Strategies for change

An analysis of Spanish entrepreneurial strategies for creating a sustainable Innovation System

University Utrecht

Master Program: Science and Innovation Management

45 ECTS

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Date: 24th August 2011

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Summary

This research focuses on the combination of the theory of *Innovation system* and *Entrepreneurship*. To identify the relation between those two theories, a case study is performed in the Spanish wind energy industry. The investigation includes an analysis of the Spanish Innovation system as well as an analysis of company strategies. The combination of both results show entrepreneurial strategies, which have a positive influence on the performance of the *Innovation system* and consequently the innovation's implementation speed. It is identified that the wind energy *Innovation* system performed well in the start-up period of the industry and that the entrepreneurs present at that time applied 14 different strategies. Within the research 16 correlations are identified to be influential between strategies and system functions. The application of those functions are highly dependent the chronological phase of the industry as well as the size of the company. With these results a first step in the combination of the two theoretical strands is taken, which provides benefits for the *Innovation system's* performance, as well as a guideline for entrepreneurs to increase their innovation´s implementation speed.

Key words: Innovation System, Entrepreneurship, Spanish wind energy, implementation speed

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1. Introduction

Currently 84% of the global energy production comes from fossil fuels and nuclear power (REN21, 2011). As a result, humanity faces climate changes, radiation danger (Chow et al., 2003) and due to high energy usage, especially industrialized countries, show a higher energy-dependency (Dincer, 2000; Elliott, 2000). With an expected increase of global energy consumption of 45% until 2030, compared to 2006, and diminishing resources, the search for a solution becomes more and more imminent (Navarrete et al., 2011). Despite to the currently 16% share of global final energy consumption (REN21, 2011), expectations are that *Renewable Energy Technologies* (*RET*) are the solution (Dresselhaus and Thomas, 2001). Having great potential, they bare the capability to become the substitutions for the traditional methods (Chow et al., 2003, IEA, 2003). In spite of high technological expectations and benefits, implementation in the energy market is a slow and difficult endeavour (IEA, 2003; Elliott, 2000).

The slow transition from fossil fuels to alternative energy sources has several reasons. Difficulties in diffusion and implementation arise from higher production costs and thus the incapability to compete with current production methods. As *RET* are emerging technologies with the purpose to integrate in an established technology dominated energy market, their competitive capabilities exist mainly in niche markets or protected spaces (Chow et al., 2003). Furthermore, *RET* are radical innovations, with the capability to "*transfer the way we think about and use them*" (Tidd et al., 2001, p. 12), which can change the face of the industry for good and intend to replace the existing paradigm, which leads to resistance from established forces (Dosi, 1988; Elliott, 2000). A very practical problem of *RET* is caused by the energy infrastructure. Over the years the energy system grew in size and stability, because of the path dependent activities of its participants, leaving no space for alternative production patterns (Stenzel & Frenzel, 2008; Unruh, 2000). In this system the traditional production methods are the central building blocks. The grid infrastructure, as an example, is build around a centralized large-scale production pattern, while *RET* are small-scale decentralized installations, spread throughout a large geographic area. Leading to the necessity of changes in the grid and thus the necessity to alter the whole energy system (del Rio & Unruh, 2007).

To stimulate radical innovation and incorporate system characteristics, innovation literature suggests the *Innovation System* approach (Hekkert et al., 2007). This theory converges the problem on system level, by providing a framework of involved actors and creates insights on the system´s dynamics to understand internal interactions and indicate directions for system intervention (Hekkert et al., 2007; Markard & Truffer, 2008). The basic structure of the *Innovation System* (*IS*) is a set of components, like private companies, universities or the government, which together form a network of organisations and institutions, that ensure the shape of the innovation process (Bergek et al., 2008; Markard & Truffer, 2008). This framework is analysed based on seven system functions. Those system functions can be used to understand and enhance the system´s overall performance, and therefore increase the innovation´s implementation speed (Negro & Hekkert, 2008; Hekkert et al., 2007).

So far most incentives to improve the *IS* were focused on the establishment of policies and regulations. Although, the entrepreneur is recognized as an important player in the *IS*, and perhaps even the most interested actor in a well performing system, little research is done on how entrepreneur's strategies and decisions can influence the *IS* dynamics (Markard & Truffer, 2008). To understand the entrepreneurs capabilities on influencing the performance of the system, by applying strategies, the *IS* is combined with the theory of *Entrepreneurship*. The emerging conceptual model is formulated in chapter 2, in which company strategies are linked to the seven system functions.

Despite the recognition of the entrepreneur's importance for technological and economical development, a generally accepted definition of the entrepreneur has not been found yet (Gedeon, 2010). In spite of various formulations, this research will use its own definition of the entrepreneur as '*an individual or company, new entrant or incumbent, who uses technological innovation to create a new product and implement it´*. Within entrepreneurship literature various strategies emerge of how the entrepreneur can approach and solve problems. In which way those strategies can be used to increase the performance of the technologies *IS*, and therefore the innovation´s implementation speed, remains unclear. This gap in the *IS* theory, as well as in entrepreneurship literature, is the focus of this research.

To identify the strategies applied and their influence on the system's performance, a case study is performed. This case study focuses on the implementation of wind energy in the Spanish electricity market. The Spanish wind industry showed an extraordinary growth of 18.000MWs within the last decade (AEE, 2011), suggesting a well performing *IS* (Negro & Hekkert, 2008). In this research, the system's performance will be analyzed, followed by an investigation of the performed entrepreneurial strategies. The combined data will then be used to create a framework of influential strategies on the *IS*, that can increase the technology´s implementation speed.

1.1 Research Question

To fill the practical and theoretical gap concerning wind energy and the *IS*, this research will answer the following research question:

Which strategies did Spanish wind energy entrepreneurs apply to increase their technology's implementation speed, by creating a sustainable Innovation System?

The practical contribution to the field of wind energy is found in the limited understanding of how entrepreneurial strategies help to implement an innovation faster in the market. With the identification of the applied strategies, by Spanish entrepreneurs, lessons can be learned on which strategies, increase the implementation speed of wind energy in the electricity market. Those lessons can be a first step in creating guidelines and suggestions on how to approach the system from the entrepreneur's point of view. These guidelines can then be further developed with more empirical research concerning this line of investigation. A detailed and focuses entrepreneurial approach in the field may then lead to more *RET* application throughout the globe and a broader implementation of renewable power production in the energy system.

The theoretical contribution is distributed in two steps. First, the implementation of *entrepreneurship* into the *IS* will be performed, focusing on the question whether there exist a relation between those two theories. Secondly, a contribution can be found in the creation of a conceptual model, explaining the exact relation between system functions and entrepreneurial strategies. The second part, respectively, the combination of *IS* and

entrepreneurship in one model, has the higher scientific relevance. By creating a model in which strategies can be used to stimulate a specific *function*, the *IS* theory is extended towards the micro level. With a better understanding of how *functions* can be triggered, using specific strategies, the entrepreneur gains an idea of how to influence the system, leading to a new angle of stimulating the system's performance. Although this is a preliminary investigation, the set of linkages between strategies and functions can be further developed and specified for various types of technologies or extended towards all actors in the *IS*. The combination of those two strands can form a new way of thinking in how each system actor can actively influence the *IS* performance.

In chapter two, this paper will continue with the explanation of the two theories and the construction of the conceptual model, which combines both theories in one model. In the third chapter the methodology applied in this research will be elaborated, alongside a case introduction and the operationalisation. The fourth chapter is a small summary of the most influential developments in wind energy technology from the company's point of view. Followed by the results, in chapter five, where first the industry development is reconstructed and afterwards the wind energy companies´ actions are elaborated upon. In chapter six, the conceptual model is tested according to the found data. Chapter seven is a discussion on the applied methodology and the results found, with some suggestions for further research and in chapter eight an answer is given to the above mentioned research question. The conclusion is followed by a management advice in chapter nine.

2. Theory

To understand the problem of the theoretical combination and the eventual constructed conceptual model, the two involved strategies are explained. First, the theory of *Innovation System* (IS) will be introduced, with the seven system functions and systems interactions, in form of motors of innovation. Thereafter the focus shifts towards *Entrepreneurship*, and the most important types of entrepreneurs in this context, while in the last subsection, entrepreneurial strategies are identified. The last sub-chapter will contain the conceptual model. IN this sub-chapter the expected link between the theory of *IS* and *Entrepreneurship* is constructed.

2.1 Innovation System

Innovation is an uncertain endeavour (Dosi, 1988), but at the same time it is the key determinate for economic growth and development (Hekkert et al., 2007). It would therefore be reckless to let it proceed without the intention to intervene. Due to the role of technological change for society and economy, to shape the innovation process becomes a necessity (Hekkert et al., 2007). Before being able to intervene, one needs to understand the process, which can be achieved by applying the theory of '*Innovation System'*.

In general, a system is a group of various entities which interact with each other to achieve a common goal (Markard & Truffer, 2008). As it was mentioned in the introduction of this research, the *IS* is a set of components, which together form a network of organisations and institutions, that ensure the shape of the innovation process (Bergek et al., 2008). Components are the various actor groups participating in the system, like private firms, venture capitalists, universities or research facilities. The network is the interaction between those components and institutions are the 'rules of the game', which all system actors have to obey (Markard & Truffer, 2008). The network interaction is separated in five different system fields: science, technology, economy, politics and culture. The better the interaction within, and the synchronisation between those five

fields, the better the innovation system performs (Freeman, 1987). The performance of a *IS* is measured by system interactions, which are measured based on system functions. Here the distribution of Hekkert et al. (2007) will be used, who identified seven distinct system functions. Those functions are: *Entrepreneurial activities* [F1], *knowledge development* [F2], *knowledge diffusion* [F3], *guidance of the search* [F4], *market formation* [F5], *resource mobilisation* [F6] and *creation of legitimacy* [F7], which are elaborated upon in section 2.1.1. Based on those seven functions the first step is taken to be able to not only identify the systems performance, but also the state of art and the possible presence of a tendency. The functions' interactions can, on the one hand, accelerate growth, leading to a clear performance increase or on the other hand create negative interaction, which slow down the growth process or in the worst case stop the whole innovation process (Negro & Hekkert, 2008). The functions' appearances will be mapped using a method called Event-History-Analysis (*EHA)*, which data is the used to define the system's performance. This method is further described in section 3.2.1.

