situation & forecast, and Customer expectations. In order to examine the internal resources a number of interviews have been conducted with employees at ABB. The market situation and technical properties surrounding the different sustainable technologies have been covered by interviewing staff at Chalmers – experts in their respective technology fields, i.e. considered applications, although the main data in this aspect derives from an examination of marketing and forecasting reports from sources such as J.P. Morgan and Morgan Stanley. The area of customer expectations has been covered by a thorough interview with one of ABB's key customers, a major player in the geothermal market, in Israel by web interface.

Throughout the data collection a semi-structured interview approach has been followed where the interviewee has been encouraged to elaborate on side tracks and not follow the interview guide to the letter. Each interview consisted of approximately 15 open ended questions, five in each grouping; market situation and forecasts, user expectations and how the technology relates to the internal resources of ABB. Interviewees with actors outside of ABB were described the properties of the resources of ABB. This approach made it possible to discover new areas of investigation and not limit the research to the interviewer's prior knowledge. Prior to the interview an interview guide was prepared with the topic areas for the interview was written as well as a few questions related to these. The reason for preparing a rather small amount of questions was to be able to focus on follow-up questions in areas where the interviewee had knowledge. The interview guide was customized to every single interview and was developed as the knowledge of the interviewers increased.

In line with the systematic combining method used in this report there has not been a linear progress that has been followed regarding the interviews. Initially the sales organization at ABB was interviewed. The reason behind this was that it was deemed that these functions could provide a holistic picture both with regards to the products and the market situation. In these interviews the topics covered were the current situation, future situation, and sustainability. The current situation covered topics such as sales arguments, market segmentation, customers, competitors, and market situation. In the future situation, it was discussed areas where the interviewee saw a potential for increased sales as well as aspects that could be changed within the ABB organization. In the final area, sustainability, it was discussed potential sustainable applications for the product portfolio of ABB Motors and Generators. It was also discussed the trends within the industry and how ABB's current customers focuses on sustainability.

In parallel with the interviews at ABB a theoretical framework was developed where the potential applications that derived from the interviews were examined more closely. Part of this was interviews with experts from Chalmers. These interviews had a focus on the technology itself as well as the current research regarding it. The forecasts and market situation for these technologies was also discussed as well as potential areas where ABB's products could fit. These interviews were part of the funnel where some technologies could be discarded due to low potential and some became subject for further examination.

Interviews with the product managers at ABB was also conducted. These interviews focused on the products as such as well as areas where it was possible to extend or change the product offering to match future markets within the sustainable segment.

The final interview with ABB's customer, the major player in the geothermal market, covered three essential areas - The geothermal market, ABB as a supplier, and improvement areas. This interview made it possible to compare the picture that was provided by the interviewees at ABB regarding their network identity with the picture that the player provided through their lens. It was also possible to get a more thorough understanding of the geothermal market as such as well as areas where ABB could manage their product offering to better match the requirements of the player. The reason why the player was chosen as an interview object for this study was that they act as multiple roles, i.e. OEM, EPC, and End User. Hence, it was possible to get an understanding of what they value depending on the role they have in their projects. In general, it was rather difficult to manage to get interviews with ABB's customers. Essentially this derives from the area of investigation in this study being rather sensitive. It is possible that the customers view this as a way of acquiring sensitive information. Hence, only one interview with ABB's customers could be conducted.

3.4.4 Analysis and Selection of Applications

As described in section 3.4.2 the scope of the first selection were rather extensive. The input to the considered applications derived from various sources such as the conducted interviews, marketing reports, and internal documents (see chapter 8). However, despite of the wide scope there were applications that were discarded directly due to them obviously not being in the scope of this study. There were two criteria for the discarding applications directly – Sustainability and Applicability. The main part of these applications was discarded as they were not sustainable, such as diesel generators and gas turbines. Other technologies were discarded as ABB Motors and Generators did not have appropriate products for the application, such as battery storage. The discarded applications were not subject for further analysis hence they are not further mentioned in the study.

3.5 Research Quality

The concept of trustworthiness is applicable in a qualitative research setting and will be used in this case (Bryman & Bell, 2015). The dimensions covered in trustworthiness are credibility, transferability, dependability and conformability. Credibility refers to the practice of how the study is conducted e.g. triangulation and respondent validation in an interview setting. A literature study in combination with interviews and benchmarking will be used as triangulation and feedback. Validation of interview transcripts will secure the credibility of this study. Transferability is the applicability of results and method in other contexts. Emphasis will be put on describing the settings in which this study is conducted as well as a detailed description of the involved companies and the context in which they operate.

In quantitative research reliability is the concept of being able to achieve the same results if the study is conducted in a similar way. In qualitative research the similar concept is called dependability. However, as the results of qualitative research is dependent on the context and constantly varies the objective of reaching the same results is unrealistic. Instead dependability focus on being able to replicate the study, and its' method, therefore a thorough description of the method will be provided to the reader. Conformability covers the objectivity of the study. In a qualitative setting subjectivity will always be present hence complete objectivity is unreachable. To overcome this the study and method will be critically reviewed by the authors and the supervisors of the study in order to provide the reader with potential disadvantages of the method and its' objectiveness.

3.5.1 Internal Validity

The project team has divided its time between the ABB Motors and Generators Västerås Plant and Chalmers University of Technology, receiving feedback, impressions and ideas both from ABB and Chalmers Staff and peers. This decreases the risk of having the project team being influenced by one actor. At the same time, since the project team are hired staff of ABB and has spent time there, they are expected to be influenced to a large degree. The influence is primarily considered to be in relation to the network identity of ABB, the appreciation of its resources and relationships, as well as focusing the work from the perspective of ABB. Confirmability values are likewise considered skewed towards the perspective of ABB, even if objectivity in this case is not considered to be required between companies, but rather in a sense between decision options. Since an objective and confirmable base is required for ABB to make good decisions, the same base is inductively transferable to other organizations as well.

3.5.2 External Validity

A high external validity in case studies are always difficult to achieve, since they focus on specific cases. Likewise, our study focuses solely on ABB Motors and Generators, its products and its network. While the specific case is difficult to replicate, the structure and methods used in this study are based on existing work within market and network analysis. The work aimed at increasing external validity through a structured approach with well-researched tools, some measure of reproducibility should be found within the bounds of the study.

4 Theoretical Framework

This chapter forms the theoretical background to the report. Initially it describes business markets when viewed as networks and elaborates on the characteristics and relationships between the entities within such a network. Additionally, it is discussed how an actor can utilize and manage the network favorably. This is followed by a discussion of the focal point of the theoretical framework, resources. A description of a triadic relationships concludes the chapter where the focus is on strategies for relationship building within such a setting.

4.1 Business Markets as Networks

A business network is comprised of a number of relationships between entities, i.e. actors (Anderson et al., 2009; Håkansson & Snehota, 1995; Håkansson & Snehota, 2006). One such relationship is the dyadic relationship which is the direct relationship between actors such as a supplier and a buyer (Anderson et al., 2009; Anderson et al., 1994). The dyadic relationship can be described as the focal relationship between two actors. However, once the network is considered the dyadic relationship becomes inadequate to describe the larger picture. As the companies within the focal relationship have relationships with other actors, as well as some common relationships with the same entity, that influences the focal relationship the network map soon becomes rather complex. This is illustrated below.

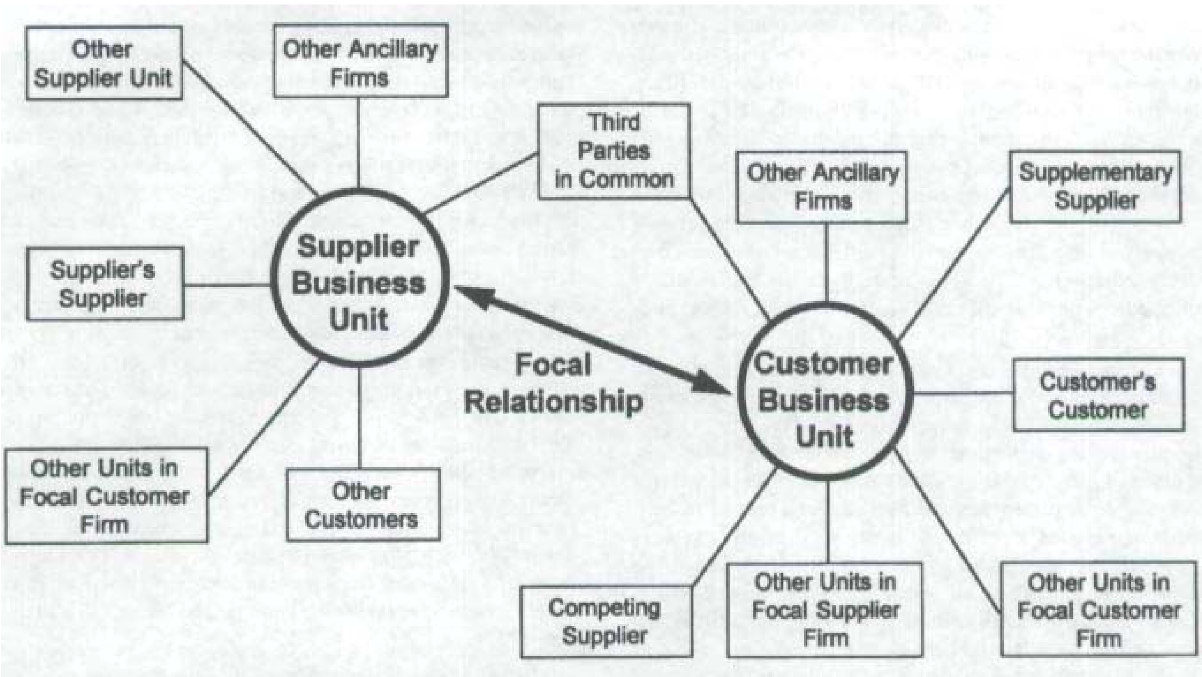


Figure 8 - Relationships within a Business Network. (Anderson et al., 1994)

A relationship within a business network contain three different dimensions namely actors, activities and resources (Håkansson & Snehota, 1995; Anderson et al., 2009). Through these dimensions it is possible to analyze a network. Actors are entities that control resources in some way, hence the term goes beyond just companies and include other entities such as governmental organizations (Anderson et al., 2009). These actors control, and transform, resources through value adding activities (ibid.). Relationships between actors creates a possibility to conform their activities to increase the performance (Anderson et al., 1994). One common example of such conformance is just-in-time approaches (Frazier et al., 1988). Resources can be both material, such as raw material and equipment, and immaterial such as knowledge and expertise (Håkanson & Snehota, 1995). In order to understand and analyze the effects of these dimensions the framework presented below can be used.

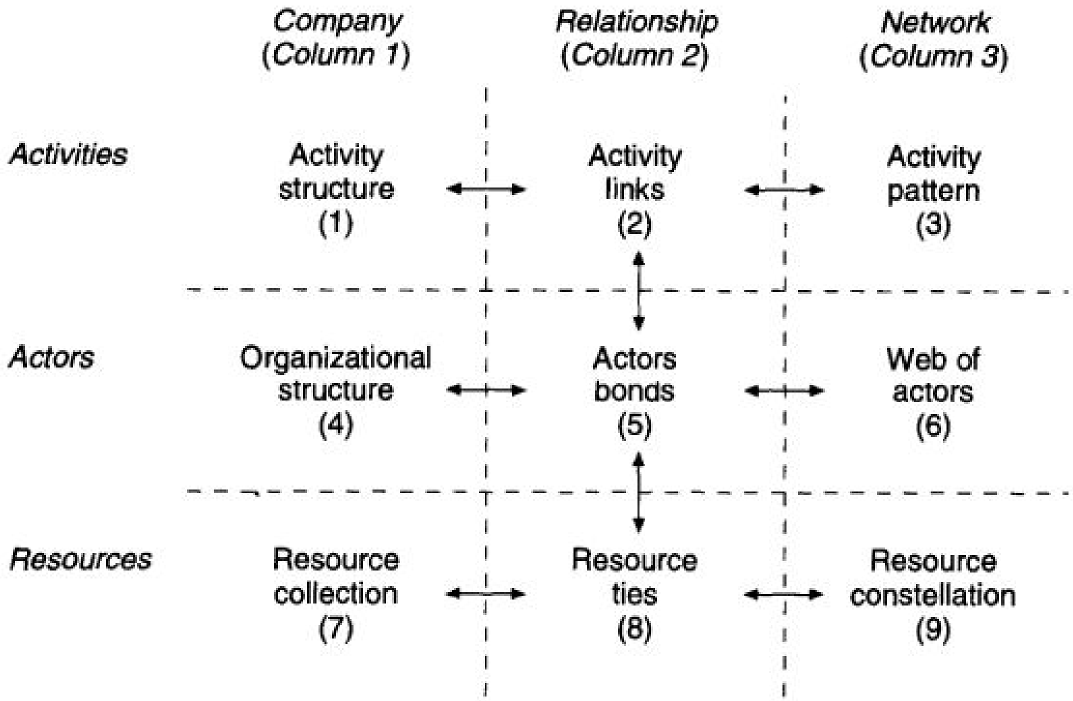


Figure 9 - The network model - Framework for analysing business relationships and networks. Source: Håkanson & Snehota (1995)

The framework illustrates the possible effects a change in a relationship might bring (Håkanson et al., 1995). This is illustrated on three levels - Company, Relationship and Network. First of all, a change in activity could have an effect on the company per se, as well as on the focal relationships that the company has. Furthermore, a change in activities might have an effect on the network and on indirect relationships such as third parties. If, for example, a company change their order handling system it might have an effect on the company's supplier (focal relationship) as well as on the supplier's supplier (indirect relationship). The same method can be used for the other two dimensions as well, actors and resources.

