On the acquisition of knowledge in eco-innovation firms:

The influence of external sources

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Abstract
This study was conducted to explore the external sources of knowledge that are present around the eco-innovation firms. Our study has focused on eco-innovations with the aim to find sustainable solutions, leading the reduction in greenhouse gases, on the extraction of renewable energy sources, since studies have indicated a link between the industrialization and the impact on the climate.

The purpose formulated for this study was to explore the external sources of knowledge that are present around the eco-innovation firms. By conducting this exploratory study we will contribute to existing research by adding empirical evidence to identifying what the external sources of knowledge are and further explore what kind of knowledge eco-innovation firms gain from these external sources. The participating companies in the study was chosen since they represent Swedish firms in the development of eco-innovations with the goal to minimize the environmental impact.

We conducted the thesis with a qualitative approach and the empirical data was gathered from four different companies in the field of wave and tidal power. The four interviews were executed through telephone interviews with both the researchers acting as interviewers. The respondents were either the CEO of the company or a board member, since these persons were most likely to possess the relevant information for this study.

In our study we have found the external sources of knowledge to be of significant importance to the eco-innovation firms. Based on our theoretical framework, we have identified the external assets as suppliers, customers, competitors, governmental actors and research institutions. These external sources have different importance depending on the character of the knowledge that is gained. The external sources showed to contribute with important knowledge in areas of R&D capabilities, technology development, market orientation and regulation. By assessing the external sources of knowledge firms will unlock great potential knowledge that would otherwise be very costly. A conclusion was that as eco-innovation firms acquire knowledge by their external assets in parallel there are signals, unconsciously communicated going out to the external environment. Since our study has shown that academic experience among the founders seemed to have been helping the firms in their contact with governmental actors in order to attract subsidies and in the approval process for test sites, this indicates that what seems to be communicated from within the eco-innovation firms to their external environment is certain legitimacy, credibility and reputation that strengthen the relationship with governmental actors.

This study was performed as a multiple case study on four different eco-innovation firms working with development of technology to extract energy from renewable energy sources in terms of wave and tidal power. Our choice to only interview one person on each firm, due to a limited time frame and resources, might make it hard to generalize the findings since there is a possibility of biased data. Other limitations that make it hard to draw to much from the results are the fact of focusing on a limited area on eco-innovation in only one country, since regulations play an important role this might differ between different countries.
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1. Introduction

The first section of this thesis presents a background to the research subject as an introduction for the reader. Then a problem discussion will follow, which will lead to the research questions and an explanation of the purpose of the study.

1.1 Background

In the modern world, both social and business, people have taken for granted the modern infrastructure in terms of the usage of and dependency on electrical power. What many people do not consider is from where these resources are harvested and how it affects the environment on our planet. Concerns regarding the negative environmental impact (Stern, 2007) of the industrial society have really gotten to drive the political debate in the matter forward creating regulations and standards for environmental policies within the business world (Porter & Linde, 1995; Demirel & Kesidou, 2011). Thus, a new branch of innovation has emerged due to the environmental attention, which goes under different names in the literature, e.g. eco-innovation, environmental innovation, sustainable innovation, green innovation, clean tech etc., as a means to find the solution to countries’ ecological problems without reducing the extent of economic activities (Beise & Rennings, 2005; Rennings, 2000; Cooke, 2008, 2011; Carillo-Hermosilla, del Rio & Könnölä, 2010). Studies by the Swedish innovation institution VINNOVA (2009) have found that technological difficulties and non-environmental alternatives are reasons why eco-innovation firms still struggle to commercialize their eco-innovations. VINNOVA (2009) explains the technological struggle with the fact that most firms working with eco-innovations are small, with small influence and a constant need of financing, and the different solutions vary in technological type making it hard to standardize a technology platform. Thus, the construction costs for each firm are substantial. Further, the challenge on the market in order to succeed is also hard and eco-innovation firms have difficulties gaining customers simply on the environmental appeal (VINNOVA, 2009).

There has been a lot of research done on the identification of the determinants of eco-innovation (Horbach, 2008; Horbach, Rammer & Rennings, 2012; Kesidou & Demirel, 2012; Rennings, 2000). These determinants are presented as technology push, market pull, and regulatory push/pull (Rennings, 2000). Later, in a study by Horbach et al. (2012), firm specific factors regarding the organization was complemented as a determinant of eco-innovation. Technology push regards supply side factors (i.e. technological capabilities and appropriation problems), market pull regards demand side factors (i.e. market demands, environmental awareness and preference for environmentally friendly products) and regulatory push/pull regards institutional and political influences (i.e. environmental policy and institutional structure) (Horbach, 2008; Horbach et al., 2012).

When starting to explore eco-innovation one can easily wonder if there are any differences between eco-innovation and conventional innovation. In this thesis we argue for the separation of the two categories of innovation, meaning that there are substantial differences. Further, this is supported by previous research presented by Belin et al. (2009), which shows that eco-innovation firms differ from conventional innovation firms.
in terms of what external sources they utilize. Belin et al. (2009) found that eco-innovation firms are more relying on public research organizations and suppliers’ knowledge whereas conventional innovation firms showed more reliance on internal human capital. When considering innovation economics, the positive spillovers of R&D activities are investigated and in this area the major difference is identified (Horbach et al., 2012; Rennings, 2000). As both conventional and environmental innovations have positive spillovers, regarding knowledge externalities, in the innovation phase, eco-innovations are distinguished for generating positive spillovers also in the diffusion phase due to the reduced external costs, i.e. reduced negative environmental impact, compared to other alternatives on the market (Rennings, 2000). Rennings (2000) called this peculiarity the double externality problem. Hence, the double externality problem reduces the incentives for firms to invest in eco-innovation, since the results of eco-innovation lead to reduced external costs, which the firms cannot profit from due to the competing environmentally harmful alternatives. Thus, the competition between eco-innovation and non-environmental innovation is distorted and is part of the reason why eco-innovations struggle to survive on the market. Rennings (2000) suggests that environmental policy and innovation policy should be co-ordinated to foster eco-innovation on the market and level out the distorted competitive situation. The double externality problem is a contributing factor to why the regulatory push/pull has been proven to strongly impact eco-innovations (Belin, Horbach & Oltra, 2009; Horbach, 2008; Porter & van der Linde, 1995).

1.2 Definition
The term eco-innovation has been used in diverse contexts, since the attention on the research field has increased, with different connotations that might end up reducing the practical value. Most definitions in the literature so far are mostly general in type, thus making it possible for a wide range of innovation to be classified as eco-innovations (Carillo-Hermosilla et al., 2010). For example, a definition from OECD (2008, p.19) states that eco-innovations are, in contrast to conventional innovation, “the creations and implementations of new, or significantly improved, products (goods or services), processes, marketing methods, organizational structures, and institutional arrangements which — with or without intent — lead to environmental improvements compared to relevant alternatives”. According to this definition a firm working with innovation might result doing eco-innovation if the result shows to lead to environmental improvements without having any intention of doing so. But the eco-innovations referred to in this thesis are all purposely devoted to minimize the negative impact on the environment when producing energy. Thus, another definition more closer to what this paper is aiming: “Eco-innovation is any form of innovation aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment or achieving a more efficient and responsible use of natural resources, including energy” (European Commission, 2007). In this thesis, eco-innovation will be defined as a mix of the definitions from European Commission (2007) and Cooke (2008), meaning that in this thesis we shed light on eco-innovations that are any form of innovation aiming at significant and demonstrable progress in improvements of the clean energy supply chain from energy source through to the point of
consumption and recycling, which results in reduction of greenhouse gas emissions. With this definition we are limiting ourselves to a focused area of research within the field of eco-innovations, which makes it more likely to draw relevant conclusions and contribute to the existing research on eco-innovations.

The investigated firms’ business foundations are striving to find a profitable way to extract energy with the intention of not causing any negative environmental impact. All firms explored in this thesis are working 100 % with eco-innovations and are further referred to as eco-innovation firms. This branch of business has a strive for finding a sustainable solution within renewable energy sources.

1.3 Problem Discussion
Studies have shown how eco-innovation firms are more relying on and influenced by external sources of knowledge in their business environment (Belin et al., 2009) as well as they are more likely to cooperate with other firms (Carillo-Hermosilla et al., 2010; Mazzanti & Zoboli, 2006; Pujari, 2006; Rennings, 2000). Interestingly, here it is indicated that eco-innovation firms are more likely to rely on and be influenced by external sources of knowledge. However, there is a lack of empirical studies presenting who these external sources are, what kind of knowledge they tend to assist the eco-innovation firms with in the development process. Such knowledge would help eco-innovation firms to overcome barriers to eco-innovation related to the use of external sources of resources.

From the experience of the encounters with some of the Swedish eco-innovation firms, the manager of the newly founded business unit is the same man behind the idea that ultimately led to a new business working with the development of eco-innovations. But these new business units are not granted with all necessary resources, both financial and human, that is needed to reach technological innovation (Greene & Brown, 1997; Hofer & Schendel, 1978). Firstly, what is not considered by earlier research is whether there are alternative ways to acquire necessary resources in the particular case for firms working with development of eco-innovations. The eco-innovation firms need to regard environmental regulations and policies as well as weigh the environmental impact into their decisions to a greater extent compared to the conventional innovation firms (Pujari, Wright & Peattie, 2003). Additionally, the eco-innovation firms might have great potential sources of competencies in their external environment (Polonsky & Ottman, 1998).

In order to innovate and develop new products, firms must have an adequate technological base and be aware of its ability to meet future customer needs as well as to respond to sudden and unexpected technology shifts (Adler & Shenhar, 1990). Adler and Shenhar (1990) present in their article four dimensions of the technological base: Technological assets, organizational assets, external assets, and projects. The technological base responds to the means of how firms transfer their knowledge and competencies into new products. Here, in particular, the dimension of external assets was recognized and is presented as the competitors, customers, suppliers, governmental actors and research institutions (Adler & Shenhar, 1990). These external assets were found to be of further interest due to the fact that they are being connected
to the firms under the dimension of projects and in this thesis the projects are represented by the development projects of eco-innovations. Projects are the means by which firms utilize and interact between the different dimensions of the technological base. Further, the attention to the external assets was given because of the support from previous research on the high likeliness of eco-innovation firms to rely on and be influenced by external sources of knowledge (Belin et al., 2009; Horbach et al., 2012; Rennings, 2000).

Though much has been written on the subjects of what determines and drives firms to invest in eco-innovation, research has not considered how the results regarding the external sources of knowledge to eco-innovation firms should be used. We see a need to extend the empirical exploration of the external sources of knowledge that eco-innovation firms have and present what kind of knowledge is utilized during the development process. This study opens for a new perspective on the external assets, exploring how the knowledge of external sources can assist firms during the development of eco-innovations. This study will consider how these findings regarding external sources of knowledge can be used and contribute to existing research on how eco-innovation firms, from a micro perspective, may possess great sources of knowledge in their external assets and how they should deal with challenges connected to these external assets. What would be of great interest for eco-innovation firms are how these sources of knowledge can be used to influence the eco-innovation strategy and thus ease the way for firms in the development of eco-innovations by knowing what external assets to use in order to affect the outcome and success of their eco-innovations.

1.4 Research Questions
RQ 1: What are the external sources of knowledge that eco-innovation firms are utilizing during the development of eco-innovations?
RQ 2: What knowledge do eco-innovation firms gain from these external sources in the development of eco-innovations?

1.5 Purpose
The purpose of this study is to explore the external sources of knowledge used by eco-innovation firms, and the impact on the success of the development of eco-innovations by using external sources of knowledge. By conducting this exploratory study we will contribute to existing research by adding empirical evidence to identifying what the external sources of knowledge are and further explore what kind of knowledge eco-innovation firms gain from these external sources.
2. Literature Review

In the second part of the thesis the theoretical framework is presented, which is used in this study. This part includes the reviewed literature organized according to the theoretical framework, starting with a presentation of the determinants of eco-innovation followed by the dimension of external assets from the technological base of the firm.

2.1 Theoretical Framework

The figure below (see figure 1) is constructed to explain our theoretical framework, which will be used in the analysis of the study. In the red circle are the determinants of eco-innovation, and in the green bubbles are the external assets. The external sources, presented by Adler and Shenhar (1990) are used as a simple framework to explore the external sources of knowledge that are present around eco-innovation firms. The choice to use a framework based on the article by Adler and Shenhar (1990) is motivated by the how well it corresponds to what this study is aiming to explain regarding the acquisition of knowledge from external sources among eco-innovation firms. This theoretical framework is also supported in a study by Fey and Birkinshaw (2005), which finds that the approaches on acquiring external knowledge are based on co-operation with universities, governmental actors, and other firms in the close environment, i.e suppliers, competitors and customers. Fey and Birkinshaw (2005) also state that in a well working R&D environment the firms are relying on a constant inflow of knowledge from other places making our theoretical framework relevant for this study.

2.2 Determinants of Eco-innovations

Figure 1 Frame work based on Adler and Shenhar (1990)
When reviewing the determinants of eco-innovation they are presented as three parts; technology push factors are regarding new eco-efficient technology, preferences for image and eco-friendly products are subsumed under market pull factors and the double externality problem is subsumed under regulatory push/pull. As the literature shows, behind the determinants exist underlying factors. In this study these factors will be representing suggested knowledge that are of great importance to eco-innovations. Following under this headline, the factors behind each determinant will be reviewed and present what knowledge, suggested from previous literature, is important to eco-innovation firms.

2.2.1 Technology push
When going through the general innovation literature, there is an emphasis on the technological capabilities of a firm (Baumol, 2002; Rosenberg, 1974). In the study by Horbach (2008), data shows that technological capability improvements, i.e. improvements of a firm's physical and knowledge capital, by R&D activities trigger eco-innovations. Furthermore, as suggested by Baumol (2002), inputs like investments in R&D and highly developed capabilities in R&D might have a positive impact on future innovation success. Accordingly, it can be suggested that the availability of greater technological capabilities in firms mitigates the vulnerability to future technological and environmental obstacles and induce future eco-innovation (Horbach, 2008; Horbach et al., 2012). However, few empirical studies has considered the more traditional factors for innovation, i.e. R&D activities, supply chain pressure to be more involved in the innovation process, and then add the environmental perspective on suppliers arguing for that the technology push factors regarding eco-innovations are not that different from other innovations apart from the environmental perspective (Mazzanti & Zoboli, 2006). Interestingly, Belin et al. (2009) found that eco-innovations also show higher dependence to public support, meaning that eco-innovations to a higher extent are influenced by state dependent research institutions as an innovation source regarding the R&D activities. A reasonable expectation to the fact that research institutions have great influence regarding R&D could be that eco-innovations in this thesis are working on new technology, which usually are characterized by a greater need of basic research.