2.1.1 System functions

In the following sub-sections the seven system functions, as they are defined by Hekkert et al. (2007), are described.

Entrepreneurial activities (F1)

Entrepreneurial activities are the main driver behind a well-functioning innovation system (Hekkert et al., 2007). As it was said in the definition of entrepreneurship in the introduction, an entrepreneur is *´an individual or company, new entrant or incumbent, who uses technological innovation to create and implement a new product'*. Entrepreneurial activities are the application of a new product in the field. In terms of application one may also think of product supplying facilities. Activities therefore include all entrepreneurial actions that directly or indirectly increase the product´s presence in the market. As Hekkert et al (2007) point out "*The presence of active entrepreneurs is a first and prime indication of the performance of an innovation system. When entrepreneurial activity lags behind, causes may be found in the other six functions*." (p.422).

Knowledge development (F2)

Learning is an essential aspect within a development process. Knowledge acquirement and R&D are therefore central themes within building a new technology *IS*. Hekkert et al. (2007) define three indicators to measure knowledge development. Those are R&D projects, patents, and investments in R&D. All those three indicators are related to research and therefore require financial support (Hekkert et al., 2007). Although it is not active knowledge production 'learning by doing' and 'learning by searching' are essential parts of knowledge acquirement after the R&D process (Arrow, 1962) and therefore part of knowledge development as well.

Knowledge diffusion (F3)

For a well-functioning *IS* knowledge spread is essential (Carlsson & Stankiewicz, 1991). In emerging technologies, where developments are sensitive to external decisions (standards, norms, certification, etc.), information diffusion between developers, consumers, government and producers is of great importance (Hekkert et al., 2007). To spread information within a market, companies need to be willing to work together and share knowledge to develop a better environment for themselves.

Guidance of the search (F4)

Innovations can evolve in various directions. To make sure that specific developments, with high opportunities receive the support they needed, a selection process need to be implemented. Such a process can come from different directions, in which the government as well as public and expert opinions have great influence. Guiding the search process for innovations is selecting technological innovations. The selection process can be influenced by positive expectations mentioned in press or research newspapers, or by formulating national targets, set by the government. While the selection process can be guided into one direction, due to positive statements or targets, negative opinions, and the failure to reach targets can have a negative effect on the selection process. A negative influence on the selection process can result in different orientations of investors or research facilities, leading to fewer investments and less attention for the innovation (Hekkert et al., 2007).

Market formation (F5)

"A n*ew technology often has difficulty to compete with embedded technologies*" (Hekkert et al., 2007, p.424). Emerging technologies have the need for protected environments to grow and evolve (Gibbs, 2009). Hekkert et al. (2007) mentions several approaches to create such a protected environment, where the available options depend on the intention for such environments. One possibility is the establishment of niches or protected spaces, in which a new technology can develop, evolve and spread, to create higher expectations and as a result create more financial resources. Another possibility would be to create a temporary competitive advantage to increase application, by tax incentives (Hekkert et al., 2007)

Resource mobilisation (F6)

As it was indicated above resource mobilisation is a corner stone for technological development. Hekkert et al. (2007) argue that "*Resources, both financial and human capital, are necessary as a basic input to all activities within the innovation system*" (p. 425). To build a functioning innovation system, companies therefore need to gather resources, beyond the company.

Creation of Legitimacy (F7)

To be able to integrate an emerging technology in a system, which is based in traditional incumbent techniques, the newcomer needs to create legitimacy for their innovation (Dorado, 2005). To establish themselves within the market, entrepreneurs can either overthrow the whole paradigm at once or apply a continuous change towards a different system, so called *creative destruction* (Christensen, 1995). To achieve acceptance within the incumbent market, companies need to get their innovation into the focus of market, government and society. On the system level this can be achieved by stimulating other system function like *guidance of the search* or *market formation* (Hekkert et al., 2007), but also by convincing established players or society of the innovation´s benefits.

2.1.2 Motors of innovation

In the previous section it was established that seven system functions exist, which are used to indicate the innovation system's performance. This indication further depends on the appearance of those functions. The function's presence alone does however not indicate the system's performance (Bergek et al., 2005). A tool is needed which can interpret the functions' appearances and translate those appearances into recognizable patterns, which can be linked to the system's performance. Bergek et al. (2005) stress that it is necessary to identify how well the system works, in terms of interaction, instead of merely counting appearances. They

suggest that such functions' interaction then indicates the 'goodness' of the system as a whole. Hekkert et al. (2007) agrees on that approach by expecting *"[…] multiple interactions between functions"* (p. 426). The well-functioning of an innovation system is therefore identified by investigating the presence of the appearing functions (Negro & Hekkert, 2008). Different approaches exist to identify the interaction patterns between the functions. In such patterns a sequence of function appearances is looked for. Bergek et al. (2005) suggest an *industry life cycle model*, to link functions to the according industry phase. They suggest that in different stages of the system, different interaction patterns are needed. The chosen phases, *formative* and *growth*, are however quite broad and not very well defined. A different method, defined by Suurs and Hekkert (2009), uses a more detailed approach in identifying the systems functionality. They identify the interaction patterns as *motors of innovation* and suggest, as Bergek et al. (2005) did, that in different phases within the technological development, different interactions are needed. Suurs and Hekkert (2009) create four virtuous, chronological motors within a technological innovation system, as well as the possibility of vicious motors, which can hinder or even stop the development. In this section the focus will be on the first three motors, because those are the most important ones in the start-up period of an emerging technology. The fourth motor implies market existence and a change in the companies' strategic orientation, towards marketing and promotion strategies, instead of strategies for diffusion and implementation. As the technology is relatively new, the presence of that motor in the industry is unlikely and while the purpose of this research is to understand the applied strategies in the start-up period, an industry in the fourth motor of innovation would not provide the information necessary for answering the research question.

The motors provide the tool and structure in the analysis of the *IS*, as they will be used to translate the functions' scores into the system´s performance. The motors will perform two tasks. First, by using the motors of innovation it is possible to identify whether Spain indeed has a well-functioning system, allowing continuing the investigation. Second, the motors will be used for the provision of a framework in regards to the time of strategy application. As the motors are chronological, within each motor certain system functions are needed to be present. By knowing the state of the art of the industry, which can be identified with the help of the motors of innovation (Negro & Hekkert, 2008), one can adjust its entrepreneurial strategies. Some strategies may be dropped, while others need to be pursued.

Science and technology push motor

In the beginning of an innovation process, Suurs and Hekkert (2009) define the *Science and Technology Push motor* (*STP*), as the start-up motor of the *IS*. The *STP* is dominated by an interaction of *knowledge development* (F2), *knowledge diffusion* (F3), *guidance of the search* (F4) and *resource mobilisation* (F6). Although those are the dominant functions within this motor the functions of *entrepreneurial activity* (F1) and *creation of legitimacy* (F7) can be present as well, but in a lower magnitude.

The motor starts with a sequence of *positive expectations* (F4) about the technology, to be the solution to a social problem. Those expectations trigger governmental interest and the *mobilisation of resources* (F6), for research projects, *knowledge development* (F2) and *knowledge diffusion* (F3) (see figure 1). The results of such research either increase the cycle, by verifying the expectations or decline its activity, when research projects fail. Positive results would lead to even more support, higher expectations and more resources for entrepreneurs, while a negative outcome would lead to the opposite, with fewer resources available.

According to Suurs and Hekkert (2009), this motor gives rise to a shared system vision between the participants, and provides directions for further research. Due to higher company participation the relations between those grow stronger and cooperation is increased. Furthermore does a successful *STP* motor create formal institutions, which support an emerging technology and therefore decrease uncertainty for producers, investors and other stakeholders.

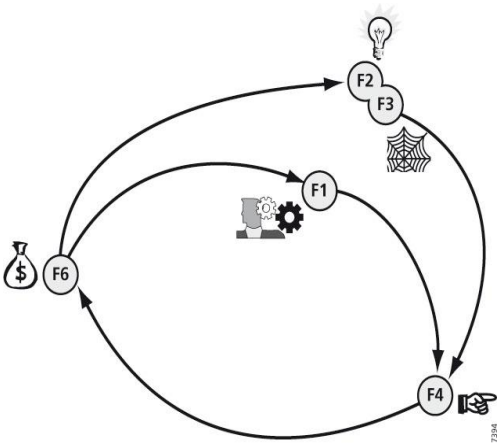

Figure 1: Source Suurs and Hekkert, 2009

Entrepreneurial motor

Following the *STP* motor the system changes into the *Entrepreneurial* motor. As with the *STP* motor, in the *entrepreneurial motor* the functions *knowledge development and diffusion* (F2 & F3), *guidance of the search* (F4), and *mobilisation of resources* (F6) play an important role. The main difference to the first motor can be found in the strong increase of *entrepreneurial activities* (F1) and *creation of legitimacy* (F7).