Ford et al. (2002) defines a company's network position by the characteristics of the company's relationships and the benefits and obligations that arise from them. A system supplier’s proximity to the end customer gives them a stronger ability to influence the end customer's decisions and thereby the revenue, operations and prices of their own suppliers in turn. A second or third tiers supplier can choose to invest in developing their own system offering so it can build relationships with other major customers.

The framework does also illustrate an important aspect of a network, i.e. the interdependency between actors within the network (Håkanson et al., 1995). When defining and drawing networks from the perspective of one company, there is a danger that the company is regarded as being more important and has more power in the network than it actually has (Ford et al., 2002).

4.2 Managing Business Networks

Naturally the network can be extended endlessly taking every direct and indirect relationship into account. However, in order to make it manageable the company does oftentimes define boundaries within which the company's network exists. This is called the network horizon and it illustrates how the actor view its network (Anderson et al., 2009; Anderson et al., 1994). Oftentimes the network horizon is rather extended including companies that are of less importance to the focus company. Due to the complexity that emerge once the network horizon is expanded it is recommended to have a narrow horizon in order for it to be manageable (Håkansson & Snehota, 1995; Holmen & Pedersen, 2003). However, more aspects need to be taken into account in order for a company to utilize its network to a higher extent. The interrelatedness of companies within a network implies that even activities far from the focal company itself can have a significant effect. Hence, it is suggested that the company has a wider network horizon that is monitored in order to be able to act on changes in the network (Holmen & Pedersen, 2003). This is conflicting to the previous statement suggesting a narrower horizon. However, the recommendations refer to different aspects - The narrow horizon being managed and the wider horizon being monitored. Holmen & Pedersen (2003) does also highlight the importance of viewing the network through the lens of other actors in order to identify opportunities and limitations.

The term network context is a subset of the network horizon and contains the actors that are of importance to the focus company (Håkansson & Snehota, 1989). Every actor within the network has a network identity which refers to how the focus company perceive other entities within the network as well as how the focus company is perceived by others (Anderson et al., 2009). This aspect is dependent on time and how the company acts within the three dimensions: activities, resources and actors. In advance, the network identity is dependent on the network context which differs from actor to actor. Hence, it is of importance to clarify the point of view that the network identity derives from (Anderson et al., 1994). An illustration of the connection between the described concepts is shown in figure 10 where the dots symbolizes companies.

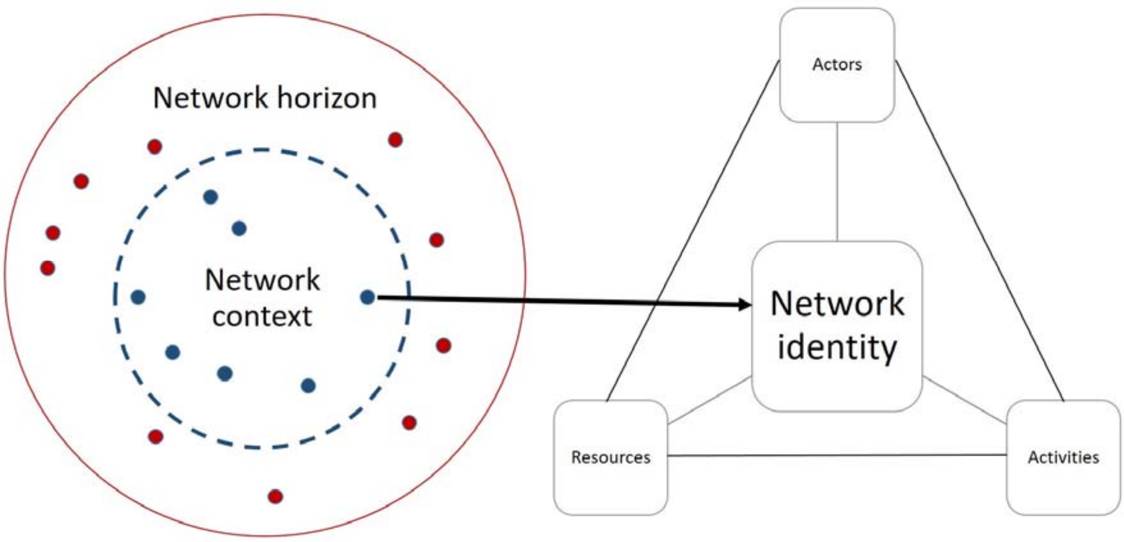


Figure 10 - . The connection between network concepts and the three dimensions of change.

As stated above there are conflicting opinions regarding whether a company should have a wide or narrow network horizon. It could be argued that a company should have a wide network horizon that is being monitored whilst having a narrower network context that is being managed. This definition would lead to less confusion and clearly connect the concepts with defined actions. With this definition it would be recommended to have a dynamic boundary of the network context where new entities could be included and existing entities could be excluded depending on their actions and relevance to the focal company.

Håkansson and Ford (1998) speaks of three paradoxes when companies interact in networks. One paradox is the connection between opportunities and restrictions that relationships between different companies bring. When resources are shared in a relationship, they can increase competitiveness and productivity, but at the same time the relationships make it less attractive to approach the other company's clients, make similar products or try to expand in markets where the other company has interests.

Håkansson and Ford's (1998) second paradox states that the more influence a company has in a network, the more influenced the company will by its network. Relationships works both ways, the more closely connected and intertwined a company is in its network, the more closely the network actors will be connected and intertwined into the company, potentially bringing both positive and negative aspects into the relationship. Håkansson and Ford's (1998) third paradox states that the more control a company has over its network, the less innovative and effective the network will be.

For a buying company, the situation is simple when it knows exactly what it needs and there are many competing suppliers in a stable market (Ford et al., 1998). However, when uncertainties are in place the buying company's situation becomes more complex. Relationships built on integration and problem solving might not survive a decline in customer need and market uncertainties, when customers are no longer prepared to pay for the problem solving service (Ford et al., 1998, page 22).

4.3 Resources in Business Networks

The definition of a resource in a business network is broad and can be divided into tangible and intangible resources. The tangibles include resources such as material and equipment while intangibles refer to knowledge, goodwill, and other resources that are more difficult to define. In advance, a relationship per se can also be regarded as an intangible resource (Håkansson & Snehota, 1995). An elemental part of a relationship is the exchange of resources that occur between actors. The most basic exchange being a purchase of a product in exchange for money. A more complex situation is e.g. when companies in a joint venture share knowledge and other resources to create joint value.

There are different views of how resources are related to value. One such view is that of resources as scarce hence the companies have to control and utilize them better than other companies in order to be competitive (Coase, 1937). With this view the resource itself has a value and the combination of resources sums up to the value of each contributing resource. In other words, resources are viewed as homogeneous. A more recent view is that of resources as heterogeneous which means that resources does not possess a value itself. Rather, it is the combination of resources that creates value. Hence, they are not viewed as scarce to the same extent, as the combination of resources does also create new resources (Håkansson & Snehota, 1995). A commonly used term is the double-faced nature of resources. In essence this term refers to resources having a provider and user side. The value of the resource combination is dependent on the way that the provider combines resources as well as of how the resource combination is valued by the user (Håkansson & Snehota, 1995).

Once resources are involved in some way between different entities they form a bond, or relationship, between these. This is called a resource tie (Håkansson & Snehota, 1995). These relationships are characteristically beneficial for both the provider and the user since the information flow makes it possible to develop the combination of resources and its application areas. The provider gets information of how the resources are being used by the user hence development is possible which is beneficial for the user. As already mentioned relationships per se can also be regarded as a resource. Due to this, the resource ties can be used for a company to get leverage over its competitors as it is difficult to imitate (Itami, 1987).

One way to analyze and view resources is through resource interaction. Aaboen et al. (2011) differentiates between two types of resources - technical and organizational. Technical resources refer to products and facilities while organizational resources refer to business units and business relationships.

Products are the resources that are being exchanged in business relationships hence the term include both goods and services. According to Aaboen et al. (2011) "*the model of resource interaction relies on a view of products as connected and subject to constant change in interaction with other resources*" (p.44). This is similar to what Håkansson & Snehota (1995) describe as the double-faced nature of resources. As products are subject to exchange in business relationships they also form the interface of companies' activities, i.e. what the buyer in a buyer-seller relationship sees is the product. Facilities can be described as supporting internal resources, i.e. resources that are needed to produce and develop the products. Facilities are defined as internal resources thus if a facility becomes subject for exchange in a relationship it will be redefined to being a product. Hence, facilities cannot be exchanged.

Business units structure the products and facilities through activities thus it is in the business units that the intangible resources such as expertise exist. The connection between business units is called business relationships. Common for the organizational resources is the time aspect, i.e. memories of previous line of action affect future approaches. The relation between resource entities and customer relationship is illustrated in figure 11.

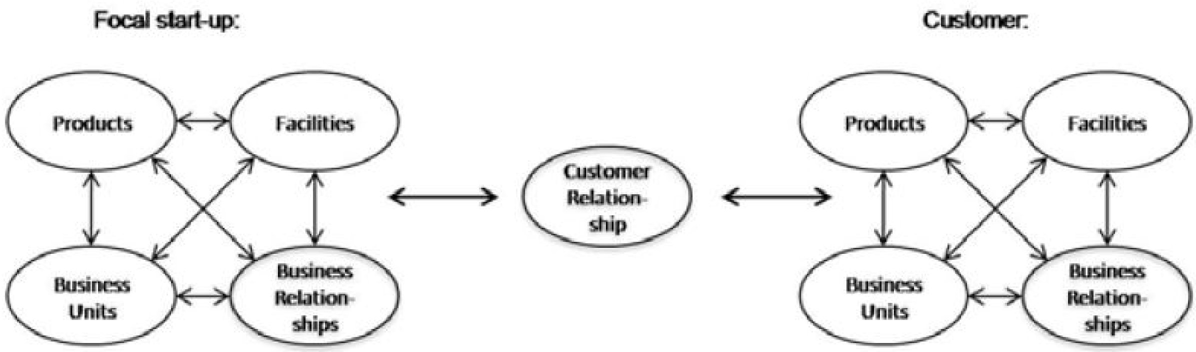


Figure 11 - Development of Customer Relationships through Resource Entities (Aaboen et al., 2011)

In the model of Aaboen et al. (2011), the value of a resource is defined as how it is used and how it relates to other resources, as opposed to having a set value. In terms of economic growth, the value of the resource is closely connected to the value of the service that the resource can provide. Further, they argue that value can increase if resources are combined, either internally in a company or be connecting two different companies in a network, combining their resources. The above reasoning forms the ground of differentiating technical resources (products & facilities) and organizational resources (business relationships & business units) This is similar to the definition by Håkansson & Snehota (1995).

4.4 Actors in a Triadic Relationship

A business context with three independent entities has specific implications that will be discussed in this section. One such example is the relationship between a component manufacturer, an OEM, and an end user. The component manufacturer is farthest upstream in the context while the end user is farthest downstream.

As the component manufacturer is one, or two, steps upstream from the end user it is possible to identify two uncertainties related to this situation - Market uncertainty and Performance ambiguity. Market uncertainty can be described as the uncertainty deriving from the component manufacturer's inability to predict the requirements, and specifications, of its product from the end user due to its relational distance (Dahlquist & Griffith, 2014). A market with unique requirements from the end user call for highly flexible suppliers and when taking the market uncertainty into account the business climate for a component manufacturer becomes rather complicated.