Furthermore, the R&D process for developing new environmental products derives a couple of new levels of complexity into the R&D process. This means that the processes need to deliver the needed core benefits to the customers and also adding the needs for other stakeholders for the improved environmental performance. An interesting factor highlighted by Noci and Verganti (1999) is that the time scale is very unpredictable when dealing with situations where the areas of competence are extremely complex, e.g. when working with new technology such as renewable energy systems. Furthermore, when dealing with eco-innovations aiming to implement a new type of renewable energy system the time for invention, for adaptation, and for diffusion need at least a decade, which means that eco-innovation firms need resources to survive a long development process (Rennings, 2000). Since there is an obvious uncertainty connected to technology development as well as environmental concerns affecting the technology needs of the market, suppliers and customers would seem like
a good match in order to obtain knowledge from as external sources of the eco-innovation firms.

There are some differences in the decision-making in new product development between environmental NPD and conventional NPD when developing products for a non-existing market. According to Pujari, Wright and Peattie (2003) two of the most appearing differences are:

- A larger focus on the physical PLC of the product, such as where do the raw materials come from and what happens to the materials when the product is disposed, “cradle to grave”.

- An increased supply chain perspective, this means that the producer looks more at the whole supply chain choosing the suppliers that contributes the highest environmental performance. Also Pujari (2006) highlights the same benefits of early involvement of suppliers, he presents besides the technical benefits he also emphasizes the importance of choosing the right supplier with the theory of the “upstream” effect; that is that the environmental performance is determined of the products whole value-chain, including the suppliers impact on the environment.

By explaining the factors behind technology push, as a determinant of eco-innovation, we are establishing a base for the analysis to come later in this thesis. Here, as technology push is the first piece of the base for analysis, we are aiming to highlight the different technology push factors, which are representing the knowledge suggested to be of great importance to eco-innovation firms, that have the possibility of being gained by external sources of knowledge. Suggested in this thesis, knowledge on these technology push factors, i.e. R&D activities influencing firms technological capabilities, putting environmental pressure on suppliers, pushing supply chain actors to be included in the development of new technology as well as regarding the environmental impact, can be gained by the external sources of knowledge from research institutions, suppliers and competitors.

2.2.2 Market pull

When reviewing the factors behind market pull, customer benefits appears to be well known in marketing literature. Kammerer (2009) contributes to the market pull literature with his introduction of customer benefits as a driver for eco-innovation as well, and finds empirical evidence to customer benefits as playing a key role for eco-innovations. Further, Rennings (2000) also supports market pull factors to be of great relevance to eco-innovations, to which Cleff and Rennings (1999) found evidence that market considerations are of great importance for environmental product innovations. As suggested by Reinhardt (1998), the environmental products can utilize the differentiation of the environmental improvements to their products and have a competitive advantage. There seems to be a natural link between the market pull factors and the customers, as Kammerer (2009) mentions customer benefits, since there is a focus on market forces of the market pull factors. Further, market forces also
include competitive forces, which clearly bring competitors into the spotlight regarding market pull factors.

Accordingly, Pujari (2006) suggests that having a clear market orientation during the development gives a better understanding of the target market and the customer needs. Therefore, firms need to get a better understanding of its market orientation, since it is considered to be one of the key factors to success (Pujari, 2006). However, the market needs related to the environment also change over time, even if the social environmental concerns will increase in the future. How these will affect the market and the customers’ requirements is difficult to predict (Noci & Verganti, 1999).

According to Pujari, Wright and Peattie (2003) a difference between environmental R&D and conventional R&D regarding the market pull factors was:

- *The need of a broader reflection of the customers’ satisfaction* as the customers’ environmental concerns leads to a new set of requirements such as how the products are manufactured or how they are intended to be disposed.

To clarify how we continue to grow our base for analysis, the market pull factors are explained and highlighted. Since there is a lot of support for the newly presented fact that customer benefits play an important role for eco-innovations, we intend to explore how eco-innovation firms can gain knowledge from external sources regarding the market pull factors in order to strengthen and support firms’ ability to meet market needs, which during development of new technology can be unclear and change. The market pull factors are suggested to represent the firms’ knowledge about their market orientation, to the extent of customer requirements and market existence, and this thesis suggests that the knowledge of market pull factors can be gained from customers and competitors.

### 2.2.3 Regulatory push/pull

Traditionally, in the literature on eco-innovation, much attention and focus have been given to the determinant of regulation and its role for eco-innovation (see e.g. Belin et al., 2009; Horbach, 2008; Horbach et al., 2012; Kammerer, 2009; Rennings, 2000). As mentioned before, regulation has been a major driver for eco-innovation and that is the reason why the literature has suggested to introduce regulatory push/pull as a determinant of eco-innovation. Belin et al. (2009) conducted a study on firms in Germany and France and found that regulation and subsidies from governmental institutions are highly influencing eco-innovations. Horbach (2008) confirms, in his study from german panel data, what other studies in the eco-innovation literature have found, namely that firms compliance with regulation is a significant determinant for eco-innovation and that subsidies has shown to be a trigger of eco-innovations.

In the study by Horbach et al. (2012), the determinants of eco-innovations are being studied by the type of environmental impact and are carried out in a way to establish comparability to prior analyses, e.g. Horbach (2008). Horbach et al. (2012) are restricting their analysis to the eco-innovation firms and present results supporting the strong regulatory influence on eco-innovations. Interestingly, firms show increasing
expectations on the importance of future regulation but in most eco-innovation areas, expected regulation in the future already acts as a trigger for eco-innovation (Horbach et al, 2012).

Kammerer (2009), presents in the study on environmental product innovation by introducing a novel unit of analysis, where it is suggested to distinguish between the environmental issue of environmental innovations. The results in the study by Kammerer (2009) shows that regulation effects on the environmental product innovations tend to differ by the area of environmental impact. However, when it comes to distinguishing between the target of the environmental impact from the eco-innovations, Kammerer’s study focused on the electronic appliances industry, which makes it more susceptible to regulation of the areas investigated, i.e. energy efficiency, toxic substances, material efficiency electromagnetic fields, than in the case in this thesis where all eco-innovation focus on the reduction of greenhouse gases.

In the article by Rennings (2000), it is stated that eco-innovation differs from other innovation due to the "double externality problem", i.e. eco-innovation produces the positive spillover effect associated with R&D activities as well as producing improvements in the environmental quality. Rennings (2000) states that this "double externality problem" causes sub-optimal investments in eco-innovation due to the fact that the firm investing in eco-innovation has to carry all cost when the entire social environment can benefit from environmentally improved quality. This calls for a coordination of environmental policy and innovation policy, which could help firms cut costs in technological eco-innovation, e.g. in the phases of invention and market introduction when high costs regarding pilot projects arise. Based on the "double externality problem", most knowledge regarding regulatory push/pull factors are concerns of governmental actors, thus governmental actors can be expected to play a major part for obtaining the appropriate knowledge in this area.

The regulatory push/pull factors complete the base for analysis as shown in our illustration. Here we explain the factors behind regulatory push/pull, as the third determinant of eco-innovation. As presented by previous research, the factors behind regulatory push/pull are pointed out as regulation, policies, subsidies and public support in terms of state dependent research. In this thesis it is suggested that the regulatory push/pull factors pointed out above represent what knowledge that is crucial to eco-innovation firms and have the possibility of being gained from external sources of knowledge. From the external source of governmental actors, firms are suggested to gain knowledge in order to attract support through subsidies, processes regarding approval to test sites for pilot prototypes, and come up with eco-innovations compliant with existing and future regulation.

2.3 External sources
At this point, the knowledge behind the underlying factors of the determinants of eco-innovation have been presented and reviewed. In this following section, the external sources of knowledge, according to our theoretical framework based on the article from Adler and Shenhar (1990), will be presented and reviewed. This section will continue to contribute to what knowledge that is suggested to be gained by external sources of
knowledge. Here, the literature on eco-innovation is still rather unexplored and therefore the choice was made to also review the literature on innovation regarding external sources of knowledge.

2.3.1 Suppliers
Within the concept of the innovation process there is research that have looked at the supplier involvement in the field of innovations and new product development.

Ragatz, Handfield and Scannell (1997) presented in their study that there are several benefits that result from suppliers’ involvement such as material cost, quality and also a reduced development time. Other benefits that were presented in their study, for companies developing complex products or process, were better access to technology. No single company has all knowledge of all relevant technologies. This resulted in that those who were able to use the knowledge from the suppliers were able to take better decisions regarding technology, make better designs and also influence the supplier’s direction of technology development. Suppliers that are involved in the development and design of a product can help to spot issues that can be a problem in the future and help give solutions to reduce these problems, which would result in a reduction of both time and money spent in the development phase (Ragatz et al, 1997). They also present the fact that there is occasionally reluctances from both the company developing and the supplier in these actions, the developing company has problems letting the supplier in on, as they feel, secret information and also there is the “not invented here” feeling in those who work there. For the supplier it can be the same reasons for keeping the “secret” within the company (Ragatz et al, 1997).

Also Pujari (2006) highlights the same benefits of early involvement of suppliers, he presents besides the technical benefits he also emphasizes the importance of choosing the right supplier with the theory of the “upstream” effect; that is that the environmental performance is determined of the products whole value-chain, including the suppliers impact on the environment.

When looking at the supplier’s involvement the different materials and components that are purchased from the suppliers have a major impact on the quality, competitiveness and developments risks but also the market availability of the manufactures products. This influences according to Pujari, Wright and Peattie (2003) the involvement of the suppliers in the early development phase of the eco-innovation; they also highlight the benefits of the involvement from suppliers early in the NPD:

- Reduced development costs.
- Higher quality.
- Reduced time to market.
- Supplier-originated innovation.

In this section the first external source of knowledge is presented, namely suppliers. The advantages of supplier involvement are highlighted as well as the benefits that can
be offered when suppliers are properly approached in the innovation process. According to previous research, the suppliers can be expected to contribute both regarding technological advantage and environmental performance for the eco-innovation firms in the development of eco-innovations. It will be analyzed if the suppliers are an external source of knowledge and if they are, what knowledge is gained from the suppliers. This section acts as the first part of the external sources later in the analysis.

2.3.2 Customers
When we go through the literature of the innovation processes, there are research that have looked at the customer involvement in the field of innovations and new product development.

In the article from Cooper (1984) it is presented that one of the crucial factors for a successful product is knowing the needs and wants of the users. Further, Cooper (1984) argues to get a better understanding of the users it is vital to have a clear project definition, good market analysis, market research, and sales forecasting. By working in close collaboration with the customers firms have a better chance to develop new products that lead to sustainable competitive advantage (Fang, Palmatier & Evans, 2008).

Many empirical and theoretical studies emphasize a way to achieve a higher economic and innovation success by collaborating with the customers (Cambell and Cooper, 1999; Fang et al., 2008). These studies have shown several potential benefits that results from partnering with customers, i.e. new product ideas, increased customer value, improved effectiveness in product development and shorter product development time (Cambell and Cooper, 1999; Fang et al., 2008).

Cambell and Cooper (1999) present two main reasons for partnering with customers that they have found in the new product development literature. The first reason is by working close with customers the firm has the ability to gain a higher knowledge from the customers of what is demanded on the market which results in better product designs with a higher quality of the innovation. By identifying a clear view of the customer demands, the eco-innovation firms will increase the chances of succeeding to implement the customer demands as a standard among their supply chain companies and thereby reach improved environmental performance (Theyel, 2006). The second reason is the possibility to use the expertise that the customers often incorporates, the more complex the industrial products are the less likely it is that the innovating company has all the needed knowledge for design, testing, manufacturing and commercialization in house; by partnering with customers the innovating company has the ability to use expertise and other resources that would otherwise be either hard to locate or costly to acquire. The result of this is often reduced development costs and time.

Schrader and Gopfert (1998) argue that limited knowledge from the customers can result in an ineffective new product development. Also Cambell and Cooper (1999) provide a couple of disadvantages in partnering with customers such as:

- Partner selection, who should we partner up with?
• How involved should the customers be?
• Also if the customers are willing to provide the needed knowledge?
• The risk of damaged relations with customers who are important in the longer run.
• Bad publicity.

However, with all information it is still, according to Cambell and Cooper (1999), important to do the homework for a necessary strong market and customer orientation, which is vital for a better-quality new product performance.

Cambell and Cooper (1999) also mean that choosing the right customer as a partner increases the resources that are available to the project, which means improved access to having all the needed resources available for completing the project. Furthermore, they present a few long-term advantages such as access to customers and their network.

Involving customers in partnerships is not only associated with benefits, there is also a great risk and in the article by Cambell and Cooper (1999) they present a few reminders to think about when choosing a customer as a partner:

1. Relationships do consume a large amount of time and resources from the firm, so you have to decide if a partner is needed, not all projects are in need of a partner or a customer to take form.

2. It is important to look at the partnership and see if the time for payback is reasonable some partnerships consume more resources than they actually generate.

3. It is important for the managers to be realistic in the expectations of what is expected from the customer partnership, when deciding whether or not to partner up with a customer the expected interaction of what should be shared between the two partners should be clear so no misinterpretation should occur.

Here it has been presented what existing literature suggest can come out of the customers, as an external source of knowledge in the innovation process, and the benefits of involving the customers in the development of innovations. This is the reason why customers are taken into consideration in the analysis, to see if the eco-innovation firms utilize the customers as an external source of knowledge. Then, if customers are shown to act as an external source of knowledge it will be explored what knowledge is gained. Interestingly, it may show what knowledge that will lead to advantages, since there also are great risks connected with the involvement of the customers in the development process.

2.3.3 Competitors
If companies wish to stay competitive they need to evolve and adapt to new conditions. This also means that they need to keep renewing and improving their product-base as
they operate with the knowledge that their competitors will change the market with a new set of products and this will change the competition on the market (Trott, 1998). Trott (1998) means it is important for innovating companies to evaluate the competitive evolution to find out several different factors that will affect the market:

- When will the competitors arrive?
- Is it possible to predict their way into the market?
- How is their product differentiated?
- What are the entry barriers for the competitors?

When technology evolves certain turbulence is created on the market. This is because technological development mutates the markets dynamics and this either updates or outdates the market (Millier, 1999). The new technical innovation can either come from existing competitors that introduce new improved products or it can also come from new to the market competitors that emerge from unexpected areas and change the market as it is earlier known (Ibid). A good example is the watch industry presented by Millier (1999) when the Quartz came in and changed the market and suddenly took over the market from the mechanical watch manufactures. When reviewing the external source of competitors, most of the literature concerns the situation on the market, which is logic to the sense that competition creates turbulence on the market. One way to deal with market turbulence is when two firms on the same market, i.e competitors, engage in co-operation of technology development. This scenario is known in the literature as co-opetition between firms (Gnyawali & Park, 2011). Gnyawali and Park (2011) studied the co-opetition between Sony and Samsung, that co-operated in the development of LCD TV flat screens and were able to identify drivers of co-opetition. The engagement in co-opetition provide access to knowledge and resources that otherwise would be unavailable for the firms. For firms to be able to compete on today’s global market co-opetition has shown to be important in order to acquire technological skills and knowledge to utilize in creating new technological innovations (Gnyawali & Park, 2011; Quintana-Garica & Benavides-Velasco, 2004). Thus, competitors seem to be connected to the factors behind market pull and can be expected to offer knowledge regarding market orientation, i.e firms’ approach that focus on identifying and meeting the needs and wants of customers that can be either stated or hidden.