With the increasing positive expectations about the new technology´s profits (F4), the number of entrepreneurs in the market increases (F1). With more actors involved the amount of lobby (F7), for extra support and resources for projects, experiments, and research activities (F6) increases. More resources again increase the expectations for the technology's development (F4), which then lead to more entrepreneurs entering the field (F1). The outcomes of the projects and experiments in the second phase of the cycle determine whether the cycle will continue and repeats itself, or whether it will be brought to an end and activities decrease. Apart from this cycle, in the *Entrepreneurial motor* another interaction between the entrepreneurs´ activities (F1) and the development and diffusion of knowledge (F2/F3) is present. Because of high project activities, knowledge due to 'learning by doing' increases, enhancing the operational knowledge, which again increases the possibilities to perform projects and experiments. A possible side effect of those two cycles is the establishment of niche markets (F5) outside the *IS*, where opportunities for entrepreneurs arise to develop and diffuse knowledge and to provide extra support for the emerging technology (Suurs & Hekkert, 2009) (see: figure 2).

The entrepreneurial motor influences the *IS* by expanding itself towards a broader audience and including local government and new companies in the process. Networks are created between participants and the government, where standards and licensing procedures are developed, leading to the integration of the technology into the existing institutions. Another benefit, especially due to the interaction between entrepreneurs and knowledge development, are technological improvements on a higher scale thanks to learning by doing (Suurs & Hekkert, 2009)

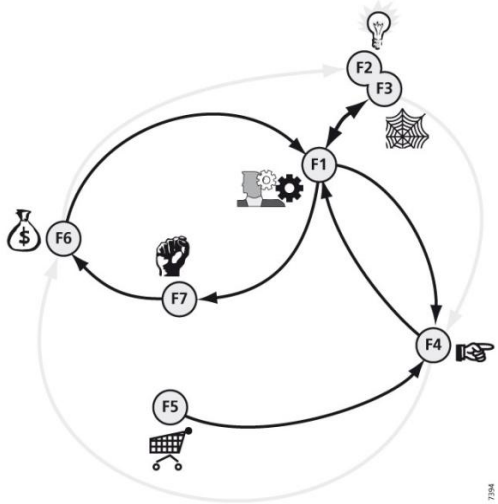

Figure 2: Source Suurs and Hekkert, 2009

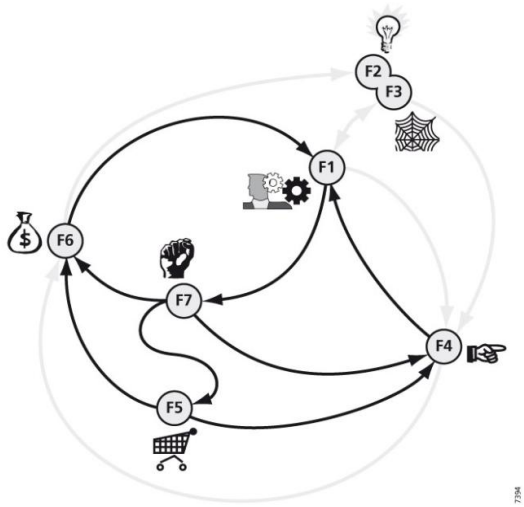

Figure 3: Source Suurs and Hekkert, 2009

System building motor

In this motor all seven system functions are present. The difference with the earlier motors is the strong presence of *market formation* (F5).

The motor starts with increasing number of participating companies (F1), which lead to more successful projects and experiment outcomes (F4). The participating companies and research facilities form platforms, where they can share gathered knowledge, coordinate further actions and projects (F2/F3/F4). Such platforms lobby for support and resources within and beyond the industry (F7/F6). The main difference with the earlier motors is that company and platform activities focus on the creation of markets (F5). Although most interactions remain the same, in comparison to the *STP* or the *entrepreneurial motor*, the main focus of the system building motor is on policy measures and intentional market formation to improve the *IS* as a whole (see: figure 3).

The results of this motor are first, the tighter integration of the national government, with a focus on protected markets and competitive advantage, secondly the development of stronger networks, where even incumbent firms may participate in, and thirdly the formation of markets for emerging technologies (Suurs & Hekkert, 2009).

Motors of decline

Suurs and Hekkert (2009) indicate that most motors of innovation have positive influence on the development of an emerging technology. Nevertheless the possibility exists that some interactions may lead to a negative cycle. Similar argumentation can also be found in Negro and Hekkert (2008) or Bergek et al. (2005). All of those authors state, that depending on the system function´s interactions, a cycle can lead to hinders for, or even the end of a development process. Which negative interactions appear and how such a decline takes place, depends on the problem encountered in the system. Negro and Hekkert (2008) for example show that a cycle can lead to a decline, if the technology cannot fulfil the expectations (-F4), which increases disappointment and negative lobby by competing technologies over the technology (-F7). Such a process eventually leads to the end of entrepreneurial projects and activities (-F1), resulting in less knowledge production and decline of available resources (-F6). Another possible negative cycle could be triggered by a change in governmental regulation and policy measures (-F4). Those could result in decreasing funds (-F6) and fewer entrepreneurial activities (-F1),

because of a higher uncertainty in the field. More vicious cycles like unsuccessful research projects or failed experiments can be thought of. The result of such vicious cycles are in the best case a hinder for the development and in the worst case the end of the technology (Negro & Hekkert, 2008).

2.1.3 Theory limitations

Although Bergek et al. (2008) underline the *IS* analytic power, they also point out that the explanatory power of this theory is limited. In their words "*The innovation system is a tool we use to better illustrate and understand system dynamics and performance*" (p. 408). The framework is thus suitable to understand interactions and network actions within the system. To provide solutions for a better functioning system, or to find out how to improve certain functions appearance, is however more difficult. This difficulty emerges, because the theory investigates the appearance and interactions, not the reasons for those appearances. A function can be triggered by various sources. Social or political interest, technological achievements, company interests; the theory does not investigate why the government provides policies, or how companies receive financial support, even for projects that do not have high revenues. It lacks the understanding on how an individual player can interact and stimulate certain system functions. Although the influence of the entrepreneur is recognized in especially system functions *one* and *two*, a clear influence on the other five system functions is less obvious. Neither can those functions be linked to concrete entrepreneurial actions. As a result the understanding about the influence of the entrepreneur's decisions and strategies, on the appearance of system functions is limited.

Beside the limitation of the theory, with respect to the identification of the underlying reasons for the function's appearance, another gap can be identified. Hekkert et al. (2007) emphasis that *IS* explicitly includes entrepreneurs in the system, they do however not recognize possible differences within this group. All entrepreneurs are taken as one and perhaps that maybe the case in pursuing their goal, but as Bergek et al. (2008) point out "*Actors do not necessarily share the same goal, and even if they do, they do not have to be working together consciously towards it"* (p. 408). The *IS's* generalization of the entrepreneur as a group may have benefits in relation to the practical application, but it has weaknesses as well. By assuming that all entrepreneur's act in the same way, it neglects the possibility of different types of entrepreneurs pursuing similar or different goals by applying different strategies. In other word, the theory neglects the possibility that small companies pursue different strategies than big companies, or are interested in the appearance of different system functions. As an example, small companies could be much more interested in *knowledge diffusion* than bigger companies, because they do not have the resources to develop that knowledge themselves. Bigger companies on the other hand could be more interested in the *development of knowledge* to assure their dominance and technological advantage in the market.

Despite the theory's limitations mentioned, the *IS* is a suitable approach on understanding the systems performance and development over the years. By applying the seven system functions, the history of the industry can be reconstructed and interpreted. The *IS* analysis and the necessary system functions therefore form the verification of the assumption of Negro and Hekkert (2008) that, "*a well-functioning TIS is a requirement for the technology in question to be developed and widely diffused."* (p. 467). Furthermore the *IS* is necessary for the investigation, to relate the applied strategies towards a framework which shows the system's dynamics and understand whether the intended goals of the companies' correspond with the according dynamics in the system's development. In the analysis of this research the *system functions* thus perform two functions. First they

are used to reconstruct the development of the innovation system and second they are used as orientation points for applied strategies.

As described, the limitations form a problem in the practical use of the *IS*. The two problems mentioned can however be solved by expanding the theory. Integrating *Entrepreneurship* in the framework both limitations mentioned above are approached. On the one hand the link is constructed between the appearances of system functions and actions taken in the system, leading to a better understanding of how functions can appear and on the other hand, differences between entrepreneurs are identified and whether they indeed act as one.

2.2 Entrepreneur

As mentioned in the introduction, in this research the entrepreneur is described as '*an individual or company, new entrant or incumbent, who uses technological innovation to create and implement a product'*. This definition approaches the entrepreneur from a broad perspective. The definition includes the 'new entrant' entrepreneur as well as the 'incumbent' entrepreneur, who initially uses different technologies in the same market. Furthermore does this definition imply that it is not only the creation, but also the implementation of the innovation into a market, which described the entrepreneur's activities. Reviewing the entrepreneurial literature, it can be distinguished that, despite the importance of entrepreneurship for innovation and economic development, no common definition was found (Stam, 2008; Gedeon, 2010).

The first definition head back to Schumpeter (1934), who defined this group as "*individuals that carry out new combinations*". Since then various definitions have been written, all without general agreement. Especially the rising interest in the role of the entrepreneur in technological change has increased the amount of research (Low & MacMillan, 1988). In this context Gartner (1988) underlines that it should be looked for skills, rather than characteristics and goals, to determine who or what an entrepreneur is. He says *"Entrepreneur is not a fix state of existence, rather entrepreneurship is a role that individuals undertake to create organizations.*"(p. 64). Hébert and Link (1989) define the entrepreneur as those who are *"risk takers, creative venture into a new business or the one who revives an existing business*"(p. 39). Recent literature still tries to get a grasp on the concept. Stam (2008) uses the definition of an entrepreneur to be a person who "*introduces new economic activity that leads to change in the marketplace*" (p. 5). Eventually those attempts neither lead to a generally agreed upon definition of the entrepreneur, nor to a suitable definition for this research. Although the initial goal of a general definition is not achieved, those approaches did create typologies of entrepreneurs, each with particular goals and strategies, which taken together as a group, may be able to grasp the concept that inhales the entrepreneur (Gedeon, 2010).