The second uncertainty is called performance ambiguity which refers to the component manufacturer's uncertainty regarding how the component is used, installed, and assessed by the end user (ibid.). Due to the performance ambiguity it may be difficult for the component manufacturer to direct efforts in an adequate way. Dahlquist & Griffith (2014) exemplifies this by describing component manufacturers that have to replace components in the system that are not actually faulty. These two uncertainties increase the costs for the component manufacturer.

The obvious way to overcome these uncertainties would be to increase the efforts to build relationships with the end user. The aim with such a strategy would be to convince the end user to prefer the component manufacturer's component in the offer from the OEM, see figure 12.

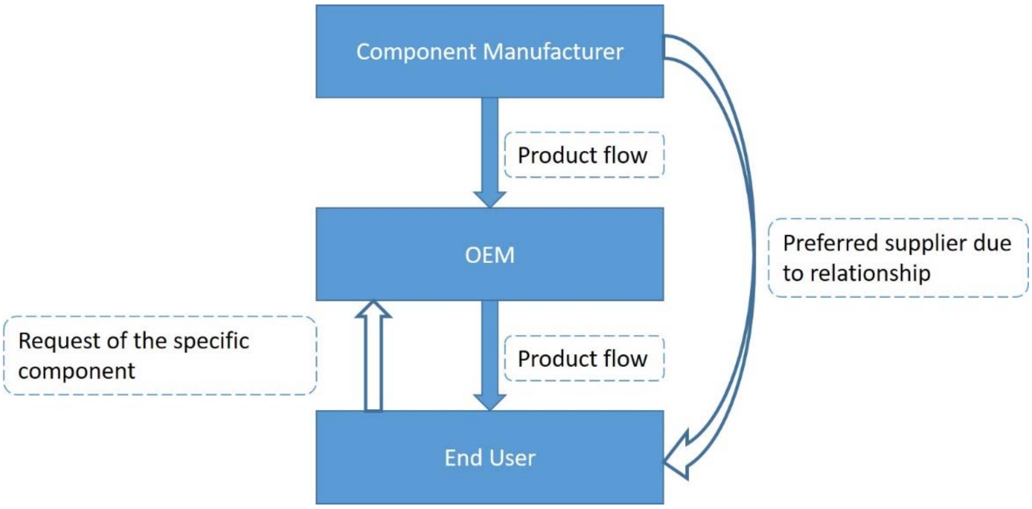


Figure 12 - Strategic relationship with the end user.

However, such a strategy would have implications on the relationship between the component manufacturer and the OEM. Essentially, there are two ways for the OEM to react to the marketing effort of the component manufacturer (Dahlquist & Griffith, 2014). The ultimate aim with a marketing strategy towards the end user by a component manufacturer would be to increase its profit. It could be assumed that such profit would otherwise come into the possession of the OEM (ibid.). Due to this the OEM could react to the opportunistic behavior by taking action that mitigate, or even harm, the positive effects of the component manufacturers marketing. Such actions could be to offer a substitute solution where the component manufacturer's product is not incorporated or to invest in increased relationship building with the end user to create leverage. In the case of an opposing reaction by the OEM the relationship between the component manufacturer and the OEM may also be harmed due to opportunism.

The second option for the OEM would be to utilize the marketing effort by the component manufacturer to increase its own competitiveness. This aligning approach would let the OEM free-ride on the efforts by the component manufacturer and strengthen the relationship to the end user as well as to the component manufacturer. Additionally, the OEM can pursue complementary activities to increase the synergizing effect.

Similar uncertainties to that of a component manufacturer can be identified for an OEM. The market uncertainty derives from the inability to predict the specifications from the customer (Dahlquist & Griffith, 2014). This drives cost for the OEM as they have to be flexible with their product offering, hence they also have to maintain sufficient relationships with its suppliers. Additionally, performance ambiguity can also be identified for an OEM. As the OEM does not install, maintain, or use the product it is difficult to control the circumstances under which the product operates. Thus, they may be responsible for defects that occurs due to misuse and not by a faulty product per se.

The combined assessment of risks caused by market uncertainty and performance ambiguity determines the counteraction of an OEM in the situation described above, i.e. a situation where component manufacturers take effort to create a relationship with the end user (Dahlquist & Griffith, 2014). From the perspective of an OEM it is reasonable to assume that they feel threatened by the situation in two ways. First, the OEM may fear that the relationship between the component manufacturer and the end user creates a lock-in situation where the OEM’s acting space is limited (Wathne & Heide, 2000). This leads to the second risk which is that the component manufacturer takes advantage of the situation to increase the price which would decrease the profit of the OEM (ibid.).

However, the OEM possess an opportunity to free-ride on the component manufacturer’s effort to improve the product offering. Dahlquist & Griffith (2014) state that the product is deemed as more valuable if it contains the specific preferred component which can create a leverage towards the end user and increase the price. Hence, mutual benefit between the component manufacturer and the OEM can be obtained.

5 Industrial Context of ABB Motors and Generators

This section will describe the context in which ABB M&G operate. The different types of companies that exist in the market will be described and how they are connected to each other, i.e. Component Manufacturer (see 5.1), OEM (see 5.2), Distributor (see 5.3), System Integrator (see 5.4), EPC (see 5.5) and End Users (see 5.6). The information derives from the conducted interviews as well as from internal documents at ABB. The generalizations made in this chapter regards the market for motors and generators, hence they are not necessarily applicable in other markets. As ABB Motors and Generators operate in multiple markets this description will be through the lens of its largest market, i.e. oil & gas. The general sales channels for ABB Motors and Generators are illustrated below where ABB act as a component manufacturer, see figure 13.

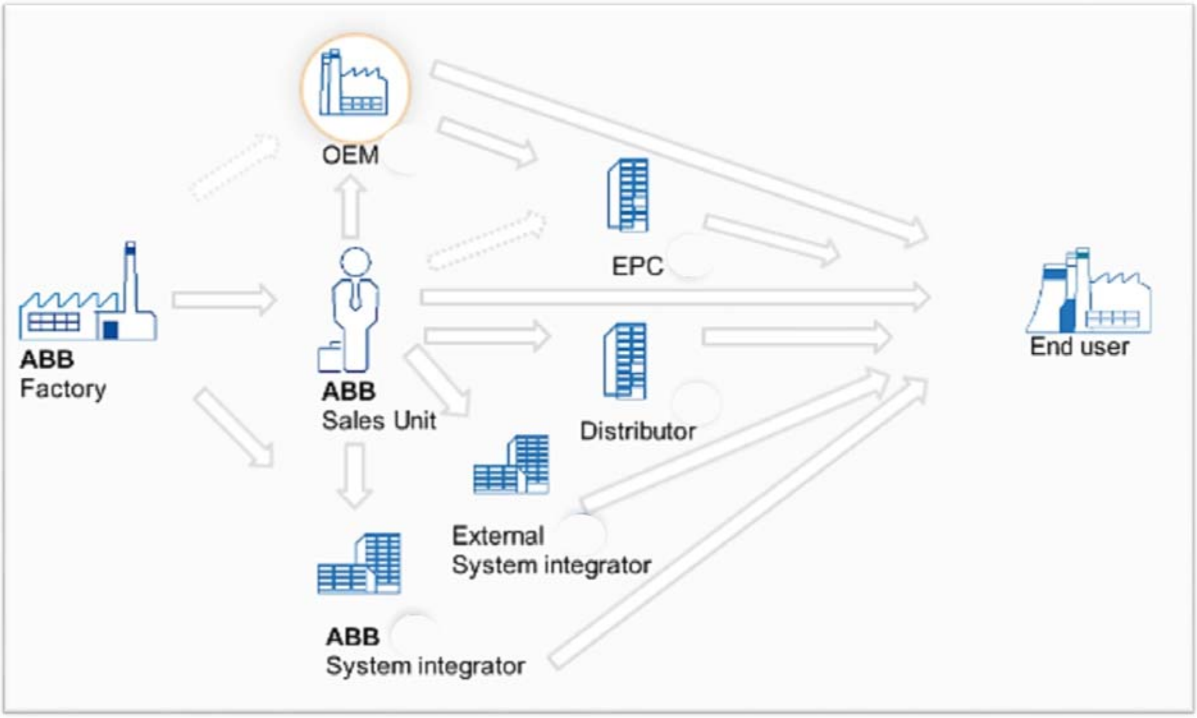


Figure 13 - ABB M&G's sales channels

5.1 Component Manufacturer

The component manufacturer delivers one or multiple components to a system. Here, a system refers to the composition of different components assembled to perform a certain task, e.g. a steam turbine. The steam turbine as such is the system while e.g. the generator and gearbox connected to the turbine are the components. The component manufacturer delivers its products to either an OEM (see 5.2), Distributor (see 5.3), System Integrator (see 5.4), EPC (see 5.5) or directly to the end user (see 5.6). The largest share of a component manufacturers sales is to the OEM's. In these deals it is common that the component manufacturers compete on price.

The product portfolio of a component manufacturer of high-end products can be divided into two segments, commodity products and customized products. Commodity products are standardized products that can be bought off the shelf, while customized products oftentimes are engineered-to-order.

The component manufacturer's resource combination depends on the buyer of the product. A commodity product has less room for expanding the offer in terms of additional services compared to a product that is customized. Another advantage of customized products is that they are less sensitive to price. Due to the more complex requirements the number of actors that are able to meet these are significantly lower than the number of actors in standardized projects. Hence, the high-end component manufacturers have a difficulty in competing on projects where low cost is the main order winner as several component manufacturers, especially in Asia, is utilizing economies of scale to offer a low price on standardized products. In ABB's case the larger synchronous machines are generally subject for more customization than the smaller inductive machines which are more standardized.

During the period of high oil-price the market for projects within the oil & gas industry flourished which set a new standard. Neither the component manufacturers nor the OEM's had to seek projects and sales to the same extent causing that external local sales offices took a larger share of this process. The component manufacturers had a large backlog due to the increased sales. Once the oil price dropped by the year of 2014 the number of sales decreased and the component manufacturers were left with a sales organization that were optimized for a flourishing market, not a market in decline. In advance, the customers began to emphasize price to a larger extent which caused that the purchasing departments of the customers had more impact than before. In the flourishing market before 2014 the discussion where more related to the technical aspects of the project.

The customer's increased focus on price has limited the sales arguments of the high-end manufacturers such as quality, efficiency, and life-cycle cost. Hence, in order for the component manufacturers to compete on these aspects they seek technically advanced projects with customized products. Additionally, these affairs can lead to framework agreements with the particular OEM which is desirable.

5.2 Original Equipment Manufacturer

An Original Equipment Manufacturer (OEM) is a company that delivers a system to the next company in the value chain. An OEM is oftentimes a component manufacturer of one or several components in the system. The missing components are purchased by the OEM from another component manufacturer so that the system can be formed. The OEM is responsible for the delivered system which means that the purchasing company hold them responsible for defects in the system regardless of the faulty component. The purchaser is either an EPC (see 5.5) or an end user (see 5.6).

There is a difference between a standard OEM and a project OEM. A standard OEM purchases standard products, commodities, from a component manufacturer to integrate in the system. A project OEM on the other hand purchase customized products that are being engineered-to-order.

The OEM receives specifications and requirements from the customer, i.e. EPC or end user, which is processed and translated into requirements for every single component in the system. Hence, one of the core resources of an OEM is its knowledge and competence. In addition, the relationships that the OEM possess is also vital. Occasionally the specification from the customer includes preferred manufacturers of the components. Hence, the OEM has to have a sufficient relationship with its suppliers to be able to meet these specifications.

The relationship, or partnership, between an OEM and a component manufacturer has possibilities to share both resources and activities. An example of this is that the component manufacturer contributes in the research and development driven by an OEM. Additionally, the component manufacturer can contribute in value chain optimization and logistics. Characteristically it is in a partnership that these benefits become significant.

5.3 Distributors

A distributor operates closely to the end user and serves them with components to their already installed base. Hence, from a component manufacturers point of view they are buyers of commodity components without customization. In ABB’s case distributors are a channel for motors but not for generators. This derives from motors being commodities to a larger extent than generators.

As the distributors serves the already installed base with components they are not regarded as a channel to increase sales. However, they still drive a large share of sales on the motor-side. These are mostly connected to smaller components such as LV-motors.

5.4 System Integrators

System integrators focuses on combining subsystems of components into a whole system that fit the end user's requirements. There are several similarities between an OEM and a system integrator. They both deliver systems and hold system responsibility. However, the main difference is that an OEM generally manufactures components themselves and customize them to the end user while a system integrator more often uses off the shelf subsystems that are put together to meet customer requirements. Hence, the system integrator’s field of competence is mostly connected to the whole system while an OEM may have greater knowledge regarding the single components.