Millier (1999) presented possible sources of turbulence as can be seen in figure 3.1. By changing your own technology it can start a turbulence that puts your customers’ technology in uncertainty, and this because the customers’ technology is downstream and is affected directly by your technology. However, it works also in the opposite way, which means if your customers change their technology you will need to carry out more research and evolve your own technology too. Millier (1999) gives an example of a customer that changed from a “copper” support to an “optical fibre” which forced the supplier to develop a whole new set of products. Also upstream the suppliers’ technologies will affect your choice of technology.
In the figure illustrated by Millier (1999) two different types of competitors in technology is presented:

- Direct competitive technology, this is the technology that competes direct over a core product, e.g. a new reinforcing fibre competes with the steel rods in conventional reinforced concrete.

- Indirect competitive technology, this is technologies that remove the need of other technologies, which make them obsolete. An example would be washing machines that wash with ultra-sonic waves instead of washing detergents, this would make detergents obsolete.

This turbulence in technology creates an uncertainty on the market; which results in that the innovators feel helpless and have difficulties in what information to use and rule upon. This is challenging for the innovating companies that forces them to monitor for new technology that could disrupt the market and protect themselves by evolving their own technology or engage in co-opetition to adapt to the new environment (Gnyawali & Park, 2011; Millier, 1999).

To sum up, the competition is a powerful factor creating turbulence threatening the technology which creates uncertainty on the market. As previous literature states, this turbulence is particularly affecting firms working with development of new technology as any expected or unexpected competitive technology may evolve the market and make existing technology obsolete. Therefore, one can argue for the competitors to be an external source of knowledge regarding the market orientation, particularly regarding market existence. Thus, it will be analyzed in this study if the eco-innovation firms engage in co-opetition, in terms of utilization of competitors as external sources of knowledge and if that is the case, what knowledge was gained from the competitors.

2.3.4 Governmental actors
The phenomenon of governmental support to the business world where the issue of regulations, at least in some cases, has shown to be leading the process of creativity
and innovation forward in companies (Porter & van der Linde, 1995). As further suggested by Porter and van der Linde (1995) if environmental standards are properly designed it could trigger eco-innovation activities that in the end would lead to lower the total cost of a product or increase the customer value. Ultimately, this would lead to the development of more eco-innovations using their resources more productively, lower the environmental impact, and make the eco-innovation firms more competitive on the market.

Here we are reviewing existing research regarding governmental actors and the support systems, i.e. regulation, policies and subsidies, they offer for firms developing eco-innovations. It is important to understand how different support systems have been designed and why in order to be able to learn how to approach governmental actors. As the literature shows, governmental actors offer support systems for eco-innovation firms, but still these firms find it difficult to approach governmental actors. Here, we suggest how a dialogue between governmental actors and the eco-innovation firms could offer knowledge to the eco-innovation firms on how apply for such support systems. This will be used as a part of the analysis in order to be able to explore if the governmental actors are an external source of knowledge for eco-innovation firms. The literature on governmental actors are showing what could be expected in terms of assistance for eco-innovations on the market and if the governmental actors are shown to be an external source of knowledge this will be used in the analysis on what knowledge is gained by the eco-innovations firms.

2.3.4.1 Assisting new products on non-existing markets.

The most important drive force for innovations is market demand; this is because the most crucial success factor is the response from the customer (Rennings, Kemp, Bartolomeo, Hemmelskamp & Hitchens, 2003). Therefore it is important that governments assist radical eco-innovations that at the moment have a slow or non-existing market but instead have a large positive environmental impact in the future.

Governments have the ability to create a need and demand for radical eco-innovations, it is with the help of different policies and the tools that belong to these policies such as regulations on different markets to pressure a change and a shift in technology (Beise & Rennings, 2005). The support that governments provide is through different kinds of innovation policies or environmental policies. It is important to have in mind that regulations can be a drive force for the adoption of certain eco-innovations that are in need of regulations to push a shift in the market and create a demand in new ways that products and processes are produced. Also Kemp and Soete (1992) emphasize that regulations are an important factor influencing the development and adoption of eco-innovations. The fact that, as Kemp and Soete (1992) state, governmental actors can assist eco-innovations on markets characterized by uncertainty, connects governmental actors to the factors behind the determinant of regulatory push/pull. In the case of policies it is likely to expect eco-innovation firms to search for knowledge regarding how the innovation policies and environmental policies can be supportive to the development of new technologies. According to Rennings et al. (2003) the development phase is better stimulated by innovation policy while the diffusion of existing innovations is better stimulated by environmental policy.
2.3.4.3 Environmental policy.

It is through environmental policies and regulations the governments can strengthen the effective output of both regulatory push/pull and market pull.

Eco-innovations are often based on new technologies that have a long development time. This results in a need of support with the phase of diffusion and introduction of the technology, due to the high external costs linked with eco-innovations. Since there is competition with non-environmental technology, which is less expensive, this means that eco-innovation firms carry high costs that they cannot profit on and this is when the environmental policy is effective (Rennings et al., 2003).

Eco-innovations require close collaboration and dialogues between industry, government and regulatory bodies. This practice should give power to the regulatory bodies to work in a long-term commitment towards the interest of the consumers, environment and supplier competitiveness (Rennings et al, 2003). In order for eco-innovation firms to influence and contribute with input to the dialogue between industry, government and regulatory bodies, an essential factor would be to have the appropriate knowledge of how this collaboration takes place.

Rennings et al. (2003) mentions a few policy measures that should be considered as core-instruments for assisting eco-innovations with environmental policies:

- **Market-based instruments**, these instruments are also known as economic instruments and they are important in assisting to optimize the environmental aspects with the economical (Rennings et al., 2003). A couple of economic instruments that are used to boost the market for better eco-innovations are fuel and energy taxes, however the emissions trading system gained a large interest after the Kyoto process.

- **Regulatory instruments**, these can also be known as direct regulation instruments and they are said criticized that they provide small incentives to look for greener solutions once the obligations and standards are fulfilled. However direct regulations can also induce eco-innovation under certain conditions.

- **Environmental Management Auditing Systems**, this was introduced by the EU Commission to promote the use of environmental managing systems in firms (Rennings et al, 2003). Environmental managing systems refer to programs that in a systematic, planned and documented approach help the organization arrange and resource for developing products with the environment in consideration.

2.3.4.4 Innovation policy

The rivalry between environmental and non-environmental innovations is often out of shape due to the lack of punishments of harmful impacts on the markets according to Rennings (1999). He presents further that by introducing an innovation policy to support the eco-innovations, especially in the phases of invention and introduction, it would assist improvement of the performance of the eco-innovations. This could be done by appropriate financial support for pilot projects.
Governmental institutions can offer a variety of solutions to problems through a large field of experimentations; this is possible with a supportive innovation policy. Such a supportive innovation policy system could also aid to cut the high costs of innovation in the phases of development and market introduction with appropriate subsidies for pilot projects. Also in the diffusion phase the innovations can be aided with improvements by the innovation policy (Rennings et al. 2003).

2.3.5 Research Institutions
When reviewing the literature on research institutions, the interest for this study is to see what is done regarding the interactions between research institutions and industry. When turning to research institutions it is suggested in this thesis that research institutions are represented by universities or other institutions dedicated to research. As previous research states, research institutions act as an innovation source and contributes to a nation’s competitiveness (von Hippel, 1988). Many governments among the OECD have invested to improve the relationship between research institutions and industry with the objective of increased interaction (Cohen, Nelson & Walsh, 2002). As an example, the british government has launched a wide variety of programs aiming to support and increase commercial activities of university research (DTI, 2003b). The study by Cohen et al. (2002) indicates that firms are using knowledge from research institutions not only to generate new ideas but also to complete existing R&D projects. In the study by Laursen and Salter (2004), support is found highlighting the importance of utilizing knowledge from R&D activities not only from within the firm but also from research institutions outside the organization. According to Laursen and Salter (2004), if a firm is operating in a research-intensive industry, they are more likely to seek knowledge from research institutions. Since many eco-innovations are characterized by a higher need of basic research, research institutes are expected to be a contributing source of knowledge for eco-innovation firms and connected to the factors behind technology push in terms of R&D activities extending the firms technological capabilities.
3. Methodology

In this chapter we will explain how we performed the study. First research strategy and the research design will be presented. Then the sample and the way we collected data follows.

3.1 Research Method

Quantitative and qualitative research methods are the two that are repeatedly used and also the two that are most recognized. Bryman and Bell (2007) describe the approaches as the quantitative approach is when collecting numerical data and is usually used to explain phenomena using methods based on mathematics. The qualitative approach is more based on the gathered information of words rather than numbers and other collected mass data. This results in a more free and open research approach as a strategy suitable for exploratory studies of new areas.

The qualitative approach was chosen for this thesis, as we wanted to explore the external sources of knowledge that are present around the eco-innovation firms and what kind of knowledge that is gained from these external sources. According to Bryman and Bell (2007) having the intention of studying a subject to gain a deeper knowledge about the phenomenon a qualitative approach would be the most relevant approach to choose.

As a research design was chosen early on to conduct a multiple case study design. The reason for this was that we wanted to be able to compare the relevant experiences the eco-innovators in these companies have perceived. To be able to compare companies we chose several companies within the same field of innovation. The advantages of such decisions is that we could compare the companies and see if there is a contrast in the information we gathered and received from the cases (Bryman & Bell, 2007, p. 64-65). Our intended objective was to find two different cases where we could compare their different views in the use of external sources of knowledge, however when looking at the samples we found out that in Sweden there is only four different companies developing eco-innovations within wave and tidal power so it felt natural to contact all four of them.

When looking at the different methods in reviewing existing theory and gathering empirical data for the thesis Bryman and Bell (2007) presents two different methods, the inductive and the deductive method.

- The deductive method is building on previous research in advance and then collecting the empirical data of observable phenomena from reality and then linking these together to draw conclusions.

- The inductive method is the opposite, aiming at collecting empirical information first without any preconceived precise expectations and then linking these to applicable data and theories.

Having this in mind we started out with an inductive approach when conducting two pilot interviews, this to find out what is relevant and important to companies conducting eco-
innovations. After the pilot interviews we started a deductive approach finding relevant literature for the continuance of the thesis.

3.2 Sampling
In our study, the case selection was focused on eco-innovations in Sweden; the main reasons were the extensive availability of firms conducting development in this field of innovations.

When choosing a suitable selection of companies for our case studies, we decided that we wanted to find a certain segment that gave us the possibility to study all companies within one field. We saw early on that it was necessary to narrow down the sample of companies in the field of eco-innovations. This was due to the large population of companies that claimed to be eco-innovation firms. According to Bryman and Bell (2007) the population are all the companies in a selected field, and when doing qualitative research it is hard to investigate the whole population.

However with a personal interest in mind and some interesting hints from our supervisor we narrowed down to the segment of innovations extracting energy from renewable resources. This still gave us a population that was far too large to conduct a study on all of the companies within the selected segment. We started viewing the different segments within eco-innovations extracting energy from natural resources and found a small field of companies that developed eco-innovations extracting energy from tidal and wave movements this gave us a workable sample size for our case study.

The selected field gave us four companies that had the ambition of developing eco-innovations extracting energy from tidal and wave movements. These four companies are all located in different parts of Sweden and have different backgrounds in terms of how the firms were created and started their development of eco-innovations.

3.3 Data Collection

3.3.1 Literary sources
We used several databases when collecting articles for the literature review, the two that where of most help was Google Scholar and ISI Web of Science due to the fact that they provide information about the number of citations in relation to a publication. Other database that was also used was ABI Inform and Science direct.

Keywords used when searching the databases have been: Innovation, Eco-innovation, Environmental-innovation, Green-Innovation, Cleantech, Environmental R&D, New product development, Environmental new product development, Green Energy, Environmental impact, Determinants, Environmental-policies, Government, Management, Market, Supplier involvement, Customer involvement, Governmental, Regulations and Competitors.

The key words were used individually and in various combinations.
3.3.2 Empirical data
When collecting the empirical information the interviews we conducted were our most significant instrument. To back up our findings and to some extent enrich the data we also used public information from the different companies’ websites.

Prior to the interviews we asked the respondents if they wished to be anonymous since all the companies are in the development phase and if there was information they did not feel of ease to leave out. As one of the companies expressed their wish to be anonymous we chose to leave out all the names of the companies in the report and instead use a code for each company. In the empirical, analysis and conclusions the companies will be referred as Company A-D (Bryman & Bell, 2007, p. 134).

3.3.2.1 Pilot interviews
Conducting pilot interviews before the main interviews are an advantage according to Bryman and Bell (2007). This as a final preparation because then the researchers have the possibility to change and rearrange the interview guide or other information before the real interviews take place. The pilot interviews we conducted had a second reason in addition to the interview guide; it was to assist us in deciding the major approach of our research. We conducted two different pilot interviews with companies in the field of eco-innovation.

3.3.2.2 Respondents
For this thesis we decided to interview respondents that had all the relevant information that was needed to come to the conclusions that was desired. When we contacted the companies we presented our study and ourselves. Afterwards we asked who in the company was the right person to provide us with the right information. We later took contact with that person. All of the respondents were males in the ages from 35 years to 45 years old.

The respondent in Company A is the present CEO of the company and has been with the company since the research group at Chalmers University. The fact that he has been with the project since the early stages secures the validity of information that is presented.

At Company B we came in contact with their CEO who also has been with the company since the beginning. The CEO of Company B is the one who initiated the project and is the one at Company B who has all the relevant information for us.

In Company C we came in contact with one of the board members, he is also one of those that at the present moment are most active in at Company C.

Company D is the company that was most difficult to get in contact with. However, when we established a connection with one of the board members he was the most cooperative and the one that gave us most time. He even invited us to one of their test sites to whiteness the technology and also to gather more information. Unfortunately, at that time we were close to the deadline of the thesis, which was the reason why we had to turn down his generous offer.
3.3.2.3 Interviews

The interviews were conducted over the phone due to the fact that all the companies are spread throughout Sweden. According to Bryman and Bell (2007, p. 215) conducting a telephone interview is often easier than a personal interview when there are more than one interviewer conducting the interviews. This is because it becomes easier ensure on the interviewers violation when asking questions, such as using probes under the interview also the second interviewer can keep track of what information is needed and either intervene or signal the first interviewer of complementary questions or if the interview should change direction (Bryman & Bell 2007, p. 482).