Considering the finding that the entrepreneur exist in various types, each having distinct objectives and to achieve those, use different strategies (Gedeon, 2010), this research will focus on few particular relevant types of entrepreneurs. Although those entrepreneurs are described here in different sections and as different types of entrepreneurs, they are not mutually exclusive and they were treated as one. In different words, a distinguishing is made in the concepts description, a difference in their actions and strategies however not. The purpose of the next section is to not only to describe the different strands of entrepreneurs, but to show their importance for this research. The investigation approaches three types of entrepreneurs, which differ in their objectives and partially in the applied strategies. The three types of entrepreneurs are the '*institutional entrepreneur'*, the '*eco-preneur'* and the '*collective entrepreneur*'.

2.2.1 Institutional Entrepreneurship

The theory of *institutional entrepreneurship* was originally developed, by DiMaggio (1988), as a result of a lacking theoretical description. DiMaggio identified that there was no explanation for fast occurring market changes, not initiated by the environment, nor sharply contested markets with the tendency to delegitimize the order in the organisational field. To fill this gap he formulated the idea that change occurs *"[...] when organized actors with sufficient resources see in them an opportunity to realize an interest that they value highly"* (p. 14). Earlier Schumpeter described those organized actors as *institutional entrepreneurs*, embossing all later descriptions. Perkamm and Spicer (2006) define institutional entrepreneurs as "*agents who intentionally and purposefully work towards changing the existing or creating new novel institutions*." (p. 7). The change of existing institutions and the creation of new ones is a challenging endeavour, in which various factors should be considered. Success or failure of *institutional entrepreneurs* is highly depend on the stability and maturity of the regime, the entrepreneur's chances of resource mobilisation, field positioning and legitimacy creation (Dorado, 2005; Greenwood et al., 2002).

The main challenge of an institutional entrepreneur is to alter the existing arrangements and at the same time create support for the new ones. He needs to legitimate the new set of rules, while obliging to the rules of the institution he wants to change, also known as the 'paradox of the embedded agency' (Garud et al., 2007). Difficulties can further arise in especially stable and mature fields, because established competitors continue the 'old' way and try to hold on to the existing arrangements (Leca et al., 2006; Greenwood et al., 2002).

The change of the energy system towards renewable energy, like it is pursued by wind energy producers, is thus identical with the challenge of an institutional entrepreneur. In the definition of Perkamm and Spicer (2006), an institutional entrepreneur is described as intending to change the existing and establish new institutions within an organisational field. This can also be identified within the energy market, as the producers spread the wind energy technology throughout the market to slowly change the existing system.

2.2.2 Eco-preneurship

Entrepreneurs who not only seek to seize new business opportunities, but combine this business ideas with sustainable behaviour, and development, are describe as 'eco-preneurs' or 'green entrepreneurs'(Gibbs, 2009). Eco-entrepreneurs approach an idea on a different level as it is the case with regular entrepreneurs. Their company's activities are based on a sustainable attitude at the company's foundation. With such a foundation, the entrepreneur does not only achieve a competitive advantage in form of higher product value, due to environmental safeguard (Dean & McMullen, 2007), they create a pull-effect by *"demonstrating the economic benefits that come from being greener"* (Schaper, 2002, p. 27).

Although there are opportunities within emerging sectors and in stable markets, eco-entrepreneurship struggles with various difficulties in changing the market. A survey study by Schick et al. (2002) identified that there are four main factors influencing green entrepreneurship. Within these factors, communication plays a major role. *The lack of information on sustainable business* and the *limited knowledge of ecological issues* are two barriers for start-ups to create an environment-friendly company. The other two factors were identified to be *unawareness of green market opportunities arising from eco-entrepreneurship*, and *financing*. Certainly financing is a problem for every entrepreneur, but Gibbs (2009) argues, the ecological modernisation, initiated by eco-entrepreneurs will not be completed by convincing start-ups to go green. In other words, a "*broader*

sectoral and institutional shift" (Gibbs, 2009, p. 75) is needed to promote renewable energy outside the protected niche market. The surrounding system needs to be convinced to integrate the green 'solutions' in the path-dependent infrastructure (Unruh, 2000). In the case of RET this means that the financial needs are even higher, as the energy system is a large technical system, consisting of a fixed infrastructure, which needs to be changed to incorporate the new methods. This change implies high investments in new energy connections and an adaptation to a decentralised production pattern.

Although not all wind energy producers have an environmental friendly foundation, they can still be described as eco-preneurs. In this case it is not the companies' foundation, rather the companies' activities, which make them green. The application of wind energy and therefore the intention to change the market through green technology makes them fit the description of eco-preneur.

2.2.3 Collective Entrepreneurship

With increasing importance of the entrepreneur for economic growth this type of entrepreneurship has established itself in the field of science. Cook and Plunkett (2006) define collective entrepreneurship as a "*process of designing, financing, and incorporating a path-dependent collective action form of multi-level rent generation*" (p. 426). This definition includes the necessity for the involved parties to create a working framework between each other in the struggle for a common goal, which they are individually unable to achieve. The type of actors involved in this activity is independent the initial company orientation. While the other two types demand a certain company characteristic, this type focuses on the activities applied. Involved parties can very well be eco-preneurs as well as institutional entrepreneurs. The key aspect is that the collective pursuit of certain actions bars equal risks for all players involved, as they all invest resources into the projects (Cook and Plunkett, 2006). Collective action occurs in business if several actors within the same field encounter a similar problem or challenge beyond their own capabilities. Bundling forces in such a situation is however only possible if the involved actors neglect their own interests and operate for the greater good of the community (Comeche & Loras, 2010). The bigger this community grows, the higher the risks involved, because despite their shared interest, a higher amount of available resources, will also lead to increasing differentiation of interests (Wijen & Ansari, 2007).

There are two gaps, which are not yet fully understood in this direction. First, it is unclear what the best structure of such a collective operation looks like. Cook and Plunkett (2006) argue that there is much discussion on whether a horizontal structured group or a vertical hierarchically structure lead to better performance. Second, knowledge about initiating institutional change, due to collective action and active groups of actors within a sector is lacking as well (Wijen & Ansari, 2007). Nevertheless cooperation as method for achieving a common goal is a useful approach

An example, for collective entrepreneurship might be the wind industry. Given the technological relative immaturity wind energy companies are pioneers and face difficult challenges in the stable and mature energy market. Aldrich and Fiol (1994) point out that the lack of legitimacy is a key aspect in a collective entrepreneur's endeavour against the existing market. Individual companies will have difficulties to establish themselves within the market. The cooperation of small wind energy companies could help the branch to gain ground on the market and increase legitimacy due to collective action and higher momentum.

2.2.4 Strategies

The goal of this research is to construct a link between the *IS* and *Entrepreneurship*. This link is established between the system functions and the entrepreneurial strategies in the start-up phase of the industry. To understand the opportunities an entrepreneur has with regards to possible strategies, this section provides an introduction into the most important strategies, belonging to entrepreneurship and the three above mentioned types of entrepreneurs. The beneath mentioned strategies are therefore the a prior strategies, which are common in the entrepreneur literature, used to create an initial conceptual model of expected influences of strategies on the system functions' appearance.

An exact definition of the concept 'strategy' does not exist. Mintzberg (1987) identifies that strategies can have various meanings, which interpretation highly depends on the area of application. Military leadership would define strategy different than a football coach or a theorist. For companies Mintzberg defines strategy to be *"a unified, comprehensive, and integrated plan [...] designed to ensure that the basic objectives of the enterprise are achieved"* (1987, p. 12). It is their *"Central integrated, externally oriented concept of how one will achieve their objectives*" (Hambrick & Frederickson, 2001, p. 53). Although nowadays everybody has a strategy or applies a strategy, Hambrick and Frederickson (2001) point out that people and companies often do not know how they reach it and to what extend they need a strategy. Despite different goals, dependent company type and their intentions, some generalizations can be made for specific types of companies and their goals.

Entrepreneurial strategies

Normally there is a difference between strategies for entrepreneurs and for established companies, as they have to deal with different challenges and objectives. Although this research implies that an entrepreneur can be a new entrant as well as an established company, facing the same challenges in a new technological field, their capabilities and opportunities differ. With different capabilities the company's opportunities and strategic options differ as well. As a result companies apply strategies which correspond to their capabilities to achieve their goal. Therefore their applied strategies may differ as well. In the classical understanding, the entrepreneur enters a market with a new product, during which the entrepreneur encounters various entry barriers, where strategy should be adapted to. Those barriers are the result of an *economy of scale*, resulting in a cost disadvantage for the entrepreneur, *product differentiation*, the necessity to have a different product, able to persuade the buyer to change his loyalty, *capital requirement*, the start-up investment in the field, a *cost disadvantage,* due to the lack of a learning curve and too little field experience, *limited access to distribution channels* and finally, if present, *government policies*, which could represent itself in product licensing (Porter, 2000). Purely based on the entry criteria formulated by Porter (2000), the entrepreneur has a rather hard task ahead of himself. Ahuja and Lampert (2001) add some more difficulties, if the entrepreneur does not only want to enter the market, but wants to become successful as well. One of the three elements formulated, already mentioned by Porter (2000) is, that a company needs to develop distinctive qualities to be recognized in the market. The second necessity is that the company needs to satisfy a demand which is present, either in a way that the client is a user already and that he needs to be persuaded to change his loyalty, or in a non-existing way. In the second case the product covers a demand, which was not identified so far. The third difficulty for a company that wants to be successful is that the internal structure needs to be consistent with the external actions of the company, as it was already indicated by the strategy definition of Hambrick and Frederickson (2001).