The role of a system integrator in ABB's case can be divided into two sales channels. First, ABB cooperates with external system integrators that uses ABB's components in their system. As the external system integrator generally seeks commodities this is only a channel for the motors and not the generators. The share of sales to external system integrators is rather small. The second channel is an internal system integrator, i.e. an ABB system integrator. As ABB manufactures and sells several components to different systems it is beneficial to have a unit within ABB that can utilize the economies of scope to offer systems where the internal components are key. The internal system integrator is not limited to commodity products hence it is a channel for both the motors and the generators. The share of sales is rather large, especially for the generator products.

5.5 Engineering, Procurement & Construction Companies

Engineering, Procurement, Construction (EPC) are companies that are responsible for designing the installation, procuring the necessary material, and constructing the project. Hence, the customer to an EPC is the end user. Upstream companies for the EPC contains of two actors - OEM's and component manufacturers. Although the component manufacturer has sales channels to EPC's it is only a small share of the sales that goes through this channel. Additionally, it is exclusively the motor components that are sold directly to EPC's. Thus, EPC's purchase their system and its components mainly from OEM's.

Although the direct sales to EPC's are rather limited it is still of interest for both OEM's and component manufacturers to pursue relationship building with the EPC's. The reason for this is that it is common that the EPC's has a list of preferred component manufacturers as well as OEM's. Hence, component manufacturers can increase their sales and number of projects if they are part of the list. In addition, it is difficult, or even impossible, for component manufacturers to compete on projects if they are not part of the preferred list. The same arguments can be applied for OEM's.

It is reasonable to assume that the high-end component manufacturers, and OEM's, has greater opportunities to build relationships with EPC's than the actors in the low-end segment due to two reasons. First of all, the focus on quality increases further downstream in the value chain. Hence, EPC's has a stronger focus on quality than OEM's. The reason for this can be found in the commitment to the end user. Once the project has been built by the EPC it is transferred to the end user, usually with a limited warranty period. It is important for EPC's that the installation is functioning within the warranty period where they are responsible. Second, the high-end component manufacturers have greater flexibility which enables the EPC to have fewer partnerships that can supply a wide variety of projects. The flexibility does also enable the EPC and the component manufacturer, or OEM, to share resources and activities such as research and development.

An important relationship for an EPC is naturally that with its customer, the end user. The end user can, similarly to the EPC, also have a list of preferred suppliers - Both of the component manufacturers, OEM's, and EPC's. Thus, the EPC can face the same conditions as the OEM described in chapter 4.4, i.e. the hazard of getting into a lock-in situation where the EPC lacks acting space due to downstream actors preferring certain components or suppliers. However, the benefits of free-riding on upstream efforts can also be applied.

5.6 End Users

The end user is the final customer of the system and its components. Typical end users for component manufacturers in the motors & generators-industry is oil & gas-companies, power suppliers, mining companies etc. The end user generally emphasize quality as the cost of a non-functioning system by far exceeds the cost of the single components. The most intuitive example is probably in the oil industry where a breakdown of an oil pump, which consists of a motor, causes a significant income loss. To avoid such situations, the end user relies on two important aspects. First, the end user prefers well-tested solutions and components that has significant proof of concept from other projects. Hence, the barriers to entry this market is extensive. Second, the end user oftentimes purchases a reserve system that can be used in the case of failure in the main system.

Once the oil price dropped in 2014 the oil companies began to make less profit which set new standards on the market. Prior to the price decrease the oil companies often purchased premium solutions that held high quality. However, in today's market the price aspect has gained increased focus. Due to this the oil companies has begun to seek standard solutions that are well-tested with high quality while still being offered at a competitive price. Naturally, the preferred vendors list become even more important for the upstream companies.

Although the increased market requirements possess a threat to the profitability of the actors it could also lead to new opportunities. One such opportunity is increased relationship building and partnering between the actors within the market to better optimize the value chain and thus the profitability.

6. Market Outlook

The market for motors and generators are complex and so are the networks within the industry due to the fact that the products can be applied in such a wide variety of applications and markets. It is also an industry where the basic technology behind the products has remained the same for several decades. In the motor case the suppliers, and end users, can be divided into two groups based on their characteristics. The first group is suppliers of standardized and commodity components. These suppliers essentially compete on price and is currently comprised of a large number of actors, especially low-end manufacturers from the Asian countries. The end-users in this segment main concern is also the price and other aspects are less important. The number of actors within this segment varies to a high degree based on the current conjuncture.

The second group is high-end suppliers with a larger share of customized products. This is the segment where ABB operates. The number of actors within this segment is fewer as the barriers to entry this kind of market is higher. A high level of expertise is required to be able to customize the products to almost every single customer. Large companies such as General Electric and Siemens are competitors within this segment. Although a large share of the motors are customized there is still a market for high-end commodity motors. Hence, a moderate share of the sales within the motor segment is to actors such as distributors and directly to EPC's or the end user.

The generator segment on the other hand is characterized of even more customization than the motor segment. The market is similar to that of the second group in the motor segment, i.e. high-end suppliers and relatively few actors. As the generators are customized the sales are almost exclusively to OEM's and no sales are done to distributors.

The majority of ABB Motors and Generators's sales has historically been to the oil & gas industry while other industries such as marine, mining, and power generation accounts for a less prominent share. It can be concluded from the interviews conducted at ABB that the oil & gas industry is of focus as it is more or less the only industry that has been discussed. It is also an industry that fits ABB's product offering - high quality products that are reliable. These are aspects that are demanded from the customers within this segment. However, as discussed in chapter 1, the oil & gas market has dampened.

There are two essential reasons why this market change has set ABB in a peculiar position. First of all, ABB's product offering is adapted to a market with high standards where customers are able to pay accordingly. Once the revenue streams of the oil & gas industry decreased the customers began to seek solutions that could offer similar quality with a lower price. Such standardized solutions have to benefit from economies of scale in order for the price to be competitive. Although ABB is a significant actor within the industry, there are other actors, such as Siemens and GE, that have similar capabilities and are able to meet these demands to similar extents. The second reason is that it is arguable whether the oil & gas industry will return to its old flourishing state. This means that the suppliers has to seek sales to a higher degree than before. Hence, they have to adopt the sales organization to this changed situation in order to stay competitive. ABB Motors and Generators current sales organization are active locally in every specific region that are supposed to be the first point of contact for the customers. These sales companies are responsible for a large product portfolio which means that they do not have extensive expertise within every product's characteristics. This implies that the local sales companies have less struggle when selling commodity products compared to customized products. In an environment where the suppliers of motors and generators have to seek their sales to a larger extent this sales organization setup may be sub optimized. However, the alternative, i.e. to have a large internal sales organization, requires major restructuring of the current organization.

With a target market, oil & gas, that has less spending power it is relevant to seek emerging markets to acquire a strong position in an early stage. The emerging amount renewable applications cannot be overseen. However, power generation with renewable energy is complex and brings new obstacles to the market. This will be further discussed in the next chapter.

7. Base Power and Renewable Energy in the Grid

This chapter will describe the role of renewable energy in the grid and the fluctuation effects this causes in relation to Base Power. The chapter is initiated with a description of what renewable energy is and continues by describing the attributes and requirements of a grid. Finally, the chapter is concluded with a description of how the renewable energy sources can be applied in the grid and also a discussion of the future electrical grids called smart grids.

7.1 Renewable Energy Sources

Renewable energy is characterized by the flow of energy that exist naturally in our environment (Elliott, 2013). The most apparent utilization of renewable energy that people see is wind turbines and wind parks. According to Morgan Stanley (2017) wind energy is currently the most cost effective way of generating energy in several locations in the world. Forecasts suggests that by 2020 renewable energy will be the most cost effective source for energy generation globally (ibid.).

In order to compare different energy sources in terms of cost it is common to use a measure called Levelized Cost of Electricity (LCOE). LCOE is the total cost of the power plant over its lifetime divided by the total power output over its lifetime. Thus, it is similar to the net present value of the cost per unit electricity (J.P. Morgan, 2016). The levelized cost of electricity for wind energy currently ranges from 15-25 $/MWh while coal energy in comparison costs about 55 $/MWh. In advance, the price for Solar Photovoltaics (Solar PV) is steadily decreasing with a current LCOE of about 45 USD/MWh. As of now wind, water and solar accounts for ~2 % of the world's current energy production and in 2016 renewable energy sources stood for the majority of new power generation (Morgan Stanley, 2017). There are several promising technologies beside wind and solar power. One example is geothermal energy where the heat from the core of the earth is utilized to heat a liquid that drives a generator. By drilling two holes into the ground the power plant is able to generate energy from the warm liquid while the cooled liquid is being pumped down to the heat source, see figure 14. This cycle is flexible as it is possible to control the flow of the liquid hence also control the output from the power plant.

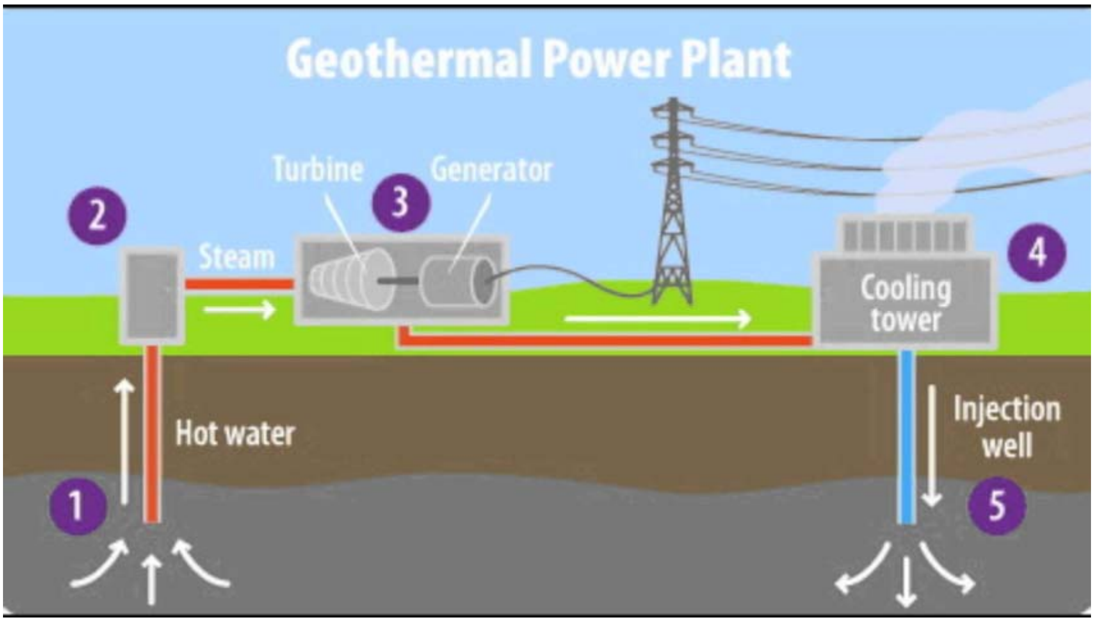


Figure 14 - Illustration of a geothermal power plant.

The ability to control the output of a power source is an important aspect that will be discussed further in the next section. However, generally this is one of the drawbacks of renewable energy sources - they are dependent on the nature and its behavior. Take for example the wind turbine, naturally it depends on the flow of wind that drives the turbine. The same goes for Solar PV which is dependent on sunlight. Besides geothermal energy there are a few renewable energy sources that possess the ability to control the flow. One such example is hydropower where it is possible to control the flow of water with two different techniques. First, the hydropower plant could consist of an upstream dam that is filled with water and when power is required water is released from the dam. This dam could be both constructed or natural. The natural dam could for example be an upstream lake. Second, the hydropower plant could be placed in an environment with a natural flow of water such as a river. In this example it is possible to control the flow of water by directing the amount that enters the power plant.

7.2 Electrical Grids and Base Power

An electrical grid is a system for transferring electricity from the producers to the consumers (Kaplan, 2009). In essence the grid has three functions. First of all the delivery, or transport, of electricity which requires a network of nodes to every single consumer. Second, the grid has to transmit the high voltage electricity that is the output from the energy producers into lower voltage electricity that can be used by the consumer. Third, the grid has to assure that the frequency of the electricity is equal at all times to avoid power breakdowns. The frequency should always be 50 or 60 Hz depending on the set standards in different countries. Deviations from this frequency causes power breakdowns and therefore unstable grids.