We contacted the interviewees in advance to decide a time that the interviewees had appropriate time to offer us. We also made sure that the interviewees had chosen a setting that were both calm and relaxed so the interview could take place in a quiet environment and also an environment that offered no distractions (Bryman & Bell, 2007).

The interviews were conducted over a speaker phone and also recorded to make it possible to use both interviewers attention without having to write down all the answers. We conducted the interview with one of us as the main interviewer, who was able to focus entirely on the questions and the dialogue taking place. The second person took notes of useful expressions and parts where he felt that the interviewee was passionate of that subject (Bryman and Bell, 2007).

We used a semi-structured interview approach that offered both flexibility and freedom when answering the questions. However, one can question whether the semi-structured interview guide corresponds to the study’s purpose. This can be explained by us wanting to understand the companies’ purposes more deeply and thus we tried to capture a holistic view of the companies. Consequently, the interview guide contains questions on wider subjects giving us the opportunity to dig deeper on areas of our interest as the interviewee touches the subject, rather than controlling the interview by forcing the interviewee on to subjects without telling the whole story behind. This way we would collect more comprehensive data on the subject since the focus of the study was not completely defined at the time of the interviews. The main reason for us choosing the qualitative semi-structured approach was that we were interested in the interviewee’s point of view and a quantitative structured approach would rather offer us hard facts and measurements with no freedom for the respondents to give us other information. Bryman and Bell (2007) also mention that if there is more than one interviewer the semi-structured interview approach is preferred due to the previous mentioned advantages.

Bryman and Bell (2007) emphasize the use of warm-up questions about trivial areas to warm up and make the respondents at ease. Accordingly, we felt that we had the time needed for these interviews bearing in mind that the respondents usually need more time to answer our real questions and ramble off on subjects that are important for them.
3.4 Reliability
According to Bryman and Bell (2007), external reliability is whether or not the research can be repeated in the same way again. Miller (2008), refers to reliability as the dependability, consistency, and repeatability concerning the way a study’s data collection, interpretation and analysis were conducted. In this study, it is believed that the external reliability is considered to be hard to judge. Thus, this depends on the accessibility of the founders of each and every eco-innovation firm and whether they still are active in their field of expertise. One problematic factor is regarding the ever-changing environment an eco-innovation firms is existing in. The business world is not static and that is why it will be hard to repeat the study, since the companies have evolved and are not in the same situation as they were during the time of the original study. However, the internal reliability, as referred to by Bryman and Bell (2007), is when there exist more than one observer, and whether the researchers share the same understanding of the information transfer that takes place during collection of empirical data. Therefore, the internal reliability was ensured through the observation of both researchers, who both were taking notes as the interviews took place which also were recorded digitally with the consent of the interviewee. To eliminate misunderstandings and misinterpretations and thereby increase the reliability even more, the interviews were transcribed and discussed by the researchers repeatedly during the research project.

3.5 Validity
Validity refers to “whether you are observing, identifying or measuring what you say you are” (Bryman & Bell, 2007, p 410), and one can measure both internal and external validity. Bryman and Bell (2007) refers to internal validity as whether the researchers have a mutual understanding or not regarding the observations and the developed theoretical ideas (ibid). When conducting qualitative research, Bryman and Bell (2007) mean that the internal validity usually is strong, because when the researchers are collecting the empirical data they participate in the social life to a greater extent.

In this particular study, the internal validity increased due to the fact that both researchers were involved in the interviews and could interact freely during the telephone interviews. Both the researchers and the interviewees were in the same social situation when performing the interviews. Also, as the researchers shared the mind set and reached a mutual understanding of the beliefs as well as the conclusions regarding the theory vis-à-vis the observations during the the empirical data collection. Further, this enables the researchers to reach high levels of agreement between the theory and the social life (Bryman & Bell, 2007). The validity of the study will also be affected, according to Denscombe (2000), if the various viewpoints are considered and if there is confirmation among these different viewpoints. This study was done on a small number of eco-innovation firms. However, the answers were frequently closely related, meaning that the respondents shared their points of view and were therefore confirmed, which make us believe that the validity increases in this particular study as argued by Denscombe (2000).
In contrast to the internal validity when conducting qualitative research, external validity is, according to Bryman and Bell (2007), harder to reach due to the difficulty of generalizing the study’s findings in different social settings. Therefore it is hard for a qualitative research like this to be generalized, especially since only the Swedish branch of the eco-innovation firms was explored. But the goal for this study was not to generalize the findings across all social settings, but to gain a deeper knowledge about the particular case of this research subject and trying to identify ways to pass around these obstacles that exists. The firms interviewed, or the persons behind the firms, were all experiencing the early development stages of the innovation process, but had different strategic policies and had a mixed view of where the final goal for their business was; and with these circumstances it is difficult to grade the external validity as well as to generalize the findings of this study.

Further, by only interviewing one respondent in each company can also affect the findings in this study. However, the respondents who participated in this study was considered to have all the needed facts and relevant information for a valid outcome. This is mentioned by Bryman and Bell (2007) as the significance of credibility. Yet, there is still a considerable risk of us having a biased data, since by only having one respondent we don’t have a reasonable chance to estimate whether the data is valid. But, considering a tight deadline and lack of resources at the time, we chose to proceed with only one respondent from each company.
4. Empirical data

In this section a presentation of the telephone interviews of the participating companies will follow. This part will be structured in order of the determinants of eco-innovation to follow the same pattern as the literature review and the external sources of of relevance will follow under each determinant.

4.1 Company A

Company A is working in the eco-innovation branch with a project aiming to extract energy from tidal water. The project was started 2003 within a multinational enterprise, further referred to as MNE A, and after about 4 years of development Company A was founded as a spin-off of this project. This was in 2007 and Company A was from that year devoted to drive the project forward on the journey towards the commercial phase. Company A’s headquarters is located in Gothenburg, Sweden, which makes it an interesting actor for this thesis since we are exploring Swedish eco-innovation firms. Their business concept comprehends sales and development of power plants working cost-effectively utilizing the tidal streams in the water to generate electricity. The innovation of Company A is an underwater kite, which was considered to be outside of the MNE A’s economic area but the potential was too big not to utilize on this concept, that works with the underwater current in low velocities generating electricity. The concept is a new development, called Project A, and the advantage with this system is that an underwater kite, running the generator, works at the speed 10 times the current’s and since energy and speed has a cubic relationship the energy extracted at 10 times the current’s speed means 1000 times more energy. Company A is using a business model focusing on business to business.

4.1.1 Technology push factors.

A new radical innovation like this with such high technology takes time to develop. In the first stages of development Company A struggled to get attention from MNE A Venture, the research and development unit within the MNE A, but once they were convinced about the great potential of the idea the project really took off. But since the venture wasn’t really in line with MNE A’s economic area they turned to Chalmers University and started a research group for the Project A and through Chalmers they came in contact with the present CEO A. At this stage they had a unit from Chalmers working on the R&D with more basic research regarding the feasibility of the technology. However, the research and testing of Company A’s technology took several years before having a working prototype to prove the concept. They estimate the time from the idea to the commercial phase to be about a decade and this is a long time in the modern business world.

CEO A of Company A is under the impression that supplier involvement is very positive in the development phase of an eco-innovation project such as the one Company A is running. In the case of MNE A, the suppliers’ technological capabilities are a major base in the innovation, one could say that the suppliers are the true experts in the area and MNE A is using the suppliers’ technological expertise to keep developing the innovation and the technology platform. CEO A experiences a positive correlation between supplier
involvement in the R&D process and the success of the project so far in the development phase.

4.1.2 Market pull factors.
From the very beginning Company A thought it is of great importance to know what the market wants and by the market they mean the customers. Before the initial contact was made to Chalmers the man running the company really wanted to make sure that there was a potential customer and a market for the project, since it would be a complete waste of both time and money developing something of no interest to the market. During the first year CEO A explored the interest for such an innovation and when he realized that there both was a need and desire for a product such as their innovation he decided to initiate the development for the innovation. He mentions that the best way to gain information about the market is to contact the customers early on in the project and make them take part in the potential opportunities that results with the project.

Company A emphasizes the importance of continuous development through innovation activities. This is an area that is too important not to have a strategy for in order to have a reasonable possibility of gaining credibility on the market and continue to be the market leader or at least have competitive advantages. CEO A continues to argue about the importance of constantly searching for what is going to be the next successful business model, such as formulating advantageous partnerships and which actors could be an opportunity to work with.

Company A does not have any signed deals regarding customers’ involvement, meaning the involvement of customers in the project so far has not been characterized by official involvement in the project. However, Company A consider the customers as valuable input in order to meet expectations and customer requirements.

Company A’s greatest market potential is located outside Sweden, since the conditions for a tidal water power plant is not optimal in the scandinavian region. However, CEO A sees a great value and opportunity to be located in Sweden as a respected innovating country with many firms with expertise in the technology branch. Company A, follows public research regarding tidal water in order to understand where the greatest potential would be for a tidal water power plant. Further, CEO A sees the opportunity to create new jobs as a major supplier for the renewable energy market. He further states that tidal water exists in all of the continents of the world with huge potential to supply people all over the globe with electricity.

Company A considers themselves to be ahead of existing competition among the eco-innovation firms. They perform continuous market research of potential newcomers, new technology and the research is generally based on the latest participants on the larger exhibitions and seminars. CEO A also mentions that any cooperation with competitors is not to be considered in terms of the technology part of the eco-innovation. However, cooperation do exist among the actors within the industry when it comes to common interests, e.g. development and education of the market and its
customers’ knowledge about the new technology that is about to reach the commercial phase and start generating renewable electricity.

CEO A mentions that the advantage of using tidal water is that it is 100% predictable. This is essential to the customers’ requirements that the power plant always has the potential of generating electricity. He also states that compared to other actors, in general, Company A will produce electricity at lower costs than the competitors meaning that once they reach the commercial phase and start to sell the tidal power plants they will be able to operate without any financial support from the government. The investment cost will also be very competitive compared to what prices other actors preliminarily have presented.

4.1.3 Regulatory push/pull factors.
Company A is of the point of view that in a branch like eco-innovation, with a development phase that is both extremely costly and time consuming, in the development of a new technology there is a need for governmental support, especially since the market has emerged through policies and regulations formed by governments with the environment in focus. They mean that during the development phase, in which this branch is considered to be in, governmental support is crucial for the industry to survive, if not during the commercial phase so at least in the critical development phase.

Many countries have promised to lower the pollution around the world and have designed policies about how much they are going to rely on renewable energy in the future. This is a great opportunity for the eco-innovation firms, but Company A still experiences difficulties dealing with governmental institutions handling matters of environmental concern. The bureaucracy is complicated when approaching governmental actors, thus making it difficult for companies to invest the time and resources on learning how to deal with governmental actors, especially when these resources could be spent on development. However, there have been improvements. Regulations about where to put experiment sites did not exist until recently, this made it hard to get permission to find a test site. However during 2009, the Swedish governmental actor Energimyndigheten approved locations on where to test pilot plants for experiments, and the CEO A agrees that this really shows a desire from the government to be willing to offer the Swedish eco-innovators the opportunity to lead the development on eco-innovation. Company A cooperates with different organizations to be updated about the ongoing debate on the subject of the environment in both Sweden and abroad. They mention that as an individual actor it is almost impossible to get the information needed and it is so time consuming that no single actor in the industry could survive working alone on the matter with governmental involvement. However, Company A thinks that other countries have understood the market potential more than the Swedish governmental institutions in comparison to the contact they have had with organizations in other countries. Company A has found Vinnova and Energimyndigheten to offer support and knowledge that have been crucial to the approval of test sites and to attracting subsidies.
4.2 Company B

The project behind Company B started in the year 2007 and it was by a man, further called CEO B, with a passion for utilizing the energy from waves. During this period he started to think about possible solutions for utilizing the great energy resources that waves carry. His passion for wave power resulted in a possible solution and after about a year he felt the idea had matured enough to start a business around it. The CEO B is proud to have formed a company with experienced and dedicated people working with what they love to do. Company B has a much focused road map on what they wish to establish with the venture and believe they have found a turnkey innovation for generating electricity in a new renewable way. Their technology is based on a system with two floating buoys on the water surface and a mechanical transmission using a counterweight as the part utilizing on the energy in the waves. This counterweight can be considered as a simple accumulator with adequate capacity that at low cost can even out the energy pikes over the wave periods. The fact that a counterweight technology has been able to capture peak energy from waves without a necessity to over dimension the system has resulted in a patent. Company B is using a business model focusing on business to business.

4.2.1 Technology push factors.

The CEO B estimates the time to market will be around 8-10 years, and since it is a new technology for wave power with patents ready he believes they have a good chance of producing electricity very cost efficient reaching the commercial phase in 2015. At this stage Company B is working together with Blekinges Tekniska Högskola (BTH), who supports the verification with help from simulators trying to optimize the construction of the system. Together with BTH they are constructing a prototype and if everything is on schedule, CEO B is confident that they will be able to start testing the pilot plant in 2011. The prototype is a small scale version of the one they will present at a later stage so the focus now is to test the validity of the plant and collect as much data as possible to be able to optimize everything over again until the desired results has been met. CEO B continues to mention that it is very hard to stick to the original idea during the development phase when you get so many different inputs all the time. But he states that Company B has been successful in sticking to their original base line. Even though it is almost impossible to do all adjustment you would like to do it is important to accept that sometimes good is enough, it doesn’t have to be the best since the development phase is very costly. CEO B has great knowledge of the importance to keep innovating the product to stay on top of competition. The BTH is a great way to get access to creative and innovative point of views from students with a passion for this technology and give them an opportunity to experience what they are about to work with when they finish their studies.

Company B’s strategy on further development is to cooperate with BTH and since Company B only consists of three employees they are using their suppliers in the innovative process. The suppliers contribute with a large part of the expertise in the area because they are the ones building the prototype for Company B so the main part of the innovation process is involving the suppliers’ engineers. The employees of Company B have the function of being system engineers and are responsible for the
functionality of the system. The suppliers are taking care of the deep knowledge of construction, design, and of course to manufacture subsystems to the wave power system. In addition to suppliers, Company B are utilizing smaller competitors as a technology forum where technological insights and experiences are shared.

4.2.2 Market pull factors.
Company B is trying to closely follow the political debate and thereby gather useful information about where the market is going and what to expect from the governments in the matter of environmental policies. They also attend exhibitions and seminars that occur 2-3 times every year, usually focused around late spring when the largest actors take part and updates the whole industry. These exhibitions works, at least for the smaller actors, as a chance to pick up on where the market is heading, making it possible for the firms to improve the understanding of their customer requirements. Out of what has been presented on the latest exhibitions they can say that they are working in the right direction, CEO B adds.