For entrepreneurs to solve those problems, a plan or a 'strategy' is necessary. In section two of this chapter, it was identified that three types of entrepreneurs fit the profile of wind energy entrepreneurs. Those three types are used here, to generate a set of applied strategies, which create a theoretical foundation for this research. With those strategies an initial link, based on argumentation and logic in correspondence to strategies and system functions, will be made between entrepreneurship literature and *IS*, which can then be tested during the research. With the formulation of strategies beforehand, an overview is created of the possibilities and opportunities the entrepreneur has on influencing the innovation process. As it was pointed out in the beginning of this section, there is no general definition of strategies which could be applied. In this research strategy is defined as '*intentional actions by entrepreneurs to achieve the company's goal, of implementing their technology in the market'*.

In the following various practical entrepreneurial strategies are described. Those strategies emerge from the three strands of entrepreneurs described above. Although some strategies may only be performed by one type of entrepreneur, a difference is not made between the strategies' origin. As wind energy companies have the potential to fulfil the characteristics of the three types of entrepreneurs, all strategies are treated equally. In different words, the strategies described are of the most important strategies emerging from entrepreneurship, as it is defined in this research. The strategies will be described by explaining what the strategy looks like, by elaborating on their purpose or goal and by pointing out in which phase of the implementation process they should be applied.

Action in context

As the name of the strategy already implies, the goal is to put the innovation into a wider context. This strategy pursues two goals. Therefore a difference will be made between action in context on *industry level* and action in context on a *social scale*. In the first case, as Leca et al. (2006) showed, the creation of standards and norms can help the application of the technology and the amount of projects. This standardization method can increase the entrepreneurs competitive positioning as a structure is built within the emerging institution (Garud et al., 2000). The creation of standards and norms form the basis for a broader application of the technology in the market. It also increases the opportunities for cooperation and provides focus to research and development. It can also be used as a stepping stone in motivating the government to support the research endeavours, because the industry focuses itself on a specific research direction, leading to less 'sunk' research funds. The *social scale* of action in context underlines the theoretical social and environmental context, in which technological benefits are communicated towards the public. This can be achieved by organizing school projects, publicity acts or information events at wind parks. The purpose is to show the necessity of change and increase understanding for application and implementation in the market. Such actions can lead towards a positive opinion about the technology and create social acceptance in society (Leca et al., 2006).

Although it is the same strategy, the two levels are applied at different points in time. The standard application is needed in the start-up phase, to help the search process and focus development. The social aspect is needed in the later application phase, when the technology is put into use (Perkamm & Spicer, 2006). Especially in the case of wind energy, social acceptance plays a crucial role, as wind parks and singular wind mills are often perceived as disturbing by the local community. The higher the application level, the higher the need to increase social understanding and social acceptance surrounding the technology (Toke et al., 2008).

Collective action

This type of strategy is proposed to be used in the case that a certain amount of companies encounter the same problem, which they are individually not able to solve, but with combined forces, they have sufficient momentum to master the barrier. Classical difficulties are resources, knowledge or skills. Exact actions present themselves in for example joint ventures, research projects or ordinary cooperation. The key aspect is that the companies share the same risk and follow the same objective for the greater good and neglect own interests (Aldrich and Fiol, 1994). With such an approach, on the one hand, forces are bundled and smaller companies can act and compete with the bigger ones. On the other hand, the gained momentum increases attention for the applied activity.

According to literature, the best use of this strategy occurs in the start-up phase of the industry, when there is only little publicity about the product and few resources are available. A problem of collective action can be the differences in interest between the participants. Although in general all actors involved pursue the same general goal, with a higher number of entrepreneurs involved the variety of individual interests increase, possibly leading to frictions within the group (Leca et al., 2006).

Cooperation with established players

The cooperation with established users can be beneficial on different frontier. It can help the individual company and as Elamti and Kathawala (2001) suggest, it is especially important when entering existing and mature markets. With the help of an established company, the entrepreneur can avoid some of the difficulties mentioned, by Porter (2000) and achieve a faster implementation of the innovation in the market (Dorado, 2005; Greenwood et al., 2002). As it was the case with collective action, different forms of cooperation can be thought of. For bigger companies such cooperation are interesting, as it can be used as an entrance and acceptance method in localized markets or the source of knowledge about specific geographical characteristics (Hitt et al., 2007). The second type of benefits such cooperation can bring along is the creation of legitimacy. An entrepreneur with a new technology has to fight to be taken serious. To establish new ideas in an existing market often encounters resistance from within the market (Dosi, 1988). By interacting with an established player, an entrepreneur can transfer the established company's credibility towards the innovation and prove to the sector, as well as the society, that the technology contains the necessary capabilities in the market and has opportunities for the future (Hitt et al., 2001).

Literature suggests the usage of that strategy between the introduction of the technology and a broad scale application. As in this phase most of the by Porter (2000) formulated problems arise, a strong and experienced partner in the field at one's side can make the market entrance easier.

Cooperation with the government

In an emerging field gaining support, no matter from which site, is important. One of the most interesting stimulation however comes from the government. By *cooperating with the government* the company can directly influence the decision making and interests of the government. Beneficial for the emerging technologies can be the establishment of policy measures in the field. Such incentives arise from the presentation of technological benefits and opportunities for the industry or even the country as a whole. Cooperation can be achieved by regular meeting with government representatives and the frequency of those meetings. Such cooperation thus

pursuits the creation of support on a national scale and motivates the government to help by setting targets, creating sub-fields and protected niches (Elmati & Kathawala, 2001).

This strategy should be applied in an intermediate stage of the industry. The first projects should have been established and the technology´s functionality should be proven. With a successful first implementation the cooperation with the government is easier, more convincing and from that point on a stimulation for the industry.

Cost management (R&D)

Cost management or the decrease of costs is an important aspect in competitive markets. McDougal (1989) points out that *cost management* creates a competitive advantage and will lead to higher implementation rates and construction procedures. To limit costs, various orientations can be chosen. Depending on the industry, saving can be achieved in for example administration, economies of scale, logistics, product design, technological improvement and R&D (Tidd et al., 2001). The main purpose is to produce for the lowest cost per unit and enhance the company's competitive advantage on cost competition (McDougal, 1989). If cost management is performed by applying R&D activities, benefits also arise in terms of technological performance. In a technology intensive market, or in competition between technologies, such performance enhancements have high influences on the competitive advantage of the technology.

R&D should be applied throughout the whole process. Technological improvements are always necessary as the competition develops as well. The focus on cost competition is however more important in the later cycles of the industry, when technological performances level between competitors and competition is decided upon costs rather than design (Anderson & Tuschman, 1990; Utterback, 1994).

Developing a discursive strategy

This is an entrepreneurial specific strategy, as it is designed to undermine the existing argumentative framework and create fractures in the current technological system, to create spaces for other technological solutions (Leca et al., 2006). In this strategy the entrepreneur develops arguments that point to the weaknesses of the existing system. The level can vary between social, technological or environmental weaknesses. While other authors name this strategy the destruction of the existing system (Greenwood et al., 2002), the entrepreneur faces a problem which in literature is described as the 'paradox of the embedded agency'. The entrepreneur need to break with the existing regime and question the framework, while obliging to them, to be able to justify the innovation's superiority in a later point of time (Garud et al., 2007). The creation of fractures in the argumentative framework is the stepping stone in creating legitimacy for the innovation and a necessity to start and implement the innovation as a solution for the fractured framework (DiMaggio, 1988).

For an entrepreneur trying to implement a technology, which so far has not proven itself in the market, the mobilisation of resources and the generation of support is difficult. This strategy should therefore be applied in the beginning of the industry. Fracturing the system, creating space for the own technology and generate support for the innovation's solution is essential to raise attention (Leca et al., 2006).

(Green) marketing

Close to action in context on a social scale, green marketing or marketing in general can be used on enhance the company's own image in society. While action in context focuses on the technology, this strategy focuses on the company and on their competitive advantage. Marketing methods vary too wide to be mentioned here. The main

goal is to gain support for the company and mobilize resources for projects and programs (McDougal, 1989). Furthermore, if the marketing methods are combined with a 'green' aspect, either from the company's sustainability or the applied technology, marketing can be extended towards the utilization of 'green marketing', underlining the environmental benefits the company provides (Parkash, 2002).

Because this strategy is used to gain support and resources in the field for the technology, it should mainly be applied in the beginning of the technological phase (Perkamm & Spicer, 2006). When the focus shifts towards a more competitive field, where marketing is used to show the benefits a specific company has, the application in a later phase can be useful as well, when the market is established and competition arises between companies rather between technologies (Menon & Menon, 1997).

Market entry

Two approaches can be identified. Companies can choose to enter on a small scale, with a limited amount of application and little risk, or they can enter the market on a large scale, baring more risks but producing more benefits in the event of a success. The decision, whether to enter the market on a large or a small scale differs between companies. The size of the company can be a reason for a different approach as well as the available resources and the willingness to take risks. As a result the, goal of this strategy depend on the company decision making. A small scale entrance could for example focus on creating sub-fields and protected niches, where companies can learn and increase their technological understanding. An example of the power of a small scale application of technology can be found, in recent Denmark, where this strategy has brought benefits for the industry and the creation of a market (Ackerman & Söder, 2002). Large scale entrance would on the other hand focus on the competition with other technologies already existing in the field (McDougal, 1989).

Although it was said that the entrance strategy depend on the company's goals, Elliott (2000) suggests that in the start-up phases of an industry, small scale entrance is a better approach, because of less technological knowledge, a higher learning curve and limited risk. With increasing knowledge as well as a higher social acceptance large scale entrance becomes possible against smaller financial and social risk.