The challenge of having a stable frequency in the grid is increasing as the share of renewable energy increases. The frequency is dependent on the demand and the supply. The frequency decreases with an increased demand, hence the supply has to increase to keep the frequency stable. Similarly, the frequency increases with a decreased demand hence the supply has to decrease to keep the frequency stable. As the demand varies over the day the grid has to be flexible in order to be able to keep a steady supply. In advance, the grid needs capacity to handle the maximum demand independent of time.

The non-renewables such as coal- and nuclear power plants can control its output and are therefore suitable for supplying the grid with a Base Power that counteracts deviations in demand from customers and supply from uncontrollable sources. These power plants also possess the capacity to produce a large amount of electricity, hence the connected grid is always able to supply the consumers. A scenario where the supply only consist of renewable energy sources would have to have Base Power produced from other sources. Today the only clean base power produced in larger scale comes from hydro- and geothermal power plants. However, today the sustainable base power generation is nowhere near what would be required to match the uncontrollable sources, which instead results in increasing base power production in coal and nuclear power plants. Another option is to store surplus energy for use when supply/demand coefficient is lower, which will be discussed in the next section.

To conclude, inconsistency of supply from renewable energy sources and varying demand from consumers causes increased stress on the electrical grid. Not only does the grid have to adapt to the varying demand but also the varying supply. This challenge is the background to the smart grid applications for ABB Motors and Generator Products which will be discussed in the next section.

7.3 Smart Grids and Renewable Energy

As described in the previous section an increased share of renewable energy puts larger requirements on the electrical grid. With wind power being the most cost effective power supply and a decreasing cost for solar PV it is motivated to solve the issue of an unstable grid. Once the previous flexibility of the power supply is being phased out the flexibility instead have to be transferred to the grid itself. With the current technology it is possible to handle small deviations in the frequency with synchronous condensers, see chapter 2. The synchronous condenser rotates in the system and if the frequency goes down the rotation in the condenser can increase the frequency for a short period of time until the frequency is stabilized. However, the grid does also require the capacity to keep the frequency stable for a longer period of increased demand or decreased supply.

Two important aspects have been lifted by Kaplan (2009) to handle this issue - storage and communication. First, once it is possible to store energy to a reasonable price the grid itself could possess the capacity to handle the varying demand. This solution is similar to the hydropower plant where water is stored in an upstream dam. However, instead of storing water the grid stores energy that can be used when there is increased demand. Second, the grid requires extensive communication between producers and consumers. Once the high capacity power plants are phased out the grid becomes more vulnerable. It would have to rely on forecasts of both the supply and demand side to balance and cope with the inconsistency (Kaplan, 2009). As the demand and supply varies both dependent on time-of-the-day as well as summer/winter season the challenge of forecasting is a difficult issue.

8. Analysis of Business Applications

This chapter describes and analyses the applications that has been considered in the study and motivates the reason why they are deemed as viable or not, i.e. subject for further analysis. The funnel approach described in chapter 3 has been used to review the applications through an external and internal point of view. The data used in this chapter derives from the conducted interviews at ABB, actors within ABB's network, as well as experts and researchers within the concerned areas from the academia. The considered applications have been generated from multiple sources such as interviews at ABB as well as from internal documents at ABB and forecast & market reports. The considered applications as well as the source from which they have derived is illustrated in figure 15. A summary of the key points regarding the applications will conclude the chapter.

Application	Source
Carbon Capture & Storage	ABB Sales
Concentrated Solar Power	ABB Sales
Solar Photovoltaics	Market report – Morgan Stanley (2016)
Wave Power	Literature search – Elliott (2013)
Tidal Power	Literature Seach – Elliott (2013)
Hydro Power	ABB Product Manager Power Generation
Biomass	ABB Sales
Wind Power	Market report – J.P. Morgan (2017)
Grid Stabilization	Market report – Morgan Stanley (2016)
Combined Cycle Solutions	ABB Sales
Geothermal Power	ABB Sales

Figure 15 - Considered applications

8.1 Carbon Capture & Storage

Carbon Capture and Storage (CCS) is a technology used to store carbon dioxide (CO2) below the ground to avoid it leaking out into the atmosphere. CO2 has for long been a large driver of the greenhouse effect, hence these emissions should be limited. The CCS technology is used in applications with large emissions such as coal- and gas power plants. The CO2 is extracted from the emissions in these power plants and pressurized to reduce its volume. The compressed CO2 is then pumped into the ground, often in existing caves in the bedrock. A number of projects utilizes caves in the bedrock that are left behind when drilling for oil. In this situation the CO2 is pumped down on the opposite side of the oil field hence the oil is pressed to the extraction site. In Canada the Boundary Dam project by SaskPower is one such project. This cycle is positive in two ways - The CO2 is stored in the ground and oil from the oil field can be extracted to a larger extent, see figure 16.

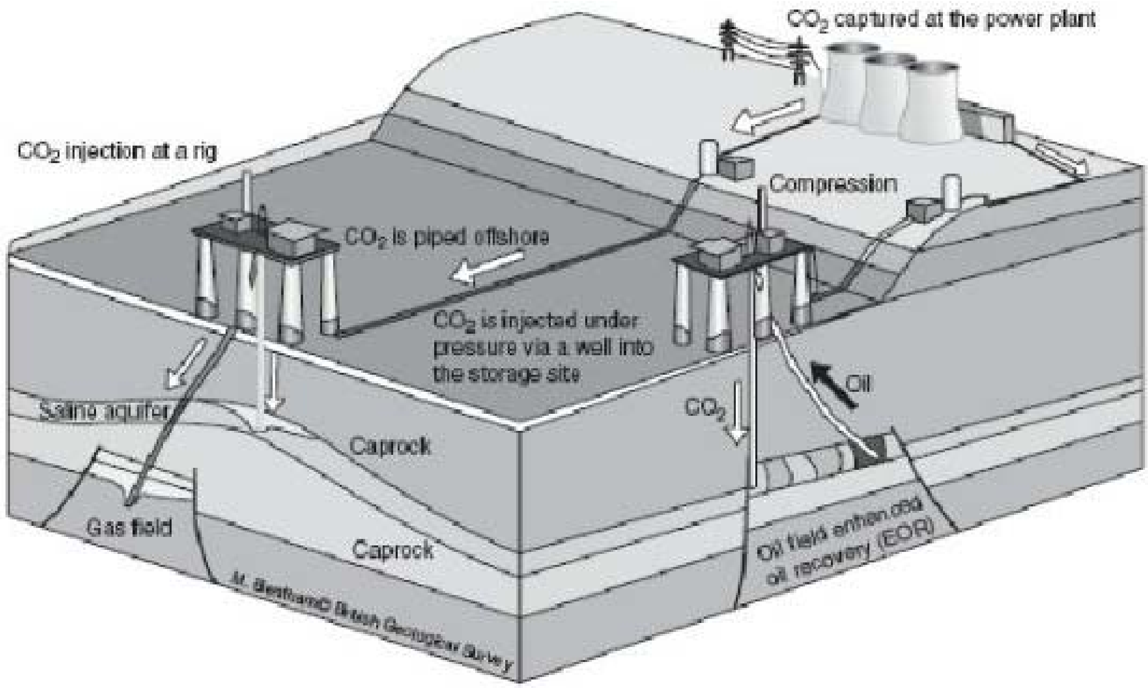


Figure 16 - Illustration of CCS in an oil rig.

Despite of the positive effect that CCS can bring it is questionable whether this application is viable from a financial perspective. It is deemed that the incentives for utilizing CCS as of now is rather low. Except for the financial limitations there is also a problem of mapping storage locations. Today the storage locations have to be located offshore despite of the few risks that storing CO2 bring. Experts within the area claims that the cost for emission licenses has to increase by a factor of 10-20 in order to make it financially motivated to utilize the CCS technology - From today's level of 5£/ton to 70-100£/ton. In advance, the technology is still in a first-of-a-kind phase hence it is rather expensive, although the separate process for extracting CO_2 from other elements is well developed. Over time it is deemed that the cost will decrease given that the technology is exploited to a larger extent.

Other regulations such as a limitation of CO_2 emissions per MWh could also motivate increased applications. Such limitations exist in Canada hence there are a number of projects that utilizes the technology, foremost in coal power plants. The technology has also been used in Norway for about 20 years through the Sleipner project which is owned by Statoil. The Sleipner project is a facility where natural gas is extracted, which makes CO_2 a byproduct that can be stored in the ground.

The process industry is an industry with extensive CO_2 emissions. Due to this there is an effort to reduce the emissions by optimizing processes, as well as capturing CO_2. However, it is not viable to have a storage location at every single plant due to the limited volume of emissions. Hence, the CO_2 would have to be transported to a shared storage location which further would increase the cost.

In conclusion, the CCS technology would be a sufficient approach to limit the emissions from CO_2. However, the incentives for such an approach is not enough as of now. Further regulations and actions from a political point of view is required. Due to this the CCS technology is not regarded as a viable business opportunity in the short term perspective.

8.2 Concentrated Solar Power

In essence, Concentrated Solar Power (CSP) is a technology that utilizes the sunlight to produce electricity (Zhang et al., 2013). The solar irradiation is concentrated, using mirrors, to a limited area that contains a stream that is heated up. Once the stream has been heated the produced steam is used to drive a turbine that generates electricity. There are several different technologies utilizing the CSP concept. The two most commonly used technologies are called Solar Power Tower (SPT) and Parabolic Trough Collector (PTC), see figure 17.

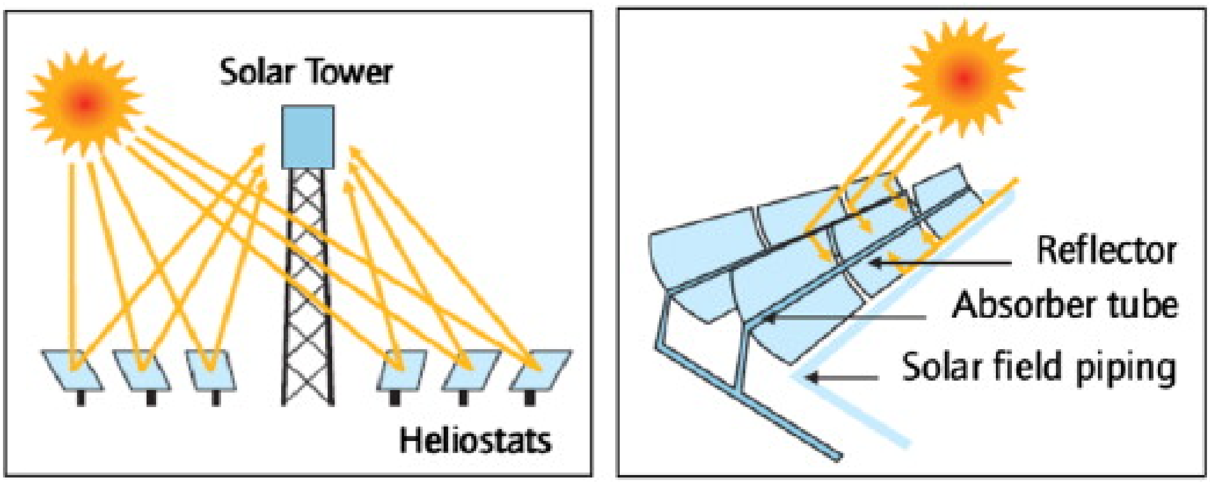


Figure 17 - CSP technologies. SPT to the left and PTC to the right.

The SPT technology concentrates the sunlight to a solar tower where the stream is contained. The stream in the tower is called Heat Transfer Fluid (HTF) and it usually consist of steam, air, or molten salt. The heat from the HTF is transferred to an exchanger which drives the turbine and produces electricity.

The second technology, PTC, concentrates the sun to a tube that contains the HTF. Similarly, to SPT the heat is transferred to an exchanger that drives the turbine. However, in contrast to SPT the reflectors in PTC is not static, instead they move according to the sun to absorb as much as possible of the sunlight. The heat transfer fluid in PTC is similar to that in SPT.

The market for concentrated solar power is increasing and the investments rose by more than 100 % between 2014 and 2015 (Frankfurt School-UNEP Centre, 2016). However, currently there are a small number of projects, less than 10 deals in 2015. Additionally, the Levelized Cost of Electricity (LCOE) for CSP is significantly higher than other applications such as wind and geothermal (ibid.). These two main arguments, high LCOE and small number of projects, imply that ABB should direct focus towards other markets than concentrated solar power. However, in a situation where the development enables CSP with possibility to store energy, the prerequisites change. In such a case CSP becomes another application with the possibility to provide baseload power which would increase its attractiveness. Due to this ABB would benefit from increased monitoring of the CSP market to detect trends that could enable increased business opportunities. However, in the current situation it is deemed that ABB's resources should be directed towards other more promising markets, see chapter 8.