Company B just recently signed a deal with a MNE, referred to as MNE B, which was a great step for both parties. MNE B works hard to promote a sustainable supply of energy and in the end a better environment. Company B is given the opportunity to access MNE B’s experts making it easier to ensure they comply with the demands from the customer requirements. The CEO B is hopeful this would lead to an upswing in the technological development.

The market for wave power plants gets better the greater the waves are, making Sweden a less suitable spot for this type of technology. The public research regarding wave power and prospective wave power locations have shown that the bigger the oceans the better economic numbers, making the whole world as a potential location for such wave power technology. However, CEO B clearly states that more studies gathering reliable data on optimal locations are needed to ensure the best utilization of the system.

From what the CEO B mentions, Company B has a great potential innovation under development and the flexibility of the system gives it its advantages. The ability to utilize the peak waves gathering up the most energy without over dimensioning the system. The innovation has the ability to level out great fluctuations of energy and this is the key to receive good financial numbers. Company B consider themselves to be very competitive in the race to commercialization among the other firms within the eco-innovation field and they always keep in mind to look out for emerging firms with new technology that threatens their territory as an eco-innovative firm.

4.2.3 Regulatory push/pull factors.
CEO B is convinced that the eco-innovation firms is dependent on governmental support in the development phase, both regarding subsidies and expertise from environmental organizations. He further points out that Company B has been presenting their concept for Energimyndigheten, which is a governmental institution working with renewable energy projects among other things, and have been met with a positive attitude towards their innovation. But he also emphasizes that Company B has not been
given any large amounts of financial support from the governments but he feels that it is absolutely necessary that the opportunity exists for firms that is stuck in the development phase and really possess a solution worth trying. He would also like to comment on that it should be easier to get in touch with these institutions and help firms to apply for the funding programs offered by the government. Another good point made by CEO B is that it would probably help the industry and Sweden as an innovative country if the government was more willing to venture more financial aid at an earlier stage.

4.3 Company C
The Company C was founded in the Uppsala region 2001 and has close ties to Uppsala University from where the two founders are active. These two front figures have drawn the roadmap for Company C through their deep knowledge in the wave power industry. The founders have great experience from both the academic world and the business world with expertise in steam power and electricity. The idea behind the eco-innovation has slowly grown from just a thought to a business concept and through experiments in laboratories at Uppsala University showed good results and it was in the environment of the University the whole project started. Company C is right now in the phase where the final pilot plant is about to be tested and since the Swedish Environmental Court has approved their request to build the world’s largest full-scale wave power plant. Since the work with the environmental permits have been very extensive and time-consuming the founders have gotten a great deal of experience working with governmental institutions and politicians active in the matter of environmental concerns. Company C is using a business model focusing on business to business.

The technology which founds the base of Company C is another wave power technology however in this case it works with smaller units where all parts, except for the buoy, are deployed on the seabed, this creates a protection against the extreme forces that often occur in the ocean. The power plant is designed and constructed so the demands of maintenance are at a minimum.

4.3.1 Technology push factors.
Company C is getting closer to the commercialization phase by each day. Their approval from the Environmental Court was a big relief for the board and even though they are awaiting another approval from the European Union, they are convinced that the process is going to be handled faster since their Swedish request was approved. The developing process has lasted for around 10 years and has been extremely costly, but the cooperation with the Uppsala University has given Company C the opportunity to test and verify their eco-innovation with promising results. Uppsala University has been an essential part of the development from idea to physical product. Technological expertise from the university and the experience from two founders has made a perfect match to conduct development at research level within a University. Since Company C has the ambition to create their own industry, the plans for designing and construction of a production plant have already started. They estimate to have a production line for the generators and that this production type is very appropriate in their case.
All R&D activities are held within the company apart from the projects in cooperation with Uppsala University. The researchers work simultaneously with R&D and on the production unit with responsibility for the new production plant. Company C’s opinion is that in order to gain the advantages of being first they have to stay on top of competition and one way to do that is to constantly improve the product and the production process. Even though the company has the ambition to become an international player their intention is to have a R&D unit in Sweden and the city they have in mind is Uppsala because of the value they put on the cooperation with Uppsala University.

In this case, Company C’s impression is that they have been ahead of competition all the time since they started their project with the wave power plant and because of this they have valued their advantage in technology very much to take the decision to do all development activities internally and not involve any suppliers.

4.3.2 Market pull factors.
Since Company C is in the lead of the race to reach the market first they experience that the pole position has given them a lot of attention in media for free and because of that also have had the advantage of being notified as soon as the competition has made progress.

As an innovator of environmental technology it is extremely costly to carry a project like wave power on your own. Thus, Company C saw the opportunity to involve potential investors and customers to be a part of the development process regarding technology and of course to share the financial burden. However, with this comes a great risk of having actors involved that does not share their view on the long-term basis, which Company C clearly stated for the involved parties that they only looked for financially stable players who stepped in for the potential long-term profit of the wave power project. Since there are not that many actors in this segment they are instead of great economy of scale. Company C have experienced efforts from potential buyers trying to take over parts of the eco-innovation, which is a risk necessary to take when acting in the energy branch with few but powerful actors.

For a company working with eco-innovation and wave power specifically, to get good economic numbers it is a necessity to be a player on the greater markets where the wave climate is more suitable to generate electricity from. Company C has already initiated negotiations with actors, on all the world’s continents, willing to buy their wave power system as soon as it is verified.

Company C is in the lead among the eco-innovation firms within wave-power, they already have approved permits to initiate the pilot plant in Swedish water. They have already several test sites where the first tests took place but now they are looking forward to see the true potential and advance another step closer to commercialization. They express that they constantly check the competitors to follow their progress but so far they do not feel threatened by any other player within the industry.
4.3.3 Regulatory push/pull factors.
For the eco-innovation firms the governmental involvement is essential because the eco-innovation firms need approval of permits for test sites. Also the assistance of appropriate governmental support is needed and in the Company C’s case they feel content with the assistance concerning aid for test sites and pilot plants. Without the academic experience from the two founders, Company C expects the process regarding the application to the Swedish environmental court, to have been more complicated. Company C is now more interested in the governments work on driving environmental innovation forward as a lead country, especially in times when the political debate is given so much attention. Company C mentions that they have experienced a fine encounter with the Swedish authorities but that sometimes they wonder if the process really need to be that time-consuming. At the same time they are thankful for the time-consuming encounters because they feel they have had the time to optimize and make sure all units have met their goals and are ready to proceed to new goals.

4.4 Company D
The foundation of what was about to become the Company D was initiated in 1987 by a civil engineer with a passion for renewable energy. However, the company’s strive today is somewhat different than its original aim back in 1987. Through the years of development the focus shifted, from trying to extract uranium from sea water, towards extracting energy out of waves on the sea. Thus, it was of no surprise when Company D built a test plant experimenting on generating electricity from the energy of waves at sea. Then, once again, this time in 1999 the company shifted their development activities towards focusing on tidal power and to obtain the appropriate knowledge in the area, another firm active in the tidal power field of business was acquired. Company D offers solutions with technologies in tidal power, stream power, and wave power. Company D’s business model differs slightly from the other actors in this study. They have realized it is possible to sell shares in the actual plant similar to owning stocks in a company.

4.4.1 Technology push factors.
Company D has experienced a development phase full of changes, both in terms of choice of technology and focus area. Since they have been active for over a decade trying to reach a commercial phase changes are inevitable and this is one of the problem factors of not knowing where the market is pointing at due to the ever-changing environment of today. Due to the shifts in technology development towards tidal- and wave power the company can now benefit from having a product ready to sell at an early stage in the industry. Participation in exhibitions and seminars in Europe has lead to contact with potential customers and because Company D is in the front of the industry with products for sale, verified and working, they get a lot of attention from around the world.

The R&D activities in Company D is handled through cooperation with subsidiaries where researchers continuously are trying to watch the technological development from emerging companies and search for new patents on new innovations. The R&D
business unit is located in Sweden to have access to the leading technology in the industry of eco-innovations.

When preparing for future innovation and system design, Company D values the environmental aspect regarding which supplier to cooperate with. Their logical choice is to look for local suppliers, partly because the distance is shorter which ease the communication and also due to the environmental aspect to minimize the impact. Company D has no research units on their own but uses supplier involvement for the innovation process regarding technology development and construction of new prototypes and discussions have been initiated on forming a joint venture with one of their suppliers in terms of an independent business development unit.

4.4.2 Market pull factors.
The men behind Company D do not perform market research more than participating in exhibitions and seminars offered within the eco-innovation industry, where suppliers, competitors and potential customers attend. They mean that there is so much information available for the public that it would be considered a waste of time to dedicate resources to conclude what is already known. Nor do they take part in the political debate regarding laws and regulations of the industry or competitive industries as they feel comfortable being in the front of the competition among the eco-innovation firms. Company D bases most of their knowledge about the market and where it is heading on existing public research and from the information they get from taking part in the existing environmental exhibitions and seminars that is arranged for the eco-innovation industry.

The formulated strategy of Company D regarding customer involvement is limited. They have not involved any larger players to take part of the projects this far and intend to keep the limited customer involvement and deliver an advanced technology in a reliable product with as low maintenance as possible at a competitive price. Based on what Company D has learned from the exhibitions, they feel confident in providing a product that meets customer requirements.

Regarding the question about whether Sweden is a reliable market for these types of eco-innovations, Company D responds that they do not consider Sweden as the prime market, but rather as a test site for innovation activities. The greater the see the better the economical numbers is a general stand point among the eco-innovation firms and with a special focus on the waters around the British islands, where it is particularly favorable.

In the race to commercialization, Company D believes that they are in the front with parts of their project ready for sale and with pilot plants up and running awaiting results to verify the reliability of their technology in wave power.

By utilizing public research of the industry, Company D consider their market orientation to be according how the eco-innovation industry looks like in terms of competitors and emerging firms. Among the players working with eco-innovations, Company D has discovered good potential in the competitors projects and do believe that there is a possibility in the future for joint ventures within the industry to take a step closer to find
an industry standard among the eco-innovations in wave and tidal power. However, at the same time they feel that they are offering a superior product in terms of price and cost-effectiveness. Company D has also considered too lead the market forward by finding solutions for platforms where different technologies can be combined. Compared to the competition within the eco-innovation market Company D see themselves as the firm with a relatively easy assembled product despite the advanced technology they are using.

4.4.3 Regulatory push/pull factors.
After having discussions with governmental organizations in both Sweden and England, Company D is of the impression that the driving forces from the Swedish government’s side is insufficient and that it should be easier for eco-innovation firms to find their way among the Swedish governmental organizations to get assistance and support regarding upcoming and existing projects as well as to possible funding. According to Company D, in contrast to Swedish governmental organizations, the British are more cooperative and supportive, with a clear aim to become the lead market and become the center of the industry. The British government has spoken environmental goals trying to reach 40 % production from renewable energy sources in the year of 2020. However, in England there are a great number of governmental organizations helping eco-innovation projects, almost too many as it gets hard to find the right department according to Company D. Once firms get the attention from the governmental organizations the regulations on what is allowed to do and not to do is very shallow. Company D is currently using loopholes in the regulations to perform tests and experiments on their eco-innovations, awaiting pending directives.
In this section, the analysis of the empirical data is presented. This section is structured to present the analysis in the same pattern as the literature review was presented.

From our illustration in chapter 2, which explained our theoretical framework, the structure of analysis will be taken. The underlying factors of the determinants will be analyzed under each determinant presenting what external sources of knowledge are utilized among the eco-innovation firms. The analysis will continue to further include what knowledge is gained from the respective external sources under each determinant. The external sources of knowledge that were shown to be of most importance will be further presented under each of the determinant factors.

5.1 Technology push factors
The first piece of the base for analysis will cover the factors behind the determinant of technology push as illustrated in the figure from chapter 2. In the literature review regarding the technology push factors there is an emphasis on the technological capabilities of a firm (Baumol, 2002; Rosenberg, 1974). Horbach (2008) presented data showing that improvements in the technological capabilities, i.e. improvements regarding a firm’s physical and knowledge capital, by R&D activities actually triggers eco-innovations. Looking at what Baumol (2002) presented, saying that inputs like investments in R&D and highly developed capabilities in R&D have a positive impact on the success of innovations. Further, to support this fact by Baumol (2002), Horbach (2008) and Horbach et al. (2012) suggested that greater availability to technological capabilities will mitigate the vulnerability to future technological and environmental obstacles. Mazzanti and Zoboli (2006) realized that few empirical studies have considered the traditional facts, e.g. R&D activities and supply chain pressure of involvement in the development, arguing that the difference among technology push factors for eco-innovations may not be that big compared to other innovations.

When looking at the four companies’ technological capabilities they have all different approaches on how to improve their technological capabilities. Company B was the one who stood out of the four companies. Company B approached customers, competitors, suppliers and research institutions in order to gain increased availability to their external sources’ technological capabilities. As literature on competition generally is about protecting the market situation and being aware of the turbulence that can be created by competitors technology it is surprising that Company B utilizes competitors in forums of technological character (Millier, 1999; Trott, 1998). For a firm to open up and have discussions of a technological character with competitors, when working and competing on the same market with technology not too far from each other, is a bold strategy. However, if the two firms can find synergies from their technological discussion this approach of engaging in competitor involvement may be giving the two firms an advantage. Suggested by Baumol (2002), Company B’s ability to approach almost all of their external sources of knowledge, in terms of R&D activities, is an explanation to their success so far of their eco-innovation development process. Company B found knowledge connected to the technology push factors at most of the their external sources of knowledge in terms of technological capabilities regarding R&D activities,
which according to Horbach (2008) and Horbach et al. (2012) mean that they have less vulnerability to future technological and environmental obstacles meaning that Company B is well prepared to meet whatever future challenges lies ahead of them. Especially since, according to Noci and Verganti (1999), the time of development is unpredictable and as Rennings (2000) states that the time scale for innovation and diffusion of new technology is about a decade.

Three out of the four companies (A, B, D) chose to approach the suppliers in order to gain knowledge in terms of technology push factors, which was not already possessed within the company. This did not come as a surprise considering that the technology push factors are represented by mainly supply side factors (Horbach, 2008; Horbach et al., 2012) and due to the fact that these eco-innovation companies are small firms dedicated to find products based on new technology leading to a sustainable solution of the environmental challenges of today. Supported by Pujari et al. (2003), the companies A, B, D made approaches to utilize external sources of knowledge, especially since it is highly unlikely for a company to possess all knowledge about relevant new technology.