Mobilisation of allies

Allies, here understood to be companies beyond the industry boundaries, can be useful for different goals. If own capabilities are not sufficient to execute a specific project, support either in the form of financial, human or knowledge skills, can be bought in form of another companies' assets (Teece, 1986). Besides the possibility of buying certain skills, it is also possible to share revenues according to investments, to make participation for financial institutions more interesting. Furthermore allies can also be used to spread the technology's importance beyond the industrial field. Creating more support and resources, on an industry level, increases the level of awareness surrounding the technology and therefore legitimacy for the innovation (Elmati & Kathawala, 2001; Hitt et al., 2001). Although this strategy on itself is already useful for the company and the industry, a collective mobilisation, as it is described by Aldrich and Fiol (1994), can lead to the creation of networks which increase the momentum of the innovation even further (Hitt et al., 2001).

Gathering resources for the start-up phase of the industry beyond the field is a useful strategy, especially in the case of emerging technologies (Gibbs, 2009). Using allies beyond the field, to spread the importance and

application of this technology, is better applied in the later stages of the cycle, as it can be a useful strategy to gain support and legitimacy (Perkamm & Spicer, 2006).

Using company's own assets

This strategy is a very useful strategy, which however cannot be applied by all companies in the field. As the name already suggests, the company's assets are used. If the entrepreneur is a new entrant to the field, and has not been established in a different type of industry before, those assets do not exist and the strategy is not applicable. If those assets however are present, those can be used to create legitimacy, execute pressure or to gain support because of a higher trustworthiness (Hitt et al., 2001; Leca et al., 2006).

Perkamm and Spicer (2006) suggest this strategy in the early beginning of the industry. After fracturing the existing argumentative framework with a discursive strategy, company's assets can be used best to gain support for their innovation.

2.3 Conceptual Model

In this last section of the theory chapter, the theory of *Entrepreneurship* is linked to the *Innovation System*. This link will be structured according to the distribution of the seven system functions. To each system function the expected influential strategies are allocated. The expectations are then summarized in table 1 at the end of the chapter. Alongside the expected influences, some hypotheses will be formulated, related to the research question and the theories limitations.

Entrepreneurial activity

From the description of this system function earlier, it can be concluded that the entrepreneurial activity is a key aspect in the development of a well-functioning *IS*. Due to the definition of the entrepreneur used in this research, it includes new entrants as well as established companies, who use technological developments to create new products and implement those in the market. The activities the entrepreneur performs, the construction of wind parks or the set-up of wind mills, are the basic goals of the entrepreneur. A specific strategy that influences the amount of activities is therefore rather difficult to find. One strategy which is expected to have an influence on the amount of activities is the *market entrance*. This strategy decides, upon which market the entrepreneur focuses himself. There is the chance that the focus will be on small-scale production, leading to a higher amount of parks and construction sites, or the focus is on large scale centralized parks, leading to, on the one hand higher amounts of energy production, per Wind Park, but also to less activities in the field and higher risks per project.

Knowledge development

To produce knowledge one needs to experiment and therefore one needs resources (Hekkert et al., 2007). In some cases the necessary resources come from within the company and in other cases, the company is forced to mobilize resources from the outside. Finding financial resources can be achieved by *mobilizing allies* (Hitt et al., 2001). In the strategy section it was established that the mobilisation of allies works on an industry level to produce legitimacy for the innovation, as well as on a company level to generate resources. With those resources made available, the entrepreneur can develop knowledge by applying R&D activities. Although not specifically formulated in the strategy section, the focus of a company on R&D activity can be seen as a sub-strategy of the

overall *cost management* strategy. Cost competition is often achieved by increasing productivity, efficiency or improving working and production processes (Tidd et al., 2001). Those developments are the results of technological improvements, thus knowledge development in the field. Actively looking for cost reduction therefore means searching for new knowledge about how to lower costs of materials, production or construction can be achieved. Those goals are reached by increasing R&D activities (Tidd et al., 2001), therefore R&D can be seen as a sub-strategy of *cost management*.

Knowledge diffusion

In an *IS* the diffusion of knowledge and information is an essential aspect, which is even more important in emerging technologies (Carlsson and Stankiewicz, 1991). Different ways can be used to spread and diffuse information. Hekkert et al. (2007) mention workshops or conferences. Other options are, according to Elmati and Kathawala (2001), *strategic alliances* as a source of information or a common research project with shared costs and therefore shared risks. In this case, strategic alliances are the cooperation between companies within the field, which share interests in trying to solve a mutual problem. As a result, strategic alliances are understood as *collective action*. It is however not necessary to cooperate with a company within the field. The creation of an external network, therefore cooperation with companies beyond the field or the *mobilisation of allies*, can be a source of information as well (Hitt et al., 2001). Even if strategies do exist to spread knowledge within the field, the companies need to be willing to offer that information to companies, which may become potential competitors in the field at a later point in time.

Guidance of the search

Directions for research and expectations about technologies are often triggered by influences beyond the entrepreneur´s reach. Governmental decisions or public expectations are factors that cannot directly be influenced by the entrepreneur, as those represent opinions, political decisions or personal preferences. The way in which an opinion is formed can however be targeted indirectly by the entrepreneur. To influence the public opinion about the technology the entrepreneur can use the strategy described as *action in context*. As it forms an argumentative framework, surrounding the technology, underlining its benefits for society and making the innovation understandable for the public. The technological benefits become more popular and therefore increase expectations in society (Leca et al., 2006). To influence political decisions and the establishment of targets the company can form networks, which include the government as a regulative entity. Although an external network would already influence the way of thought about the technology (Hekkert et al., 2007), in society as in politics, a faster way to approach governmental preferences is expected to be an active *cooperation with the government*. Problems can be discussed, projects can be funded and targets can be set, which then again stimulate the participants in the field to enhance research in a specific direction.

Market formation

Similar to function 4, in function 5 the entrepreneur cannot directly influence the formation of a market either. Hekkert et al. (2007) mention indicators like protected niches or favourable tax regime. Activities which are rather be related to a government institution, than to the entrepreneur himself. Similar to function 4, again the government is the regulative entity and needs to be influenced to establish a situation, which provides the entrepreneur with the possibility to learn, improve and grow. Once more, *cooperation with the government* can influence the appearance of this system function (Leca et al., 2006). Here as well *action in context* can be used.

While in the previous function this strategy was also applied to increase understanding and acceptance in society leading to expectations, here it is especially the creation of norms, labels, and certification which are of interest (Leca et al., 2006). With a structured environment surrounding the technology, the application and usage becomes easier, because standardized products are easier and cheaper to be constructed and applied (Hitt et al., 2001). A last, entrepreneurial related strategy is the *entrance strategy*. Approaching small markets and niches provide the developers the opportunity to limit risks and increase the learning curve, before having to compete with the main players in the market. Approaching isolated markets, where energy provision is difficult, can bring benefits to the entrepreneur.

Resource mobilisation

In section 2.3.4, it was pointed out that a network can be the origin of resources, leading to research projects and knowledge production (Hitt et al., 2001). *Mobilizing allies* therefore is expected to be a positive influencing strategy to create resources in a market. A second approach to create financial support is the creation of a positive image about the technology, as well as the company and their projects. Creating a company or industry image can be achieved through publicity and *marketing* (Menon & Menon, 1997). Given popularity is not within the hands of the entrepreneur, at least not entirely, companies should focus on marketing and in the case of wind energy on green marketing (Parkash, 2002). Showing the environmental benefits, potentials and opportunities the company provides, the entrepreneur can promote their individual importance to the investors and raise resources as a way to support the company's way of thinking. Essential however is that the projected image coops with the company's activities (Menon & Menon, 1997).

Creation of legitimacy

In most literature, legitimacy is defined as the most important aspects in the implementation of innovations (Leca et al., 2006; Dorado 2005; Perkamm and Spicer, 2005). To create legitimacy, several strategies are expected to be influential. By creating *networks and mobilize allies* the company can gain weight within the field, the sector and with governmental institutions (Hitt et al., 2001). The importance of a group increases with the size of the cooperation, as it was the case with *collective action* where strength and strategically orientation are combined (Aldrich & Fiol, 1994). Furthermore legitimacy can also be created by an individual. *Using company's own assets*, like resources, capabilities or the positioning in the market, a company by itself can raise legitimacy for their ideas and innovations (Leca et al., 2006). This approach is especially useful after applying a *discursive strategy*, as it fractures the argumentative framework of current technology and underlines problems, to which the innovation provides a solution. While this strategy is used to gain support, in a later stadium it can also lead to the mobilisation of resources in the field. Undermining the current argumentative framework thus underlines the importance of the innovation for society (Leca et al., 2006). Another strategy which is mentioned in literature and also related to the creation of a network is the *integration of established players* in the process. Established players mainly intend to hinder the innovation process and prefer the current, traditional way as they pursue high interests (Utterback, 1994). Incorporating those established players implies the capability to convince them to help the implementation process, which results in competition to their original activities and can thus be considered a boost for the innovation (Leca et al., 2006). The established players are then not only used as a source of help or resources (Elmati & Kathawala, 2001), but the entrepreneur can use their, already existing legitimacy and transfer those to their own endeavour (Bergek et al., 2005). One last strategy which can be used

to create social acceptance is *action in context*. As in function four it was used to increase expectations, a step in that same direction is the creation of legitimacy. With legitimacy, society accepts the flaws of the technology easier than in the case of a hardly criticized innovation. Basically the creation of legitimacy by *action in context* is the first step to increase expectations in function 4.