8.3 Solar Photovoltaics

Solar Photovoltaics (PV) utilizes the photovoltaic effect to generate electricity, i.e. the sunlight causes photons to replace electrons within the material so that an electric charge occurs (Elliott, 2013). Once the sunlight hits the solar panel it generates a DC current hence an inverter is connected to the solar panel to convert the DC current to an AC current that can be used by the consumer.

Solar PV has previously suffered from high costs and low efficiency which has limited the spread of the technology (Elliott, 2013; Morgan Stanley, 2017). However, more recently the efficiency has been increased significantly with new materials and optimization which also has led to a decreasing price (Elliott, 2013). The price for solar panels has decreased by ~50 % from 2016 to 2017 (Morgan Stanley, 2017). Partly this price decrease can be derived from the improved efficiency of the solar panels but also due to the fact that there is a large oversupply which further press the price (ibid.). The market for solar PV has experienced significant growth over the last couple of years, which is forecasted to continue. However, as the products of this study are not applicable in such a setting the technology will not be further examined.

8.4 Wave Power

Wave power is a technology that utilizes the kinematical energy of surface waves to generate electricity by conversion (Karimirad, 2014). The amount of energy in the waves around the globe is significant and theoretically there are possibilities to utilize this. The reason for the large amount of energy in waves is mainly due to water having high density (ibid.). Waves contain up to 15-20 times more energy per volume than that of sun and wind (Muetze and Vining 2006).

Despite of the large potential in wave energy there has not yet been developed any commercially viable solutions to utilize the energy (Karimirad, 2014). The stochastic nature of waves sets high requirements on the equipment. Peak waves with high frequency and height requires expensive components that can handle, and utilize, the environment. This would imply that high-end component manufacturers are suitable suppliers for the systems.

However, due to wave power being in an early phase with few actors and no commercial solutions the forecasts for business opportunities in this area is regarded as low. In advance, the current research efforts within the area focus on an array of small scale converters which would not be suitable for the products of this study that has larger output. Efforts has also been made to investigate the potential of combining offshore wind power plants with wave power in a hybrid system (ibid.). This technology is though still in the development phase where focus is on developing the wind plants. Wave power is not deemed as a viable business opportunity in the near future due to these factors.

8.5 Tidal Power

Tidal power plants is used to extract the energy of tidal waves in the sea (Cleveland & Morris, 2015). Essentially there are two different concepts for harnessing the energy of tidal waves. The first concept is called a tidal barrage, see figure 18. The flood tide fills a dam with water until the high tide has been reached after which the main valve is being closed. Once the sea level falls in the ebb tide the turbine valve is opened causing the water in the dam to stream passed the turbines, thus generating electricity. As the water is stored in a dam it is the hydraulic energy of the water that is converted into electricity.

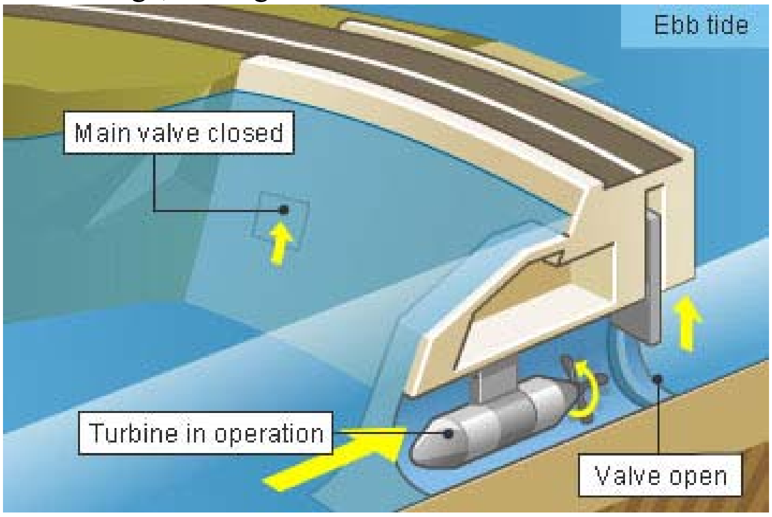


Figure 18 - Tidal Barrage.

The second concept is called a Tidal-Stream Generator (TSG). On the contrary to tidal barrages which converts hydraulic energy TSG converts the kinetic energy of water into electrical energy. The concept is similar to a wind power plant except for the stream being water instead of air, see figure 19. A large amount of energy can be generated by TSG due to the high density of water, despite of the generally lower speed of water compared to air.

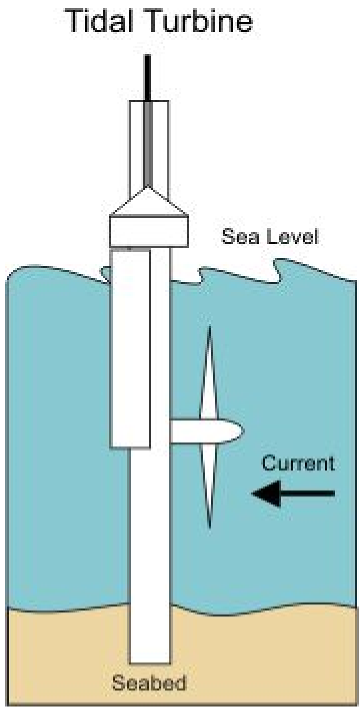


Figure 19 - Tidal-Stream Generator.

The turbines and its components, e.g. the generator, have strict requirements due to them being located under water. The technical challenge of meeting these demands is one of the barriers for exploiting tidal power technology (J.P. Morgan, 2016). This study will not analyze the potential business opportunity of tidal power at a deeper level due to the generators of ABB in Västerås not being applicable in such a setting.

8.6 Hydropower

Hydropower is usually generated by collecting water masses behind a dam and then releasing the water through a turbine under controlled circumstances. The turbine transfers kinetic energy to the rotor in a generator that then generates electricity. A hydropower plant can either be located in a natural setting, such as a river or a downstream lake, or in a constructed setting where water is pumped to an upstream constructed dam and released through a turbine. The technology in the latter setting is called pump storage, see figure 20 (J.P. Morgan, 2016). Pump storage is currently the cheapest option of storing energy although it has a number of financial drawbacks (ibid.). First, the technology requires large upfront investments in the construction of the plant. Additionally, the plant allocates a large space of land which is required in an adequate location. Former mines have recently been utilized as locations for pump storage since they have a natural height difference (ibid.).

A pump storage solution does not add additional power to the electrical grid as power is consumed once the water is being pumped to the upstream dam (J.P. Morgan, 2016). Instead, it is a solution to store a large amount of energy that is able to regulate the power supply to the grid. This is also the reason why pump storage providers are able to make profit. The water is released when the demand and price of electricity is high and is being pumped up to the dam when the demand and price of electricity is low. Typically, the water is released in day-time and pumped back up during the night. Hydropower is the only renewable energy source that can generate baseload power besides geothermal energy.

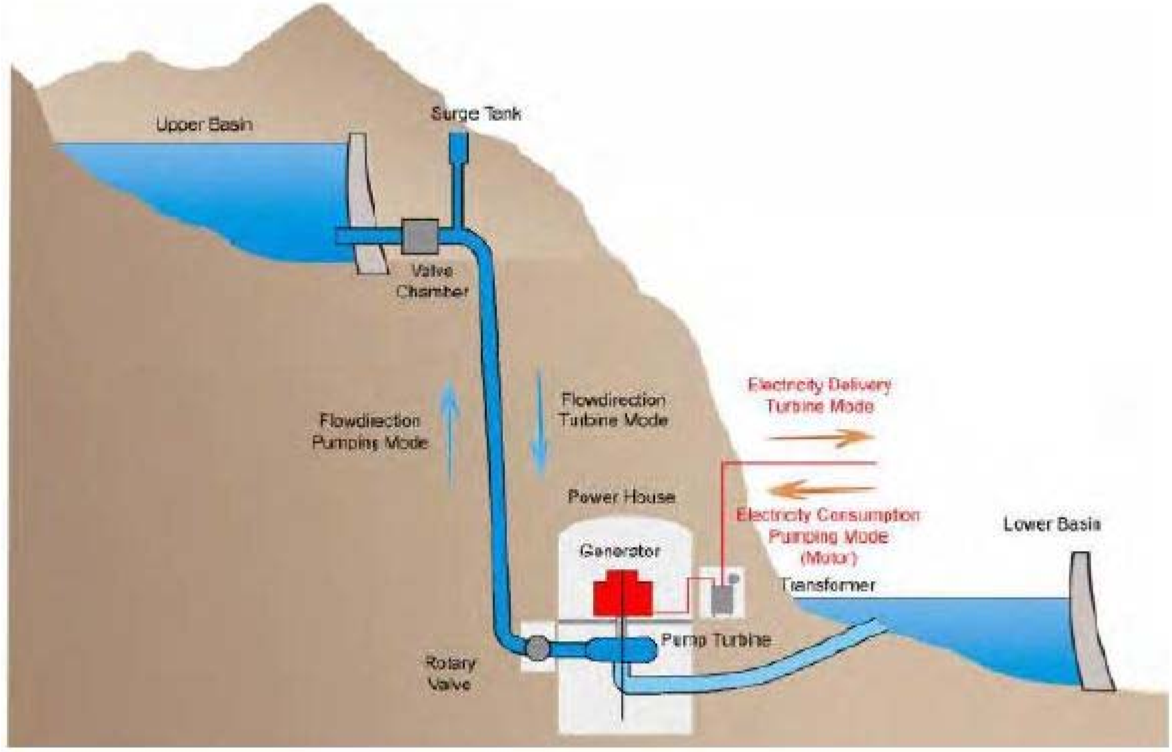


Figure 20 - Pump Storage

ABB produced units to this segment before, but sold off that business unit. Hydropower is further considered to be an unmoving market, and it would be difficult to compete with the old business units and its competitors that are experts on this very niched, one-application product segment. J.P. Morgan (2016) conclude that the hydropower market is heading towards consolidation where currently the three largest actors account for more than 50 % of the market. This supports the argument that the hydropower market has large barriers to entry and it will be difficult for a new actor to acquire a significant market share, as the requirements on hydropower generators are very specific and in addition, are not currently in the product portfolio of ABB Motors and Generators.

8.7 Biomass

Biomass is used to generate power by burning wood or other sources of biodegradable material (Elliott, 2013). The heat generated from the biomass is used to warm water into steam that drives a steam turbine that generates electricity, see figure 21. Biomass can be regarded as being in the grey zone of sustainable energy. Historically the usage of biomass has led to desolation of forests which cannot be regarded as sustainable. However, nowadays replanting is done to avoid desolation and carbon dioxide emissions to the atmosphere (ibid.).

There are different opinions regarding whether the use of biomass for energy production has a negative impact on CO_2 emissions or not. Studies show that the emissions from biomass will be larger than the CO_2 that replanted wood will consume (RSPB et al., 2012). Others state that once the lifecycle of the wood is completed the stored CO_2 within the wood would emit to the atmosphere anyway, hence instead it could be used for generating electricity (Elliott, 2013).