Two out of the four companies chose to approach the customers (B, C) to gain knowledge about technology push related factors through collaboration by including customers’ technology experts and giving them insights into the development process. The fact that the companies approached customers regarding technology push factors, which according to Horbach (2008) and Horbach et al. (2012) are related to what is known as supply side factors, is somewhat of a surprise. On the one hand, as a player among eco-innovation firms one does not expect a company to seek technological collaboration among the customers as that may weaken the chances to get the most value out of the eco-innovation as the customers, who ultimately will pay for the product, have been involved in developing the new technology. But, on the other hand, as stated by both Baumol (2002) and Horbach (2008), availability to technological capabilities mitigates the vulnerability of technological obstacles and thus including more external sources of knowledge might offer different perspectives on technology related challenges leading to better understanding of the challenges. Companies B and C, may therefore have an advantage over their competitors as company A and D did not include the customers regarding technology push factors and did not gain their customers perspective of the technology related challenges. However, none of the companies chose to include the competitors regarding technological capabilities, which was more expected due to the fact that they compete with each other on finding a technological platform to sustainable renewable energy generation. However, Company B chose to openly discuss technological concerns in forums with smaller competitors, which is clearly to think outside the box but when it is done, there are some benefits regarding technological capabilities from engaging in co-opetition as mentioned in the studies by Gnyawali and Park, 2011 and Quintana-Garica and Benavides-Velasco, 2004.

Three out of the four companies (A, B, C) chose to approach research institutions, in terms of universities, to gain further knowledge related to technology push factors. This is in line with what von Hippel (1988) states, as research institutions act as an innovation source. The choice to approach universities confirms the findings that eco-innovations characterized by new technology are in need of more basic research (Belin
et al, 2009) and thus are more likely to approach research institutes to gain knowledge from outside the organization (Laursen & Salter, 2004). Through the universities, the three companies could access more basic research resources on the technology and gained deeper knowledge with regards to verification and validation of the feasibility of the technology, which was supported by Cohen et al. (2002). Approaching research institutions also ensures the companies that the external resources will last during the unpredictable time scale of innovation and diffusion that applies to new technology development (Noci & Verganti, 1999).

Following in this section of analysis, is a closer presentation of the external sources of knowledge that were of the most importance to the eco-innovation firms regarding the technology push factors.

5.1.1 Suppliers
Early supplier involvement has several benefits such as lowering material costs, also it offers a higher quality and reduces the development time. It is also presented that having access to the suppliers technology is a great advantage since firms developing complex innovations rarely have the knowledge of all relevant technology in house (Ragatz et al., 1997; Pujari, et al., 2003).

Interestingly, Companies A, B, and D chose to approach suppliers in order to gain external knowledge in the development of their eco-innovations. When considering the way the suppliers were approached and involved, two levels of supplier engagement were identified. Firstly, Company A saw their supplier’s technology as a major part of the platform, on which they built their innovation, and could therefore see the advantage of having access to the suppliers’ experts in their field of technology. However, in this case the supplier was merely considered to be adding knowledge into the innovation but the responsibility was still lying with Company A. Secondly, Company B and D were under the same impression, however these two companies took the suppliers’ involvement one step further as the whole development of their innovation was in the hands of their suppliers; this is because of their own limited technological capabilities and knowledge. This gives them a huge advantage in accessing technology knowledge that otherwise would be out of their reach (Baumol, 2002; Horbach, 2008; Ragatz et al., 1997). Also by having a close relation with their suppliers gives the advantage of developing technology together with the suppliers that otherwise could create a risk that the supplier’s technology becomes more advanced than your own (Millier, 1999).

Company C has chosen not to use suppliers at all in the development of the innovation other than delivering materials and machinery. An explanation to this can be due to the fact that they consider themselves to be far ahead of their competitors with their project that they felt that it is more of a risk letting the suppliers in on their technology and have therefore decided not to involve the suppliers, which is in line with the findings by Ragatz et al. (1997). By not using the suppliers in the development puts them in a considerable risk to the turbulence that could change the technology settings between them us a customer and supplier if their suppliers develops their technology so it forces them to develop their own technology (Millier, 1999).
When looking at the upstream effect in the value chain that Pujari (2006) highlights, Company D has put a great deal of value in choosing suppliers with environmental preferences. By putting environmental pressure on the suppliers Company D sees the effects of minimal environmental impact on issues such as transportation and material selection.

5.1.2 Customers
There also exists literature supporting benefits from involving the customers. The two companies (B, C) showed that also the customers can add valuable knowledge regarding the technological capabilities to a company. To the extent of what Horbach (2008) found, all external sources that offer improvements in technological capabilities can trigger eco-innovations. Cambell and Cooper (1999) present studies that emphasizes on higher economic and innovation success by collaborating with the customers. Other potential benefits mentioned by Cambell and Cooper (1999) are suggestions on new product ideas, improved effectiveness in the innovation process and a reduction of development time in projects. Supported by the literature, Company B recently signed a deal with MNE B and is experiencing the benefits of having access to MNE B’s experts making it easier to comply with the customers’ demands of the product. As a result of engaging with their customers Company B have gained the opportunity to benefit from the input on the technology development, hopefully leading to improvements of the effectiveness of the innovation process (Fang et al., 2008).

Company C involved the customers with experience in the field of eco-innovation primarily because of the lowered risk and shared interest of developing a competitive renewable energy system, which is in line with the gained knowledge and expertise suggested by previous research (Cambell & Cooper, 1999; Fang et al., 2008). Considering customer involvement, Schrader and Gopfert (1998) argue that limited input of knowledge from customers result in an ineffective NPD. However, by partnering with customers there are some side effects, which according to Schrader and Gopfert (1998) and Cambell and Cooper (1999) are questions on to what degree should the customers be involved, are the customers willing to provide the knowledge needed, the risk of a damaged relationship with the customers, and bad publicity. The CEOs of Company A and Company D mention that they do not have any signed deals regarding customers’ involvement in the innovation activities. Therefore, they can express the relief of not having to consider these negative effects regarding customer partnerships. But, despite the suggested negative effects by Cambell and Cooper (1999) and Schrader and Gopfert (1998), Company B has not experienced any negative effects regarding their partnership with MNE B. However, in the case of Company C’s partnership they saw a great risk with the partnership in terms of the selection of partner. Company C values the long-term goal setting strategy and had difficulties finding financially stable partners looking to be in the game for the long run. So Company C can relate to the existing theory from Cambell and Cooper (1999) in terms of the partner selection, to what degree the customer should be involved regarding negative effects of customer partnerships.
5.1.3 Research institutions
When developing new technology, companies do not possess all knowledge and resources that are needed. Suggested by previous literature, Trott (1998) and Grant (1996) mean that companies need to interact and communicate with external sources of resources. With a broader external knowledge base, companies will experience increased flexibility (Grant, 1996). Mentioned before, Baumol (2002) and Horbach (2008) accentuates that greater availability to technological capabilities are mitigating the vulnerability to technological obstacles. Three out of the four companies (A, B, C) approached research institutions in order to gain deeper knowledge on technology development. As stated by previous research, when working with eco-innovations, which are characterized by new technology, more basic research is needed (Belin et al, 2009; Laursen & Salter, 2004). The three companies (A, B, C) gained access to research experts, simulation tools, experimental facilities and the possibility to test prototypes in laboratories. Assets of this kind are normally very expensive and difficult to acquire and the knowledge and know-how of how to run facilities as laboratories and how to perform prototype testing are not easily found. Regarding the case for Company A and C, their founders have their background from the academic world, Chalmers and Uppsala University and due to the fact that the founders had substantial experience of the academic world would explain why they saw the benefits of involving research institutions. Much of the testing took place in the laboratories in the university and Company C had access to research experts in the technology development of their eco-innovation. Benefits experienced was input to product improvements and since Company C also builds a production unit they have gained knowledge in production technology regarding how to produce their eco-innovation.

What can be drawn from the observations of involvement of research institutions is that companies can find great knowledge both in terms of technological equipment and know-how and that essential knowledge and even the future leaders of companies can be found and attracted to the companies by engaging in involvement of research institutions. The substantial academic experience of the founders (Company A, C) seemed to be a factor of choosing to engage in the involvement of research institutions and really to see all the benefits in terms of gaining access to research experts from relevant technologies. Thus, it can be argued that the academic background and academic experience among the firms is a determinant of the involvement of research institutions.

5.2 Market pull factors
We continue by including the second piece of the base for analysis, which are the market pull factors. When reviewing previous literature on the market pull factors, which also are known as the demand side factors according to Horbach (2008), Kammerer (2009) contributes to the literature by bringing empirical evidence that customer benefits act as a driver of eco-innovation. Further, Rennings (2000) supports the demand side factors of market pull to be of great relevance to eco-innovations, to which Cleff and Rennings (1999) presented evidence that particularly for eco-innovations market considerations are important. This fact was taken into consideration by Reinhardt
(1998), who then found that eco-innovation can utilize on the environmental improvements in order to differentiate their products to get competitive advantages.

According to the literature review Pujari (2006) accentuates the importance of having a clear market orientation in the development of innovations. This is to avoid the failure of the innovation and by having a clear knowledge of what the customers need is a key factor for innovation success. The findings from Pujari (2006) are obvious to most likely all organizations but nevertheless it is crucial not to ignore this part of the business operations.

Before starting the development three out of the four companies (A, B, C) actively studied the markets searching for knowledge about customer demands before starting the development process; this was performed in several different approaches. This is what Pujari (2006) accentuates; by doing market research the firms are not ignoring obvious signals from the market. The most thorough market research beforehand initiating the technology development was conducted by Company A, which explored the interest from potential customers for eco-innovations and the research took about a year. The commitment from the customers and the ability to transfer the market research into an eco-innovation seems to have been important for the success of Company A. The fact that they had a very clear view of what needs their eco-innovation had to fulfill may also be a factor to why Company A managed to get support from governmental institutions (Theyel, 2006). By presenting a business case well based on market research for the governmental institutions, showing that the company has done its homework, it would certainly make it easier to attract support from governmental institutions. The other two companies (B, C) used customers and different exhibitions to find the knowledge that there existed a demand, however both Company B and C have also early on taken in customers in the project and this is a way of making sure the project is running on track with a clear market demand. Companies A, B and C therefore conducted what Kammerer (2009) accentuates about eco-innovations, namely that companies must have enough knowledge regarding what acts as customer benefits. All of these actions were important for Companies A-C so they were sure that the innovations they were about to invest huge amounts of money in would have a market, even though an eco-innovation that takes about a decade to develop, when it finally is commercialized (Cleff & Rennings, 1999; Pujari, 2006). However, Company D felt it is a waste of resources and time to perform these activities, since they experience that all relevant information can be found from public researches. The limited knowledge due to the ignorance of market research and thereby what the customers want from the innovations is according to Pujari (2006) a reason for their continued struggle to reach commercialization and innovation success.

All four companies attend exhibitions and seminars that are organized within the renewable energy industry. By attending these exhibitions the firms gain knowledge about what other companies do, about the market orientation in the industry, about environmental concerns and regulation and breaking news on competitive technology. Accordingly, the importance of market considerations supporting the market orientation of the firms confirms what Cleff and Rennings (1999) as well as Pujari (2006) state in previous literature. Presenting on these exhibitions were also research institutions,
which was the contributing actor on new insights regarding technology and market research on suitable geographical locations for the wave and tidal power. Initiatives from research institutions to attend on exhibitions could be the result of governmental programs aiming to support the eco-innovations on the market (DTI, 2003b), since the existing literature on research institutions focus on R&D related issues mostly regarding technological capabilities. Also, the companies came in contact with customers and competitors. The fact that all companies attend exhibitions and seminars supports what was claimed by Cleff and Rennings (1999) and Rennings (2000), that knowledge about the market are important when developing eco-innovations. Because the market demand is influenced by regulations, these regulations become an important factor influencing the development and adoption of environmental innovations (Kemp & Soete, 1992). To be able to follow the markets’ different turns and changes Company B tries to follow the changes in political policies, they also use the exhibitions to keep up on the changes of the market demand. In terms of pro activeness, Company B might have an advantage as they have understood the value of being alert to the political debate and the outcome of the political changes in order to be ready to adjust their business in accordance with any new legislation. Also Company D uses the exhibitions as a source for information where the market is headed. However, they see no meaning in following the political debates on the environment to see any change in market demand risking to miss out on the chance of having the advantage to change before any competitors do. Therefore all companies utilize the external sources of knowledge from customers, competitors and to some extent research institutions considering their participation on exhibitions and seminars.

Also to constantly search for knowledge about potential markets is an important key factor for success according to Pujari (2006). This is also one of the points that Rennings et al. (2003) presents, that national markets are often limited in either size or other conditions and therefore it is crucial to find other markets to generate higher sales, this just to be able to break-even in the development costs. All four companies actively look at other markets than the limited market in Sweden; they have more or less aimed their sight on the waters around the British Islands as the first step. Through the exhibitions three out of the four companies (A, B, D) learned from presentations of public research on wave and tidal power that the bigger the oceans the better conditions for their technology. As Company A says: “Tidal water exists in all of the continents of the world with huge potential to supply people all over the globe with electricity”. They all have been aware of that Sweden is not suited as a spot for this kind of technology, Company B mentions that there is a great need to further study different locations for these kind of innovations. Company A points out that their technical innovation needs an environment with a wave climate that is more suited for their product “to be a greater player on the markets”.

Further, the most influential external sources of knowledge regarding market pull factors will be presented.
5.2.1 Customers
Cooper (1984) presents in his article the crucial factors for a successful product, which are knowledge about the need and desire from the customers. Further, Cooper (1984) argues that by having a clear project definition, good market analysis, market research, and sales forecasting the firms can get a better understanding of the market. The two companies, Company B and Company C, were the ones involving the customers in the innovation process, which according to Cooper (1984) leads to a better understanding of the market. Accordingly, Company C has managed to benefit from the customer involvement leading to a distinct strategy in terms of creating their own production plant manufacturing renewable energy systems, which once again leads to a greater understanding of the eco-innovation market (Theyel, 2006). By involving the customers the two companies, Company B and Company C, are the ones, according to Cooper (1984) and Theyel, 2006, with an advantage in terms of gathered knowledge about the need and desire from the customers.

Further presented by Cambell and Cooper (1999) among the literature of NPD is that through close collaboration with the customers the firm gets the ability to gain a higher degree of knowledge regarding customer demands on the market. Ultimately, this would lead to better product designs with increased quality of the innovation and access to the expertise of the customers, since it is less likely for an eco-innovation firm, with such complex products, to possess all the needed knowledge (Cambell & Cooper, 1999; Fang et al., 2008). As described above, Company B and C has experienced the benefits from involving the customers by utilizing the increased knowledge base. An explanation to why the two companies (B, C) involved the customers is their ability to already sell their eco-innovation to the customers at an early stage.