Table 1: Expected correlations between system functions and applied strategies

System function	Strategy
SF1: Entrepreneurial activity	Market Entrance
SF2: Knowledge development	Mobilisation of allies R&D Activity
SF3: Knowledge diffusion	Mobilisation of allies Collective action
SF4: Guidance of the search	Action in Context Cooperation with the government
SF5: Market Formation	Action in context (Standardization) Cooperation with the government Small scale market entrance
SF6: Mobilisation of Resources	(Green) Marketing Mobilisation of allies
SF7: Creation of Legitimacy	Action in context (Social scale) Collective action Cooperation with established player Developing a discursive strategy Mobilisation of allies Using company assets

In the beginning of this chapter two limitations were formulated about the *Innovation system*. The first said, that the theory does not sufficiently recognize the influence of entrepreneurial decision making on the performance of the *IS*. In other words, the critique was that although the entrepreneur is the most interested player in a well-functioning *IS*, a link does not exist between the appearance of some system functions and entrepreneurial strategies. Therefore the first hypothesis is:

H1: *Entrepreneurial strategies have influences on the fulfilment of system functions in the IS.*

The second critique on the existing theory was based on how the entrepreneur as a group was encountered. The theory makes no difference between small and big companies or the amount of resources available. From the theory's point of view all entrepreneurs in the system pursue the same main and sub-goals, independent their situation. As it was formulated earlier, it may be true that all goals are the same; this does however not imply that the ways to reach those goals are equal as well. The second hypothesis therefore is:

H2: *A difference exists in the performance of strategies between smaller and larger companies involved in the IS.*

3. Methodology

In this chapter the applied methodological procedure will be discussed. The first section is a short introduction to the Spanish wind energy industry, the research ramification, and the selection criteria for participating companies are mentioned. The second part focuses on the way of data collection; the third section describes the operationalisation of the variables formulated in chapter two, necessary to apply the methods described in the second part and in the fourth sub-chapter introduces the method of analysis used in this research.

3.1 Case selection

In the introduction it was already mentioned that this research applies a case study of the Spanish wind energy industry. Spain was chosen, because it has one of the most productive wind energy industries worldwide. Furthermore it is constantly growing since the construction of the first wind park in 1984 (Enrich, 2009). While in 1984 there was merely one park, the total amount of produced energy increased from 723MW in 1998 up to 20.676MW in 2010, resulting in the second largest source of electricity in the country (AEE, 2011). The first wind energy target was formulated in 1999, where the target op 11.400MW wind energy was set to be achieved in 2010. The intended amount of energy within the so called PLAFER plan was however already achieved five years earlier, in 2005, motivating the government to increase their target up to 20.155MW within the same time period (Montes Martinez et al., 2007; AEE, 2010). The renewed target was also reached superseding the intended amount by approximately 500MW. Investigators' opinions differ about the reasons for the blooming industry. While most researchers agree that the favourable wind regimes in Spain caused a strong industry growth, opinions differ concerning other factors. Some researches state that the stable feed-in tariff and the continuous government policy supported the development (Bocard, 2010; Graber 2005). Others argue that the government policies are fluctuating, unclear to producers and dependent on the legislative period (Navarrete, 2010).

Although the wind energy industry of Spain started in 1984 with the construction of the first wind park, the analysis focuses on the period from 1991 to 2005. The years between 1984 and 1991 were left out, because no data was found within public sources on the one side and little chance of valid information from the companies on the other side, as too much time has passed. The end of the analysis was chosen to be 2005, as the first official target set by the government, running originally until 2010, was achieved (Graber, 2005). Those first 15 years of data are therefore considered the start-up period of the technology and the time horizon of this investigation.

During the research various companies were approached to participate in the investigation. Criteria for included companies in this research are the following ones: The companies had to be participants in the wind industry field, within the above defined start-up period. By focusing on those companies the initial strategies were identified. Companies who entered the market at a later point in time (after 2005), do not poses the information necessary to identify the linkages between strategies applied in the early beginnings of the market and *IS* development and performance. One exception was made for companies who entered the market by purchasing more than 50% of an original start-up wind energy company. Those companies were included, because the original information still exists within the firm, despite the different company management. Given the Spanish wind energy market evolved rapidly in the last decade those company take-overs appeared quite often, leading to

centralisation of knowledge within either big national companies or international ones, in the Spanish market. Excluding those companies from the investigation would limit the possible interviewees drastically.

3.2 Data collection

Before the merger of the two theories, for each individual theory data needs to be collected. With the combination of two different theories the type of data differs. As two types of data cannot be collected using the same methods two distinct ways of data collection are applied. To analyse the development of the Spanish wind energy market, based on the principle of *IS*, an Event-History-Analysis (*EHA*) was used. For the second part, the company strategies, interviews were held with various companies in the field, which existed in the start-up period of the industry.

3.2.1 Event-History-Analysis (EHA)

With the *Event-History-Analysis* the development of the market can be reconstructed, following the events appearing in the industry's history (see: Van der Ven, 1999). To apply this method, each system function, as defined in chapter 2, is operationalised into indicators, which show the function's appearance, positive as negative ones. To identify the indicators through the investigation period, articles, published within that same time period are scanned for. The appearance of an above mentioned indicator, in a public article, results in an event. Each event indicates the presence of the according system function. With all events identified during the investigation period the general line of the industry's history can be reconstructed.

The publications within the time horizon were identified using the internet newspaper database of Lexis Nexis, with the search terms 'energia eolica' and 'parque eolico', respectively 'wind energy' and 'wind park'. The results showed articles ranging from 1991 until 2005, with a strong increase of publications after 1998. Eventually 1449 newspaper articles reported about wind energy and wind energy companies in Spain. Those articles, gathered from the three most important Spanish speaking newspapers in Spain (El Pais, Cinco Dias, El Mundo) and CNN, to cover international articles concerning the Spanish market, were then investigated for the appearance of the indicators allocated to the system functions.

3.2.2 Interviews

While the *EHA* is used to gather data concerning the *IS* performance, interviews are used to collect information about the companies' strategies applied during the start-up phase of the industry. The interview phase was split in two parts. First, explanatory interviews were performed with two members of the Asosiación Empresarial Eólica (AEE), the cover organisation of wind industry companies. Within those two interviews, two intentions were pursued. First, because there is no second investigator for the *EHA*, the data gathered based itself merely on the interpretation of one investigator. The interviews were used for a verification of the general historical line reconstructed with the *EHA*. The second goal of the interviews was to create an overview of the active wind industry companies and their strategies applied during the start-up phase of the industry. The interviews were held with the technical director of the AEE, Alberto Ceña and the director of external relations, Sergio de Otto. Both provided information concerning the development of the market and -as far as they were able to- about the applied strategies. Although a data triangulation is theoretically not possible with only two sources of evidence (Yin, 2009), both interviewees provided the same general information about the industry, which leads to the assumption that the gathered information is reliable. The value of a third interview, in this difficult

circumstances were only little cooperation was experienced even from academic research facilities, could be questioned to be beneficial with respect to the already gathered results.

The second round of interviews was held with the energy companies[1]. Because of the strong movement within the wind energy market, the selection of companies did not completely correspond with the existence of the companies at the start-up period of the industry. The goal of the interviews was to identify the strategies applied by the companies and the objective of each strategy within the start-up period. In the beginning of the interview, the interviewees had the opportunity to provide a general introduction about the company's history and the applied strategies during that period. After this open section the focus shifted towards the specific strategies as they were formulated in the conceptual model. By providing the company an open section in the interview, they were given the opportunity to voice their own views. For the investigation it was the opportunity to gather information about strategies, which so far were not included in the theoretical structure and decrease the chances of missing variables in the analysis. Asking for the specific strategies in the end ensured that sufficient data was gathered to reach a conclusion.

Within the industry 48 companies were asked to participate in the investigation. The companies were identified by using the AEE database and the results of the *EHA* (if they appeared within the newspaper research). Those 48 companies were approach through mail contact, phone calls or, if possible, by personal visits. At the end of the investigation seven companies accepted to participate in the interviews. A list of the interviewed companies can be found in the Appendix.

3.3 Operationalisation

This section is split into two phases. In the first phase variables for measuring the *IS* will be operationalised. In the second phase the operationalisation will focus on the company strategies, as they were defined in chapter two.

3.3.1 Innovation System

Following section 2.1, the *IS* consist of seven system functions, which can indicate the *IS* state of the art and performance (Negro & Hekkert, 2008). The functions can however not directly be measurable in the performed *EHA*. To be able to identify the various functions within the analysis, each function gets assigned indicators. The appearance of those indicators then shows a positive or negative influence on the system's development. The operationalisation orientates itself on three scientific studies. The indicators are partially extracted from the works of Bergek et al. (2005), Hekkert et al. (2007) and Negro and Hekkert (2008). From the sum of indicators, groups were formed which correspond within the three sources and reformulated to be indicators for this research. The operationalisation process led to the indicators, allocated to each system function, as it is shown in table 2.

Although most of the indicators result from the literature mentioned above, three new indicators are used because of the specific situation of wind energy and the Spanish market in particular. The three new indicators are *international projects, neighbourhood concerns* and *stock market value*. Those indicators were integrated, because they have either a relation to the characteristics of wind energy or to the special situation of the Spanish wind energy market. Argumentations for their utilization are given beneath.