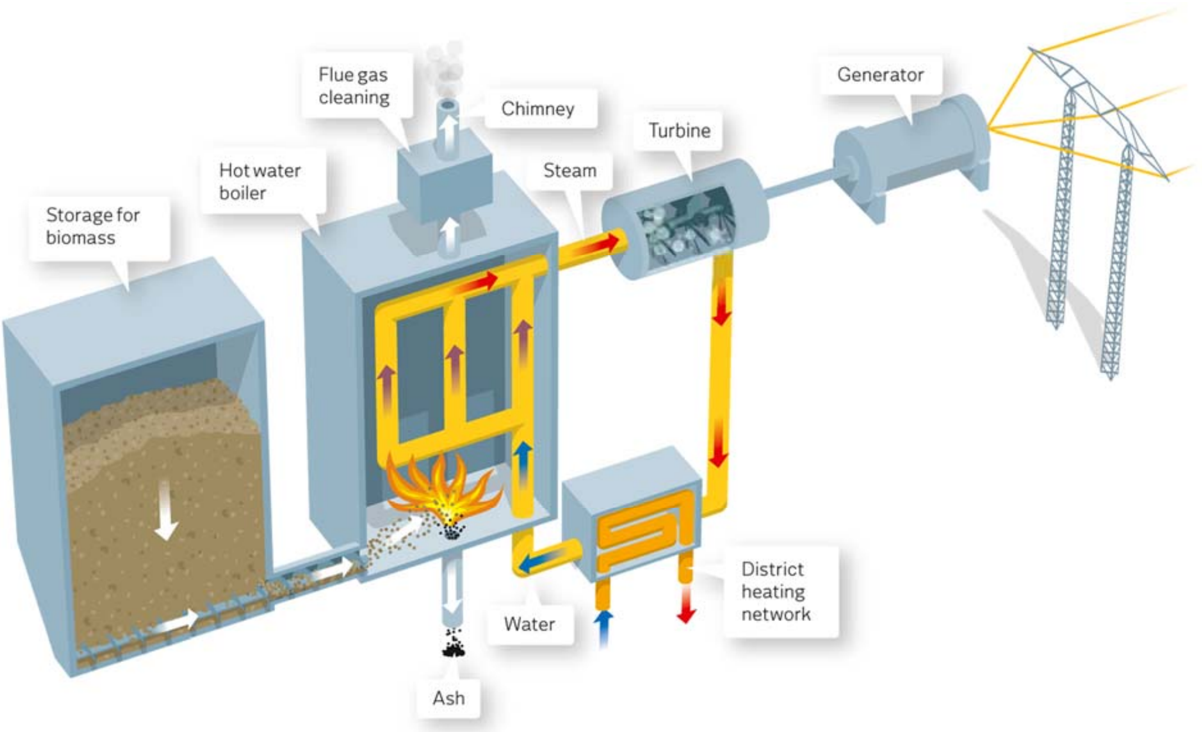


Figure 21 - Illustration of a biomass power plant

Regardless of the classification of biomass, in terms of sustainability, it is an area with high potential for supplying the world's electrical grids. The throwback with biomass is that it requires large areas for wood plantations as well as transportation of the material to the power plants. However, biomass can be used as a way of providing backup power to the electrical grid as the biomass can be stored. This aspect will be increasingly important as the share of renewable energy increases in world's power supply. Hence, biomass can be used to compensate for fluctuations in the supply of power.

ABB Motors & Generators are currently a supplier to actors within biomass power generation. As of now it is deemed that the upside of emphasizing sales within this industry is rather low compared to other potential markets. Due to this the technology will not be examined further in this study.

8.8 Wind Power

Wind power plants utilizes the kinetic energy of wind to make the turbine blades rotate that in turn rotates and magnetizes a generator unit, producing power. There are two different types of wind turbines, horizontal and vertical. The horizontal wind turbine is most commonly applied commercially and is illustrated to the left in figure 22 below. The horizontal wind turbine is at a fixed position which means that the position has to be optimized to maximize the exposure to wind. The vertical wind turbine on the other hand is independent of the wind direction which is a major benefit, see figure 22. However, the vertical wind turbine is not commercially applied to the same extent hence only small scale projects use the technology. Due to the low spread of the vertical technology it is deemed that ABB does not have any significant business opportunity within this market. Additionally, the capacity of the generators in these applications does not match the product portfolio of ABB Motors and Generators.

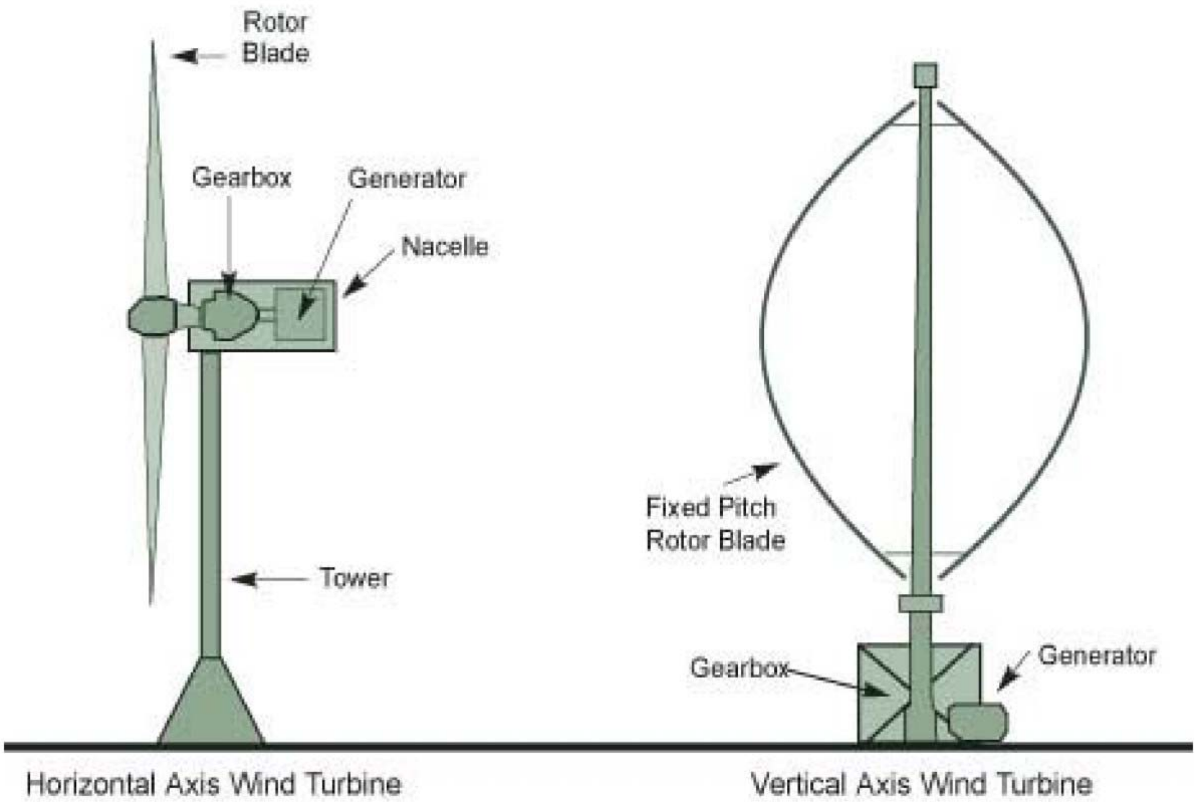


Figure 22 - Horizontal and Vertical Wind Turbines

The blade length of the horizontal wind turbines is continuously increasing which means that the capacity of the wind turbine increase exponentially (Morgan Stanley, 2017). Wind power is currently the cheapest form of power generation hence the market has grown significantly during the last couple of years, a trend that is forecasted to continue (ibid.). Traditionally wind power generation has had an output below the target market for the products of ABB Motors and Generators in Västerås. A sister factory in Finland produces smaller units that are used in wind power. However, as the market trends goes towards using larger wind turbines with a significantly higher output it is possible that these new, larger turbines could become a market for the smaller of the units produced in Västerås. The applicable product in such a setting would be an inductive generator. The steadily increasing wind power market in combination with new possibilities for larger units motivates a further analysis of how ABB can go about to take advantage of this situation. This will be further discussed in the analysis chapter.

Figure 23 - Wind power is generated from placing a structure similar to a huge fan in a windy place

8.9 Grid Stabilization and Smart Grids

Grid stabilization refers to reducing the fluctuations in the electrical grid so that it always maintains a frequency of 50 Hz (or 60 Hz in some countries). As explained in chapter 6, many renewable sources of energy are not controllable, like wind power that only produces power when its windy. The increasing energy supply from these uncontrollable energy sources increases the share of energy in the grid that fluctuates over time. In order to level the peaks and troughs of an uncontrollable power source it is necessary to preserve energy or have flexible energy sources that can support the grid by counteracting the fluctuation effects. Smart Grids refers to a grid's ability to anticipate and compensate for load fluctuations, using active sensors, sensory history, interconnected digital systems to apply means to grid stabilization.

Counteracting fluctuations in practice means to preserve surplus energy for use when there is a shortage. Preservation of energy can be done in two main ways: active and passive preservation. Passive preservation is essentially the technology of storing energy in batteries, or other static material. During recent years the price for batteries has decreased due to a wider spread of applications such as electric cars. This trend is forecasted to continue as the number of battery-producers increase as well as the application areas (J.P. Morgan, 2016). However, batteries are still both very expensive and toxic to the environment when they are produced and discarded.

Active preservation is done by connecting rotating mass to a grid. Synchronous machines, that are tuned to a specific frequency, and used as synchronous condensers, are well suited for these applications. The rotational inertia of the connected rotors provides or absorbs kinetic energy to the grid in case of a frequency deviation Δf

8.10 Combined Cycle Solutions

Combined Cycles Solutions are aimed at using heat generated from other processes for producing electricity or heating facilities. One common application is a steam turbine used in combination with a gas-fired turbine. The gas-fired turbine has relatively low (~ 40 %) efficiency (Elliott, 2013). In this combined cycle solution, the exhaust heat from a gas turbine is used to heat water that drives a steam turbine, hence efficiency can be increased. A combined cycle of this type is called a Combined Cycle Gas Turbine (CCGT). Another type of combined cycle is Combined Heat and Power (CHP) where the exhaust heat from the process is distributed to the district heating network. This combination has the potential to reach exceptional efficiency ranging from 80 % and above. However, Combined Heat and Power does not offer any business opportunities for ABB as the added component is a heat exchanger, which is not included in ABB Motors and Generators product portfolio.

Combined Cycle Gas Turbines on the other hand is well suited with ABB's current product portfolio. Additionally, an increased usage of shale gas implies that the usage of gas turbines will continue. However, J.P. Morgan (2017) concludes that the market for CCGT has a number of risks. The first risk is that an increased use of shale gas will undermine other, more environmentally friendly, technologies. Although a CCGT mitigates the environmental impact compared to a single gas turbine it is still a technology that cannot be deemed as sustainable. Second, it is less economically viable to combine a steam turbine with a gas turbine compared to alternative investments in renewable energy such as wind power.

Despite of these factors ABB may very likely win orders within CCGT in the near future as long as shale gas is continued to be used. However, the risks within the market overweighs the potential benefits of establishing a strong network identity in this segment. The market is highly dependent on political activities which makes it sensitive. This, in combination with the non-sustainable use of shale gas makes CCGT a market with moderate forecasts.

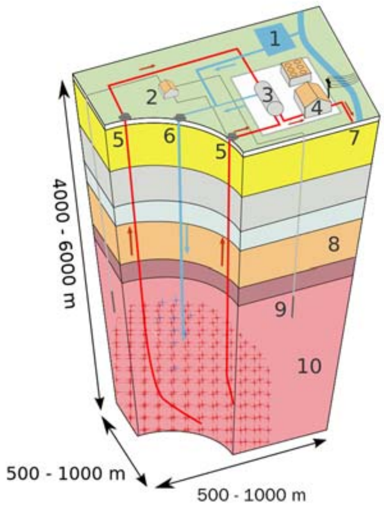
8.11 Geothermal Power

Geothermal power is based on a concept where water is pumped or lead down into a deeply drilled hole, a bore hole, warmed up and converted to steam by natural heat deep underground and then lead up through a second drilled hole next to the first one. Since steam has a lower density than water, a pressure is created that can be used to power a turbine and generator that is placed on top of the second hole. (Elliott, 2013) Another vital advantage is that a geothermal plant delivers a steady, continuous power stream, that adds baseload power to the electric grid.

ABB has a long standing business relationship with a client that is a major player on the geothermal power market, that both builds and operates Geothermal Plants. This relationship can be vitalized this fall by a new frame agreement, that could see the relationship becoming more close, the player sees a steady market expansion but at the same time tough competition from cheaper alternatives. According to the player, the payback time of a Geothermal Power plant is about five years.

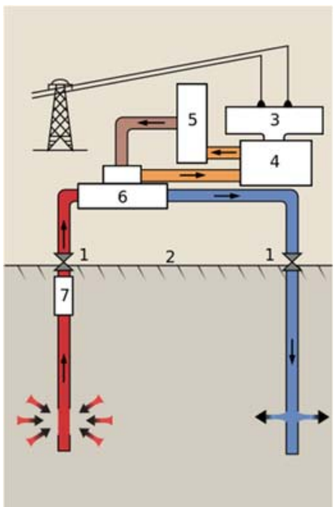
8.11.1 Enhanced Geothermal Power (EGP)

In later years, new technologies have revolutionized geothermal power generation. The most important aspect is that EGP does not need natural hydrothermal resources, but instead uses hydraulic stimulation to create geothermal resources in hot impermeable rock, that can be found deep underground everywhere in the world. The simulation is done by leading cold water under high pressure into the location deep underground and thereby creating cracks in the bedrock, or “hydro-shearing”. The water then heats up, evaporates, builds an even higher pressure and finds its way up the other borehole(s) located nearby.