5.2.2 Competitors
Trott (1998) emphasizes the importance of continued development to stay competitive on the market, this because of the risk of competitors emerging with new products and changing the market to the point that your own products are outdated. Trott (1998) also present a couple of factors to evaluate when searching for new potential competitors:

- When will the competitors arrive?
- Is it possible to predict their way into the market?
- How is their product differentiated?
- What are the entry barriers?

All of the companies we interviewed agree that they actively explore the existing competitors so they can gain knowledge on their competitors to compare their progress and to see where they stand on the market.

However only Company A, B and D admits they perform market research for emerging competitors and also for new technological innovations, which Millier (1999) present as indirect competitive technology these can pose a threat to them by emerging with technology that reduces the need and demand for their own technological innovations.
The fact that Company C does not consider possible threats from newcomers or firms that can count as indirect competitive technology can be a disadvantage for them in the longer run, this is because of the turbulence on the market that emerges with new technology solutions that appear and not being able to anticipate the threat of these makes it impossible to adapt to the new market settings that will come forward when the market stabilizes (Trott, 1998). However, Company C has an advantage due to the attention their eco-innovation has been given in media. As their technology has been presented in media and won medial focus, Company C has experienced that as soon as the competition presents new progress they are notified by the media and asked to comment on the competition’s technologies. Further, by being visible to the public through the attention by the media Company C may have gained an advantage of improved credibility on the market of their technology.

5.3 Regulatory push/pull factors
Our third and final piece of the base for analysis are the regulatory push/pull factors. The creation of the regulatory push/pull has its roots in what is referred to as the double externality problem (Rennings, 2000). As the double externality problem mean that firms are not able to benefit from the positive spillover effects of their eco-innovations, environmental policies and innovation policies are called for. Due to the fact that the public are able to benefit from improved environmental conditions, firms have to carry all the costs without firms being able to make more profit, in contrast to what was suggested by Reinhardt (1998) that the environmental improvements would imply a competitive advantage. Thus, regulation has proved to be a significant determinant and subsidies a trigger for eco-innovations (Belin et al., 2009; Kammerer, 2009; Horbach, 2008; Horbach et al., 2012). Further, Rennings (2000) argues that environmental policies and innovation policies need to be coordinated in order to be able to level out the distortion on the market that is caused by the double externality problem. The effects, suggested by Rennings (2000), to follow from such policies in terms of subsidies or appropriate tax subventions would have the possibility to give the eco-innovations a fair chance to reach their full commercial potential and compete with conventional alternatives on the market.

All of the four companies (A, B, C, D) had contact with governmental actors, however there are differences in terms of what knowledge is gained and how the conduct of the governmental actors was experienced. As stated by Belin et al. (2009) and Horbach (2008), regulation compliance is significant for eco-innovations and interestingly this fact is supported by all four companies in terms of the approval process for permits to test sites for pilot prototypes. Though all four companies had experiences dealing with governmental actors regarding test sites, Company A, B and C got even further and was given the opportunity to present their eco-innovation to the Swedish governmental actors.

As the two companies (A, C) managed to present to Energimyndigheten and get approval for test sites, their founders had succeeded to show the feasibility of their technologies and convinced the Swedish governmental actors to be given a chance to prove their eco-innovations. Companies A and C had also the most academic
experience and as those were the two companies which managed to get approval for test sites it can be argued that Company A and C could benefit from the credibility given by having a background from the academic world. However, Company B was able to attract financial subsidies but also states that it was not a matter of substantial figures. Nevertheless, Company B’s involvement of research institutions could have been a factor for the Swedish governmental actor Energimyndigheten to see the benefit from funding an eco-innovation that foster the interaction between industry and universities. Regarding the level of support experienced from governmental actors among the companies, Company C was expressing a content feeling from the interactions with the governmental actors. An explanation to why Company C is the one company experiencing a positive support could once again be the academic experience of the founders, who are well experienced in dealing with institutions. They have been successful in utilizing their experience and knowledge on institutional processes, which could be a likely advantage in order to get the support one need to reach the commercial stage. Company B and C gained knowledge from the governmental actors regarding the approval process of test sites and learned that the process is time-consuming, especially when dealing with regulations characterized by environmental policies. As Horbach et al. (2012) presented on regulation being a strong influence on eco-innovations, it can be explained why Company A, B and C found reasons to approach governmental actors, especially since the need of governmental support is substantial when it comes to companies active on a market based on new unproven technology as these environmental innovations are. Given that two of the four companies (B, C) was successful with the Swedish governmental actors, Company A stood out by their accomplishment of attracting support from both the Swedish and the British governmental actors. Company A expressed a disappointment from dealing with Swedish governmental actors but could on the other hand benefit from learning that similar support could be found outside of Sweden. Company A gained knowledge of the environmental policies of the United Kingdom and the support from the British governmental actors led to the approval of test sites in British waters. From the observations in this study, it can be argued that governments could really benefit from having a coordinated approach throughout Europe. A coordination between countries would most likely act as a motivator for eco-innovation firms since some eco-innovation is Sweden may be more suitable around, e.g. in our case Great Britain. Further, Company A also managed to attract subsidies from the Swedish innovation institution Vinnova. As Rennings (2000) suggest, subsidies is a way for governmental actors to handle the effects of the double eternality problem by easing the development and support eco-innovations to reach the level of commercialization.

5.3.1 Governmental actors

The external source regarding knowledge on the regulatory push/pull factors was governmental actors, which was expected since previous literature have presented that most matters are connected to regulation characterized with the environment in mind. The environment of the business world is protected by laws and regulations that to some extent have shown evidence of leading the process of creativity and innovation forward within companies (Porter & Linde, 1995). Further, Porter and Linde (1995) argue that if the environmental standards are properly designed this could trigger the
innovation activities, which ultimately would lead to companies using their resources more productively, lower the environmental impact, and make the companies more competitive.

All four of the investigated companies in this study, are of the impression that the eco-innovation industry is a great example of an industry created by both environmental regulations and standards. Through governments' collective viewpoint of the urgency for a sustainable alternative for producing electricity, the industry of renewable energy system has emerged. Since most of the countries have spoken environmental policies regarding how much energy that should be produced from renewable energy sources in the future, all companies in this study have understood the huge market potential.

However, Company A and D, have bad experiences from their encounters with the Swedish governmental institutions. Even though Sweden is trying, Company A does not think Sweden has understood the market potential and what it would mean for the country to be a leading innovative market. Company D means that the support is insufficient and it is too bureaucratic to understand how to find the right department for assistance. Another point of view, explaining the negative experience regarding Company A's and D's encounter with governmental actors, would be stating that they were insufficient in their knowledge of how institutions work to establish a good relationship with governmental actors. Accordingly, firms working with eco-innovations may need to be more knowledgable of the support systems available from governmental actors, working the system on the terms of the governmental actors instead of expecting support only based on their environmental-based innovations. Contrary, Company B and Company C have had positive encounters with the Swedish governmental institutions and their perceptions are that the governmental support is essential to the eco-innovation firms, especially when it could be the matter of gaining approval on test sites or subsidies. However, Company B and Company C also think that even though they have been positively met it would help the eco-innovation firms and even more if the government was more willing to take risks and support more potential solutions for renewable energy.

5.3.1.1 Assisting new products on non-existing markets.

Market demand is, according to Rennings et al. (2003), the most important drive force, mainly because the response from the customer is seen as the most crucial success factor. Therefore, it is argued that governments should assist radical innovations at times of slow or a non-existing market, but in which a great positive environmental impact could be seen. With the ability to create a need and a demand for eco-innovations, governments can by different policies pressure a technology shift within the environmental market. All the companies in this study agree with what Rennings et al. (2003) stress regarding market demand being the most important success factor. This is the reason for the Company A and Company D to think that during the development phase it is really important for such eco-innovation firms to be supported by the governments who have created the demand for the industry. Arguably, as the market has been created by the governmental desire to find sustainable solutions to the energy supply issues, mentioned by Stern (2007), the need for governmental support would be in place to compensate for the distorted competitive situation due to the "double
externality problem”. The environmental policies have in this case been a great drive for the eco-innovations among the companies studied, but when they finally reach the point of dependency from governmental institutions, e.g. when applying for permission for test sites, they experience a very time-consuming process. Only Company C has reached the phase of approval from the Swedish Environmental Court but are still waiting for a pending approval from EU. Company D has found it easier to deal with the British government and express their desire for Sweden to be as supportive and cooperative as the British.

5.3.1.2 Environmental policy.
According to Rennings et al., (2003) eco-innovations have difficulties competing on an open market; this is due to the large investments that result from the often time-consuming development of such innovations. A recognized effective way for governments to assist the eco-innovations is by implementing environmental policies (Ibid).

Rennings et al. gives a couple of core-instruments that are considered the tools for policy measures:

- Market-based instruments, these are economic aspects that help to force the market to think in different ways, such as fuel and energy taxes.

- Regulatory instruments, these are direct regulatory instruments that force by regulation, such as by setting limits on how much Co₂ a company can release.

Accordingly, Company A actually requests for such assistance for the same reasons that Rennings et al. (2003) provides; the high costs for the time-consuming development. Company A also acknowledges the fact that the market for the innovations they are developing has emerged from regulations and other policies. One factor that Company A fails to identify is the distorted competitive situation between environmental innovations and conventional innovations. Further, Company A seems to have acknowledged the fact that many countries have designed new policies for the development of renewable energy systems; this is a great opportunity for companies working with eco-innovations, such as their own. Though it is getting better as governmental institutions have made it clearer of the prerequisites of attracting assistance, they still find it difficult when dealing with the governmental institutions that handle the field of environmental regulations, when it comes to finding the right contact persons and to get their attention. This is a disadvantage for the development of the whole market as Rennings et al. (2003) emphasize that it is important that there consists a close collaboration and dialogues between industry, government and the regulatory bodies.

5.3.1.3 Innovation policy.
Rennings (1999) means that the rivalry on the environmental and non-environmental innovation firms is out of shape due to the lack of punishments of harmful impacts on the markets. Further, by supporting pilot projects governments could really trigger improvements of the performance of the eco-innovations (Rennings, 1999). Governmental institutions could offer a more supportive system regarding innovation
policy, which ultimately would help to cut costs in the phase of development. Rennings et al. (2003) stress that also the diffusion phase could be of interest to support with an innovation policy. Rennings (1999) and Rennings et al. (2003) are supported by the fact that the companies in our study feel that they, as well as the other eco-innovation firms, are dependent on governmental support. But, when finally reaching the commercial phase it needs to be clear whether eco-innovation firms should continue to receive governmental support or if eco-innovation firms need to survive on their own. The views of the studied companies are not united, as Company A is under the impression to be able to operate without any governmental support while Company B-D still feel dependent on such innovation policies as mentioned by Rennings (1999) and Rennings et al. (2003).
6. Conclusions

In the last section of this thesis, the conclusions are being presented based on the research questions and the purpose of the study. This is followed by a discussion of implications that we have discovered in the study and a few topics for further research.

Our purpose with this study has been to explore the external sources of knowledge used by eco-innovation firms, and the impact on the success of the development of eco-innovations by using external sources of knowledge. This study is bringing empirical evidence regarding what external sources of knowledge are utilized in the development of eco-innovation and further add insights of what knowledge that has been gained by the respective external sources. Following in this chapter we will present the conclusions from the study under each research question followed by a discussion about the findings.

6.1 Conclusions and Discussion of the Research Questions

RQ 1: What are the external sources of knowledge, which eco-innovation firms are utilizing during the development of eco-innovations?

In our study we have found the external sources of knowledge to be of significant importance to the eco-innovation firms. Based on our theoretical framework, we have found that the external sources have different importance depending on the character of the knowledge that is gained. The different characters of knowledge have been represented by the underlying factors behind the determinants of eco-innovation, i.e. technology push, market pull and regulatory push.

Considering the technology push factors, the external sources of most importance were research institutions, suppliers and to some extent also customers. The external sources contributing with knowledge characterized by technology development showed to be universities and suppliers. An explanation to why the eco-innovation firms chose to turn to Universities is because they had close ties within the universities from previous academic experience of their founders and that to some extent when the eco-innovations had its roots from university research. Suppliers were also shown to be of importance. The eco-innovation firms were relatively limited in terms of resources regarding technology development and thus suppliers were approached to make it possible to obtain necessary competencies to be able to develop their eco-innovations. Customers were included in the technology development in those cases when the eco-innovation firms already had attracted customers to invest in the eco-innovation. Two main benefits were seen regarding customers. Firstly, they saw the potential of the knowledge base of the customers, and secondly they reached out to the customers for the implication of lowered risk and a shared interest for the innovation process.

Regarding the market pull factors, the external sources of knowledge of most importance showed to be customers, competitors and research institutions. Thus the results were expected considering the external sources of customers and competitors. Interestingly, the eco-innovation firms put a lot of effort in the initial market studies, which is emphasized in the existing literature, and thus the knowledge from customers
and competitors is essential. In order to have a clear understanding of the market and the customer requirements there is no alternative way to gain this knowledge but to actively search to strengthen the market orientation. Exhibitions and seminars were frequently visited by the eco-innovation firms in our study. By attending exhibitions and seminars, the eco-innovation firms came in contact with external sources also working with eco-innovations and thus gained market knowledge from customers and competitors. Research institutions were also showed to act as an external source of knowledge regarding market pull factors, since research on market related issues was presented and discussed on the exhibitions and seminars.

An interesting point among the eco-innovation firms is that several of the firms were under the impression to be leading the development and did not consider competitors’ technology to be threatening their own technology. An explanation to this could be as stated by Vinnova (2009), namely that there is no standardized technology platform which can explain why, from the eco-innovation firms’ own perspective, they were not threatened by what was seen as alternative technology. This shows how important it is to utilize external sources of knowledge in order to have an accurate view of the market orientation. Another surprise was that social media acted as an external source of knowledge on the market situation, since the attention in social media resulted in media contacting the eco-innovation firm as soon as competitors seemed to make progress with their technology.

This far it can be stated that the characteristics of the development process seem to be the same for both eco-innovations and conventional innovations regarding technology push and market pull factors, which one could argue is logical to the sense that the circumstances on the technological perspective are identical whether the product is an eco-innovation or a conventional innovation. In both cases new technology needs to be developed with following verification and validation with all the knowledge that is needed in these phases, which is not linked to the fact that a certain innovation is environmental of its kind or not. This would explain why our results confirm previous literature regarding technology push factors and market pull factors.

Considering the regulatory push/pull factors, the external sources of knowledge showed to come from governmental actors. Due to the fact that the underlying factors of regulatory push/pull are of a regulatory and environmental nature, it was expected that the external source of governmental actors to be the outright external source. Among the governmental actors, the eco-innovation firms dealt with different regulatory bodies, e.g. with regards to approval of test sites, subsidies and environmental policies. The influence from the founders with previous academic background was shown to be of importance with regards to the experience with the governmental actors. This can be explained by insights and the understanding of governmental institutions’ processes that is related to experience in the academic world.

Here we have identified one important difference between eco-innovations and conventional innovations. Due to the effect of the "double externality problem", one could argue for some incentives for the eco-innovation firms as they cannot profit on all the positive effects of an environmental innovation as the values added in the product,
i.e. less environmental impact, is not linked to solely one customer. Those values are experienced by the society as a whole which arguably points to the necessity of innovation policies and possibly regulation falling under the regulatory push/pull, which confirms the major difference between eco-innovation and conventional innovations (Horbach et al., 2012; Porter & Van der Linde 1995; Rennings, 2000).

RQ 2: What knowledge do the eco-innovation firms gain from these external sources in the development of eco-innovations?

In our second research question we look at the knowledge that is suggested to be gained from the external sources. In this section we will present the knowledge by the type of external sources and of the character of the knowledge.

Firstly, when looking at the results regarding technology push factors, we found that research institutions (universities), suppliers and customer acted as external sources of knowledge. As mentioned before it was expected to see the external sources connected to technological capabilities, i.e. universities, suppliers and to some extent customers, to contribute with knowledge of technology development. Universities acted as an external source of knowledge with a more focused technological character. As the eco-innovation firms with previous experience from the academic world chose to involve universities, they would see benefits of gaining access to experimental facilities with possibilities to utilize laboratories to do experiments of their technology. By involving universities, the eco-innovation firms gained access to research groups with deeper knowledge of the technology and simulation tools, which are of significant importance in the development process. With support from researchers, the eco-innovation firms could do feasibility tests to verify the functions of their technology. The eco-innovation firms which had technology platforms with roots from university research and academically experienced founders, turned out to be the ones gaining essential knowledge related to technological capabilities, which otherwise would be extremely costly to get access to. Further, it can be said that by having experience and insights in the academic world will ease the way to involve university research, which adds essential knowledge to the eco-innovation firms’ technological capabilities considering R&D activities.

Suppliers where the other major contributing external source regarding technology push factors. The eco-innovation firms, in our study, had limited access to resources and knowledge of specialized character, such as engineering skills and experience in technology development. By putting pressure on suppliers to be involved in the technology development process, the eco-innovation firms gained deeper knowledge on the technology coming from experts and engineers from the suppliers. Since the eco-innovations will operate in settings close to the nature, suppliers need to regard the environmental concerns that are adding complexity to the development of eco-innovations in terms of design skills. However, if the eco-innovation firms have the appropriate resources in their organizations or if they obtain the knowledge from another external source, this would reduce the need to involve suppliers.
Customers were a surprising external source regarding technology push factors. But the major drive force of customer involvement in the technology development was when the customers had made early investments in the eco-innovations. However, in some cases when the customers are major players on the energy market, they may possess technological skills that can have influence on the technology development.

Secondly, when looking at the results regarding the market pull factors, we found the customers and competitors to be significant sources of knowledge. This was also expected since the market pull factors consider the market orientation of a firm, to the extent of customer requirements and market existence. Due to the market related nature of the knowledge suggested to be gained regarding the market pull factors, the competitors also contributed with knowledge on the market situation. Market research showed to be a major contributing method of knowledge regarding customer needs and requirements as well as technology benchmarking among the competitors. Interestingly, exhibitions and seminars acted as gathering point among the eco-innovation firms. Here, eco-innovation firms came in contact with customers and competitors presenting their technologies followed by seminars based on public research about market related information, e.g. on what geographic locations are the most suitable for certain technologies. Thus, research institutions acted as an external source of knowledge of market existence.

Thirdly, when looking at the results regarding regulatory push/pull factors, governmental actors showed to be the outright source of knowledge. Regulatory push/pull factors are regarding knowledge on subsidies, the process of approval of test sites and compliance with existing as well as future regulation. Interestingly, the experience from encounters with governmental actors was of a more positive kind among the firms with greater academic experience of the founders. An explanation could be that the knowledge and experience connected to the academic world increases the understanding of the bureaucracy and the time-consuming processes within governmental actors. Understanding of the approval process of test sites is crucial for the eco-innovation firms, since it could be the question of survival. Due to the nature of the eco-innovations of being related to environmental concern, pilot plants may affect the environment since they are meant to operate in the oceans. Thus, the demand on eco-innovation to comply with regulation is essential, since eco-innovation should offer sustainable solutions to renewable energy. The fact that a rejection of building a pilot plant could kill the business just emphasizes the importance of approaching governmental actors in the correct way.

Connected to the double externality problem lies another important observation. The general point of view for eco-innovations is that due to the distorted competitive situation between eco-innovations and non-environmental innovation, eco-innovation firms are dependent on subsidies from governmental actors. However, governmental support does not come easy. It is essential to have the knowledge of what governmental actors to approach as well as how to apply for governmental support.

In this study we have seen the importance of the external sources of knowledge for eco-innovation firms. Our analysis indicates that the background of the founders or CEOs
has influenced the interaction with governmental actors. Especially the academic background has shown to be of importance when dealing and interacting with the external source of governmental actors. As we have come to learn, the external sources of knowledge have great influence on a firm working with environmental friendly technology development, which was also expected by the authors and would probably be applicable across different innovation firms. We do not believe that this is particular for eco-innovation firms. However, firms with limited resources are of a nature that will be in need of external sources of knowledge in order to be innovative and competitive. Another interesting fact that our study brings out is that at the same time as external sources are contributing with knowledge, the eco-innovation firms are sending out signals to their environment. There is something going in the opposite direction, i.e. being sent out from the firms, which has not been addressed in previous studies (Belin et al., 2009; Carillo-Hermosilla et al., 2010; Mazzanti & Zoboli, 2006; Pujari, 2006; Rennings, 2000). Since our study has showed the academic background of the founders or CEOs to be an influencing factor when dealing with governmental actors, this indicates that what seems to be communicated from within the eco-innovation firms to their external environment is certain legitimacy, credibility and reputation that strengthen the relationship with governmental actors. This implicit and unconscious message could show to increase the possibility to gain the needed support from governmental actors, which have been shown in previous research to be crucial for eco-innovation firms (Horbach, 2008; Horbach et al., 2012; Rennings, 2000). We suggest that the proven track record of an academic background, firstly implies a certain reputation and legitimacy to the firms hard to achieve in another way and, secondly that an academic background has brought with it essential knowledge of how governmental actors and institutions’ processes work and how they operate in doing business as governmental actors.

6.2 Implications of the Study

6.2.1 Practical Implications
In this study we have explored the external sources of knowledge that are present around the eco-innovation firms and have come to learn that eco-innovation firms possess great knowledge through external sources. However, the different external sources tend to differ depending on the character of the knowledge. This study brings empirical evidence to the importance for managers within eco-innovation firms to be fully understood with the possibilities that exist in the external sources. We suggest that eco-innovation firms in the future will assess their external sources and based on the character of the knowledge searched for they should aim to make sure of having the appropriate connections among their external sources in order to gain knowledge that otherwise would be very costly to attract.

This study further presents alternative ways to acquire necessary knowledge and resources, especially for smaller firms that are constantly in need of financing and that may not possess the necessary resources within the organization to conduct development of eco-innovations. Since barriers of eco-innovation, characterized by technology development, are high costs related to R&D activities, market research and
dealing with governmental actors it would be of further interest to find out more on at
what stages during the development process eco-innovation firms utilize the external
sources and what knowledge that are of higher importance at what stage of the
development process.

If managers were to look for knowledge regarding market pull factors, suggested by the
findings would be to look among the customers and competitors to establish good
connections in order to gain knowledge of market orientation and customer
requirements as well as attend exhibitions and seminars that showed to be another
great source of knowledge linked to market forces. These market related knowledge will
assist firms to overcome barriers of market existence.

Regulatory push/pull factors showed to come from governmental actors, a source with
knowledge on how to attract subsidies, approval of test sites and to comply with existing
and future regulation. Further, it is important for these companies to “work the system”
by lobbying to make sure that the environmental policies stay in their favor. By
highlighting the importance of the knowledge of how to attract the governmental
institutions, the managers must understand the potential of combining the right
stakeholders in order to assure that the firm possesses competencies about the
processes of governmental institutions. As our study has shown that eco-innovation
firms are communicating unconscious and invisible messages of credibility, reputation,
and legitimacy, managers should really take a look at what mix of people may send
these signals to the external environment. This may imply the combination of people
with a certain academic background of higher degrees among the board of directors,
but also among the employees managing the daily operations. By having people who
possess high academic degrees, these people might experience a better relationship
with governmental institutions due to the implied status of the degree. An eco-innovation
firms that does not communicate a certain legitimacy and credibility with a positive
reputation, this could mean the end for such a firm even though they possess great
technological capabilities. We mean that since universities are working in a way that
remind of governmental actors, people well experienced in the academic world might be
given a trustworthiness hard to receive in another way. The credibility and the reputation
that is implied by having higher academic experience within the firm are suggested to
be a factor that helps the unconscious communication to the external sources around
the eco-innovation firms.

6.2.2 Theoretical Implications
In this study we could identify a knowledge gap in existing research that called for
further empirical exploration of the external sources of knowledge that are present
around eco-innovation firms. Previous research had been showing that eco-innovation
firms are more likely to rely on and be influenced by external sources of knowledge,
thus our interest to bring forth empirical evidence to what the external sources are, and
what knowledge that could be gained from these external sources, that was lacking in
existing research.

With this exploration of the external sources of knowledge, we have found that there is
significant knowledge to obtain among the external sources and that the different
external sources vary in importance depending on the character of the knowledge. This means that in the eco-innovation literature it is important to consider what external sources that are present in a particular industry and the degree of utilization of these external sources when conducting future research on the development process of eco-innovation firms.

In this study we have seen that the involvement of external sources is not a one way communication of knowledge, there is more to it than that. As eco-innovation firms are dependent on governmental support they need to be able to prove the legitimacy and credibility of the company as well as the feasibility of their new technology in order to gain the trust of the governmental actors. Our study shows that due to the fact that knowledge transfer is not the only thing communicated from the engagement between external assets, eco-innovations have to be explore regarding the unconscious message that is being communicated among their external assets in order to understand the full potential of the external assets around eco-innovation firms.

6.3 Limitations

This study was performed as a multiple case study on four different Swedish eco-innovation firms working with development of systems for extracting energy from tidal and wave movement. Having this in mind this causes limitations to generalize our findings on all eco-innovation firms since the Swedish regulations and other corporate issues surrounding these selected firms do not apply on all other parts of the global market. Sweden only accounts for a minor part of the world market. Thus, we are not able to speculate on how firms in other countries have similar circumstances and regulations due to the fact that only actors in Sweden were considered. However, it could be suggested that primarily the regulatory push/pull knowledge to be limited to the Swedish market, in terms of technology push factors and market pull factors we still believe to present a view that could be of a more general character. Secondly, the global eco-innovation activities accounts for more branches than the sea power, e.g. wind power, solar power etc.

For this study we decided to only interview one respondent in each firm, the results of these interview gives us only that respondents’ version and this can affect the validity of our findings, however the respondents who contributed in this study was considered to have all the necessary facts and relevant information for a valid outcome. This choice was made due to the relatively limited time frame that this study was conducted in. Thus, our data could be the case of bias due to the fact that we only have captured one mans view of the eco-innovation. However, as we felt that all the respondents had played major parts in the creation of the eco-innovation, it was considered that the respondents were of significant relevance to this study. Further, the fact that the eco-innovation firms chose to be anonymous, we believe that they had no reason to hold back information of relevance to the development of eco-innovation, that otherwise could be sensitive to reveal to the public.
6.4 Future Research
As stated earlier this study was completed as a qualitative multiple case study on firms developing systems for extracting energy from tidal and wave movement the findings are not applicable on all eco-innovation firms. We believe that it would be interesting to make a quantitative study on a larger sample of firms both to compare with other countries and other branches of eco-innovations to see if our findings relate to how other countries and branches of eco-innovation utilize the external sources of knowledge. Further, a qualitative study on the eco-innovation firms, interviewing several respondents within different areas, would be interesting to present deeper understanding on the strategy behind approaching external sources of knowledge.

Another interesting fact that our study brings out is that at the same time as external sources are contributing with knowledge, the eco-innovation firms are sending out signals to their environment. It would be of great interest to add to the existing body of research around what message is going in the opposite direction and is being unconsciously communicated from the inside of eco-innovation firms to the external assets of knowledge. Since our study has showed the academic background of the founders or CEOs to be an influencing factor when dealing with governmental actors, it would be interesting to extend the research on what advantages seems to be gained by this underlying communication.

As we found the external sources of knowledge to be of different importance depending on the character of the knowledge, we would suggest future research focusing on either technology push factors, market pull factors or regulatory push/pull factors and see more in detail how the knowledge transfers to the eco-innovation firms and the consequences of the choice either to utilize external sources or not. Another interesting focus would also be to see how the utilization of the external sources of knowledge differs in different stages of the development process. An interesting angle could be to use Cooper’s model on new product development as theoretical framework combined with the external sources in order to approach eco-innovation firms’ utilization of external sources and how the knowledge might differ in the different development stages.

A fourth proposition for future research could be to explore the ambitions and different targets of the Swedish governmental institutions in assisting and supporting firms developing eco-innovations. This approach could be looking at a comparison between the assistance of eco-innovation from the Swedish government and how the government in Denmark assisted the whole market of wind power and gave Denmark the ability to reach the goal of becoming the lead market user of wind power.
ON THE ACQUISITION OF KNOWLEDGE AMONG ECO-INNOVATION FIRMS: THE INFLUENCE OF EXTERNAL SOURCES

References


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Appendix
Semi-structured interview guide:

1. Please tell us about the foundation/start-up of your eco-innovation company?
   a. Was the innovation based on market demands or your technical knowledge?
   b. How long would you describe the innovation process to be and how would you describe your innovation activities?

2. What is your opinion of the governmental support activities regarding eco-innovation and how would you describe the company’s encounters with governmental institutions?

3. How would you describe the eco-innovation industry’s dependence on governmental subsidies?

4. Is the preparation for future innovation important in your organization and how do you prepare to foresee future demands and changes in the market place?

5. What is your company’s spoken environmental policy?
   a. How do you make sure these policies are followed?

6. How do you keep the company up to date with what is new in the eco-innovation industry?

7. Do you conduct frequent market research? How?

8. How would you describe the competitive advantages of the company?

9. To what extant are you affected by governmental regulations and standards?

10. How do you perceive the competition in your branch of the eco-innovation market?

11. Do you cooperate with the suppliers/customers/other stakeholders?

12. How would you describe your relations to the external assets and how do you work to improve your relationship to these external assets?
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