The primary result of this method of heat extraction is that the EGP plants can be built anywhere, and not just above thermally active areas. This could make Geothermal Power Generation viable in countries where it was not viable before, like Northern Europe or mainland china.

8.11.2 Binary Cycle Plants



Binary Cycle plants uses pumps up warm water from a well and runs it through a heat exchanger that transmits the heat unto a fluid with a lower boiling point in a second fluid system. The second fluid evaporates and its increased pressure drives a turbine. The cold water is led down to the geothermal well through a second hole. The primary selling point of binary cycle plants is that it does not need natural steam, and can function with water that has significantly lower temperatures than the other plant types.

8.12 Selection of applications

To summarize there are essentially three applications that has a large potential for new business for ABB - Large wind power mills, Grid stabilization, and Geothermal power, see figure 24. Wind power has seen a large expansion during the last couple of years, a trend that is forecasted to continue. This, along with the trend moving towards larger units make it a potential large market for ABB Motors and Generators. Grid stabilization will be a large issue in the future as the share of renewable energy increase in the grid. There is a need for both static and active preservation of energy which means that ABB's synchronous condensers could have a significant role in stabilizing the grid. This global issue implies that the market for synchronous condensers will be on the rise.

Finally, geothermal power is an oftentimes overseen technology that is deemed to have an important role in supplying the grid with renewable baseload power in the future. ABB's current customer, the major player mentioned before, is increasing their number of installed sites around the world and is forecasted to continue this development. This, alongside the potential of enhanced geothermal that is independent of natural geothermal activity makes it a promising market for ABB.

Additionally, there are three applications that could have the potential for business opportunities for ABB although they are not deemed to have the same potential today. Hence, concentrated solar power, biomass, and combined cycle solutions are ranked with a medium priority. A development where concentrated solar power could provide baseload power due to a storage solution would make it more attractive. As of today the number of installed sites are rather small and thus also the market. Biomass is rather widespread around the world and does possess the ability to provide baseload power. However, other technologies are forecasted to have a larger growth. Additionally, the technology is in the gray zone of sustainability. This in combination with ABB's current position as a supplier to biomass power plants implies that the potential for new business opportunities within this segment is rather low.

Third, combined cycle solutions are a market that are sensitive to political actions and the use of shale gas. As of now the spread of CCGT technology is rather low due to alternative investments in renewable energy being more economically viable. However, the products used in CCGT match the product portfolio of ABB Motors and Generators and hence there is a potential for new business within this segment. Depending on future indications it could be a potential market which should be monitored.

The additional technologies - Carbon Capture & Storage, Solar Photovoltaics, Wave Power, Tidal Power, and Hydro Power are rated with a low priority. Carbon Capture & Storage are currently not economically viable and there are no indications as of now that this would change in the near future. The rest of the technologies are not applicable with ABB Motors and Generators current product portfolio and the potential for adapting the products to match these markets are viewed as not being viable due to two reasons. First of all, it would require major changes to the current products. Second, the markets are not sufficiently promising for such investments to be motivated.

Application	Priority	Key points
Carbon Capture & Storage	Low	• Not economically viable • Low spread of technology • No indication of change in the near future
Concentrated Solar Power	Medium	• Low spread of technology today • Storage solutions could make CSP a technology that can provide baseload power which would increase its potential
Solar Photovoltaics	Low	• ABB Motors and Generators products are not applicable
Wave Power	Low	• Low spread of technology • Underwater generators are not applicable • Small scale
Tidal Power	Low	• Underwater generators are not applicable • Few tidal power plants today
Hydro Power	Low	• ABB does not have the products for this setting any longer
Biomass	Medium	• Biomass can provide baseload power • Currently a supplier to this segment • Grayzone of sustainability
Wind Power	High	• Cheap technology for energy production • Trend towards larger units • Wide spread of technology
Grid Stabilization	High	• Grid stabilization will have an increased impact • ABB is currently a supplier
Combined Cycle Solutions	Medium	• Uncertain market • Included in ABB's product portfolio • Grayzone of sustainability
Geothermal Power	High	• Provides baseload power • Cheap technology for energy production • Enhanced geothermal could have large potential

Figure 24 - Summary of considered applications and their priority

9. ABB in relation to Selected Application Areas

The business activities of ABB Motors and Generators are to a large extent tightly intertwined with its clients' activities in the cases where the business relationships have spanned over a long time. Many employees of ABB and its clients have often similarly been at their respective companies over long periods of time, strengthening the relationship levels (Håkanson & Snehota, 1995) between the companies with personal relationships between individual actors in both companies. The network identity of ABB Motors and Generators is that of a high cost and high quality supplier to a number of large client companies, many of whom ABB has had a long relationship with. The other side of these well-collected resources and well-managed relationships are a natural resistance to launching new projects into new markets and networks where resources and relationships are not as strongly developed. This fact diminishes the start-up capabilities of ABB Motors and Generators when regarding potential new markets, products and projects. At the same time ABB has should be able to commission dedicated staff to work with the startup efforts of new projects and new market areas. Currently ABB Motors and generators views their network horizon on the client side as ending beyond their end-user clients.

9.1 Geothermal Power

Geothermal Power applications are considered well fitted to the resources of the Västerås plant, in the sense that the majority of already installed generators as well as future generators considered by the geothermal company that was interviewed, can be found in the already existing product portfolio that is produced in the Västerås factory. The acidic environments where generators operate require similar expertise in regard to building resilient machines as some offshore and industrial environments that can be found at other clients of ABB Motors and Generators.

In terms of network positioning, many of the companies that are building geothermal power plants exists in the same network context as ABB in the sense that they are all supplied generators either by ABB or the same competitors that are active in other major markets where ABB competes. At the same time, large parts of the geothermal producing market might be outside what many at ABB considers to be their classic network context, even if those markets are within the network horizon.

But even if ABB has the products, the facilities and the expertise (business units) to supply the market well, it currently lacks customer relationship levels (Håkanson & Snehota, 1995) with all actors except one that has a long standing business relationship with ABB, the major player mentioned before, a relationship which might be revitalized this fall by a new frame agreement. This relationship, when viewed as a part of a triadic relationship, sees the player as both an OEM/EPC and an End User of ABB's machines, constituting two different network functions at the same time. However, since the player builds the same plants either way, the only difference being that in some cases, they own the plants themselves and sometimes they sell them, there should not be so much difference in how ABB should act as a supplier and structure their sales. The exception being if the player produces a plant by specification to another end user that might have specific requirements or ideas about which generators that should be commissioned.

The current setup where ABB has local sales offices set up globally at the same time as each business unit has their own sales team, has been voiced as a complicating factor when trying to reach a frame agreement with the major player. The idea of engaging the same actors from different business units within the same market context might seem confusing for the targeted actor.

9.2 Grid Stabilization Technologies

Since ABB Motors and Generators have already supplied machines that are connected to the high voltage grid, it is considered to have the internal resources (Håkansson & Snehota, 1995) required to produce these units. The challenge will instead be found in expanding this existing market and in finding new clients that could benefit from the rotational mass. Static energy storage, or batteries, that are connected to the grid, could in some cases see rotational mass connected instead. Since ABB is engaged in business within many different areas of power transmission, and have been for over a century, the network position of ABB Motors and generators as a part of ABB, should be favorable when engaging clients that builds and maintains power grids.

The resources available to the Västerås factory is not only the developed physical tools to make HV products of high quality, but also the knowledge, or human capital, to execute and develop internal activities, as well as maintaining a strongly interconnected business relationship with local actors and international specialized actors within power grid maintenance and production. The risk, however, is that this network position brings with it a network identity where ABB Motors and Generators could fail to find the up and coming potential clients when focusing on the historical big players in power grids. Even if the power grid owning companies will remain the same, other parts of the network, like OEMs and EPCs, could see new actors growing quickly (Holmen & Pedersen, 2003) if they have smart solutions to the increasing demands for smart and interconnected grids.

The market potential in grid stabilization products is considered to be very high. Since the increasing demand and subsequent production of clean and sustainable energy places high demands on grid stability globally, together with increasing demand on grid capacity in growing economies like China, the demand for rotating mass connected to HV-grids will most likely grow in coming years.

In order to achieve a strong position in this market segment, it will probably not be enough to simply carry on with present exposure. Focal start up and sales efforts, maybe in joint effort with an EPC supplier towards specific markets, might give ABB a better market position for taking market shares in these and similar markets within the network horizon. The risk with this approach could be that some clients are alienated as ABB might trample into what they consider to be their own market.

9.3 Large Wind Turbines

Historically, production of smaller generators for wind turbines are produced in another factory under ABB Motors and Generators located in Helsinki. As the trend is for windmills to be bigger and bigger as materials get stronger and the fact that it already is one of the cheapest ways to produce clean energy, it is likely that in a short period of time there will be a quickly expanding market in large windmills that need generators that are one size above what ABB can produce in Helsinki. This is considered a market change as described by Holmen & Pedersen (2003).

Since the Västerås factory has the resources to produce the larger generators, and the Helsinki factory has the resources, expertise and relationship levels (Håkanson & Snehota, 1995) to build and distribute generators for the wind power markets, ABB Motors and Generators should have a strong set of internal resources and existing business relationships to quickly adapt and expand its market share in the market for generators for large windmills.

The dynamics of network identity between the Västerås and the Helsinki factories might be an interesting factor, since they're both part of ABB Motors and Generators but the internal perception at the Västerås plant might see wind power as something Helsinki does, and an expansion into the wind power market might even be something that the Helsinki plant could oppose, openly or silently. Same goes for the network context; ABB, as an actor within power production and distribution, has strong business relationships with actors and companies in this sector. The challenge will be to pivot these business relationships and specific business unit expertize from the facilities in Helsinki to the ones in Västerås. The focal startup will as such not be a new start up, but rather a partial startup and a partial internal reshuffling of business unit responsibility between the Helsinki and Västerås factories. This includes the relocation of business relationships at the same time as new business relationships need to be built with other actors that are more specialized in building larger windmills.

9.4 Current Markets of ABB Motors and Generators

The current product portfolio of ABB Motors and Generators in Västerås has seen declining sales figures, and even if oil prices and global overproduction of the machines in question naturally drives prices down, the focus of ABB as a company with a network identity as a high cost, high quality supplier, should be to market and distribute understanding of the value behind this quality. Since the OEM and EPC actors care less about quality and more about pricing than the end user customer does, focus should be on educating end user customers and building business relationships with actors in these companies, and so creating a demand for the higher quality, higher cost products from the clients of the EPCs and OEMs.

Additionally, ABB's current sales organization, that relies on local sales companies being the first point of contact for customers, is sensitive in today's business environment. As the market has dampened and ABB is facing an increased struggle to sell their products it is vulnerable to have local sales units that does not possess the expertise to promote ABB's products and its characteristics adequately. Throughout the interviews conducted at ABB this struggle has been lifted as a key point. Furthermore, it can be concluded that it is necessary to be involved early in the project process in order to influence the end user in their choice of supplier and specifications of the products. As the local sales units is the first point of contact for customers ABB's central sales unit is involved later in the process which diminish the possibility to influence the end user.

10. Recommendations

Market Shares in the Growing Market for Geothermal Energy

Expand efforts to take market shares in the geothermal sector by developing new and existing business relationships with customers that are active in the geothermal energy market. The strong relationship with major players should be moved exclusively to the Västerås factory and be used as a forward network position from which the generators can be improved for future use both at major geothermal players and with other actors in this network context.

It might also be fruitful to keep an eye out for when the Enhanced Geothermal Technologies expand the market to geographies where active geothermal sources are not available. This paradigm shift is expected soon and might both change which markets the existing geothermal companies approach as well as spawn new companies that focuses solely on the new technologies.

Keeping Ahead of the Smart Grids

Expanding efforts in understanding which actors that will be relevant in creating active grid stabilization installations when the market feels its anticipated expansion, and educate actors in this network context about how ABBs machine interfaces can be used and co-developed as the grids feels demand to become smarter.

Preparing for the Future of Wind Power

Prepare a strategy for how to engage in the wind power market as demand for larger generators increase, in close cooperation with staff in Helsinki and inheriting Helsinki's wind power knowledge as the size of generators pivots in this market. Note that large generators in this market it not large enough today to warrant a dedicated expansion effort, but most likely will be in a few years.

Re-thinking Network Positioning and Customer Relationships

Focus sales and relationship building on actors that are or are closely connected to end user companies. If possible, propose joint-developments or other projects that can educate the end-user customers about the value in ABB's high quality that justifies the high price.
Consider ways to influence OEMs and EPCs, either by creating new incitement for them to use ABB, or by starting an internal EPC/OEM-organization.

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