[1] List of interviewed companies and interviewee information can be found in Appendix A

Table 2: Operationalisation of *IS indicators*

System function	Indicator	Score
Entrepreneurial activity	Wind park or construction facility set up	1
	diversification of established player	
	Internationalization Project started	
	Wind park or construction facility closed	-1
	established player ends project	
	Internationalization project ended	
Knowledge development	research project started	1
	technological improvement	
	scientific study on subject	
	research project ended	-1
Knowledge diffusion	conferences, workshops	1
	Network/cooperation started	
	Network/cooperation ended	-1
Guidance of the search	positive expectations in public about wind energy or *RET* in general	1
	Formulation of national targets	
	negative expectations about wind energy or *RET* in general	-1
	National targets decreased/eliminated	
Market formation	policy measures (tax-incentives, feed-in tariffs)	1
	licences distributed within companies	
	standardization (labels, environmental standards)	
	lack of policy measure	-1
	rejection of licenses for wind parks	
Resource mobilisation	funding for projects (private)	1
	subsidies for projects (public)	
	Stock market value of a company increased	
	Stop or lack of funding (private) for projects	-1
	Stop or lack of subsidies (public) for projects	
	Stock market value of a company decreased	
Creation of legitimacy	lobby groups for wind energy production	1
	established players transfer legitimacy	
	lobby groups for competing technologies	-1
	established players distance themselves	
	Neighbourhood concerns	

International projects by Spanish companies are used as an indicator for *entrepreneurial activity*, because it can be the source of money, knowledge and economical image in the field. This indicator is however used only once in each country the company is active in. For example, after the entrance of the American market the construction or participation of the company in a different wind energy project in the US is not considered as being an *entrepreneurial activity* anymore. Entrepreneurial activity has to be seen here as an expansion of the company's portfolio, where the establishment of a project in a different country is an activity, to increase the

company's presence in the field. Each further activity in the same country would focus on the new market and trigger support in that market. Even though from new projects in different countries benefits arise for the Spanish company, further activities were not included, because first it would not necessarily expand the Spanish *IS* and second, including all foreign activities of all Spanish companies in the market would provide a wrong image of the industry, as function one would score more events due to international activities than to those performed within the country.

The usage of the indicator *'neighbourhood concerns*' is integrated in this framework, because of the specific situation of the wind energy industry with regards to horizontal pollution and noise inconvenience. A common problem in the construction of wind energy is the resistance from local interest groups, who try and hinder wind parks close to their homes (Toke et al., 2008). This phenomenon, often referred to as NIMBY (Not In My Back Yard) syndrome, may not be neglected in the analysis. As initiatives, mainly formed by locals, often led to project delay, an increase in costs or in some cases even the program termination, this special aspect of wind energy has to be accounted for. As it is part of social acceptance, in a negative sense, this indicator is allocated to the *creation of legitimacy*. A result of such negative opinion about the technology, it can become less interesting for companies to continue in that specific direction of the technology, which would lead to a negative score in function 4. The first step however is a negative effect on the legitimacy.

The third new indicator allocated to system function 6, is the '*stock market value*'. This indicator is integrated in the analysis, because various Spanish wind energy companies are stock market listed and can therefore receive financial resources, due to the current company market value. With a higher stock value, investors may increase their interest in those companies due to higher shares. Although research indicates that a change in stock market value influences investment decisions only limited, a link between those two may not be neglected (Barro, 1990; Blanchard et al., 1993). A rising stock value receives a positive score for system function 6 and respectively a decreasing market value receives a negative sore.

3.3.2 Strategy

In section 2.2.4 the strategies were presented. For each strategy examples were given of what those strategies could look like. Although those are only a few possibilities, table 3 presents those possibilities, to give a better overview of how each strategy, was identified within the interviews.

3.4 Analysis

For the analysis of this investigation several steps are required. First the results of the *EHA* are used to identify whether the Spanish wind energy system has indeed a well performing *IS*. Although this is not the main focus of this research, investigating this aspect is essential for the later usage of the data. With a well-performing *IS* the link between the two theories can be established. A well-performing *IS* indicates a high implementation speed and therefore the link between the two theories can be established as intended. After reconstructing the industries history, following the general line in the development and the scores of the *EHA*, it is investigated whether the necessary motors of innovation were present during this start-up period of the industry. The structuring into motors have, in the case of the *IS*, the purpose to identify the performance of the system, later in the analysis they will return as a chronological orientation for recommendations and strategic application.

Table 3: Operationalisation of Strategies

Strategy	Indicator
Action in context	Lobby for standards, norms and rules Establish body of literature School projects Information events on parks Public information spread
Collective action	Cooperation with a company with comparable problem
Cooperation with established user	Cooperation with a player, that is better positioned, well known or already active in the field
Cooperation with the government	Regular meetings with government officials
Discursive strategy	Pointing out weaknesses of existing system Argumentation about problems on various levels
Green marketing	Use green aspect of company or marketing techniques in general
Market entrance	Size of first parks constructed
Mobilisation of allies	Buy assets Participation of other companies beyond the field in projects
Using company assets	Existence of own or critical assets in the company Usage of company assets Usage of company name or image

The second step in the analysis is the identification of entrepreneurial strategies within the industry. From the interviews held in this investigation the results will be summarized according to the goal they were intended to achieve. The data from the interviews is organized according to the seven system functions to make the later linkage between the two theoretical strands easier and better to understand.

With the *IS* characterized and the interviews organized, according to the seven system functions, a table can be created in which the strategies are listed that correspond with each function. This table is then compared with table 1, formulated at the end of the conceptual model. Differences between the initial formulated expectations and the identified strategies at the end of the data presentation, are then discussed and interpreted. The interpretation of differences, verifications and missing relations is then the focus of the analysis in chapter 6. At the end of the analysis a final table is presented, which shows the eventual relations identified within the market. Those can, depending on the interpretation, differ from the observed results within the interviews.

4. Wind energy technology

The principle using wind to perform work is one of the oldest and most applied methods worldwide. But it was not before 1888 that wind power was actually used to produce electric energy (IEA, 2003). Although competing with the traditional means of electricity production the technology evolved in technology and application in the beginning of the 20th century. With the first oil crisis in the 70's, wind energy received the first political as well as an economic boost, as being an alternative to fossil fuels and a solution to energy dependency of industrialized countries (Ackerman & Söder, 2000). From that time on the development of the technology increased, although

slowly in the beginning, steadily over time. While the first wind mills produced only 50kW, the evolution of wind mills has brought the technology up to a 7,5 MW capacity, with a tower up to 150 meters (IEA, 2009).

Despite the long history, in the last decade various designs appeared, varying form vertical axis or two-blade turbines to multiple blade turbines and tree shaped towers, searching for the best construction method. The current industry standard is a three-blade turbine installed on a 120-150 meter high steel tower (Gardner et al., 2009). Developments at this moment focus on new materials in tower and turbine construction for higher performance against lower production costs, off-shore application, and wind prediction and adoption technology, to provide the turbine with more flexibility in regards to changing wind speeds and directions (Gardner et al., 2009).

For the industry the most important influence on the production of wind energy were favourable wind regimes. The wind regime describes the wind's characteristics in a specific area. Regions with constant, but high wind speeds and little turbulence have a better regime for the construction of wind parks, as it eases up the technological application and increases output (Ackerman & Söder, 2002). Those areas of favourable wind regimes are however limited and decreasing. Technological developments are needed to operate in regions less suitable (Del Rio & Unruh, 2007). The geographical positioning is thus important for the development of the technology, but still technological improvements are needed to coop with the various landscapes and more difficult regimes.

4.1 Technological developments

From a political point of view, researchers identify the oil crisis as the most important impact on the development of wind energy, in Spain and the rest of the world (Kaldellis & Zafirakis, 2011; Ackerman & Söder, 2002). As it was said in the short history overview above, the amount of installed capacity and the performance of the wind mills increased ever since. Besides the political development, the technological development has great influence on the technology spread as well. Alberto Ceña, technical director of the *AEE* (Asociación Empresarial Eólica) pointed out that there were three main technological developments besides political decision making. Although he mentions the favourable wind regimes as being most influential on the expansion of wind energy, to continue expanding and increase the potential of wind energy, technological improvement was and will remain necessary (Ceña, AEE).

With decreasing amounts of optimal wind regime regions left, the expansion towards secondary regimes was a necessity. Expansion was only possible because the technological evolvement. With the current standard of a horizontal turbine, the possibility to rotate the blades to achieve a 'better' balance between high performance and less deterioration of the material was a major achievement. As a result turbines can, for example still produce energy in higher wind speeds, while in the past they were taken of the grid. Furthermore more energy is gained from low speed winds and wind directions are better absorbed by the turbine, without the necessity of turning the whole turbine (IEA, 2003). A second development, which is not that much technological, but of great influence on performance and localization, is the heights of the wind mill. Energy production by a wind mill depends on three variables, the density of the air (d), the diameter of the swept area (D) and the speed of the wind (v) (Gardner et al., 2009). In a formula this is expressed as:

$$P = d \times D^2 \times v^3 \times C$$

With C as a constant, which can be neglected for this purpose. From the formula it can be seen that the performance of a turbine increases significantly with the diameter of the swept area and the wind speed. A bigger swept area can only be achieved, if the turbine is higher above the ground, due to the length of the blades. A second variable of mayor influence is the wind speed. Given the wind speed has a cubic influence on the power production a higher wind speed rapidly leads to more power. As the wind speed increases with an increasing the altitude (Ackerman & Söder, 2002), a higher wind mill operates in faster wind regimes, allowing higher power productions. Thus, although the height of the tower is not a great technological achievement, it is an improvement for more application and higher power production, due to longer blades and higher wind speeds.

A third mayor influence identified in the technological development of wind mills is the regulation of the power output. As it was seen above the power provided by wind mills differs according to the wind speed. Given wind is not constant the power production differs as well; those output fluctuations are called the *power quality* (Ackerman & Söder, 2002). To be able to handle these fluctuations in the power provision of a wind mill, different methods can be used. On the one hand solutions can be found in the grouping of wind mills before integrating the produced power in the grid, levelling the fluctuation. On the other hand controlling and regulation methods were developed to deal with that problem. In those methods the output in times of sudden voltage jumps is buffered. Besides levelling a different method, which also protects the material, is a limitation of blade movement to prevent overloads or material damage (Gardner et al., 2009).

5. Results

In the results the gathered data will be presented. This will be done in two sections, first the *IS* will be reconstructed. In the second section, the data from the interviews is structured according to the goals which were intended with each applied strategies.

5.1 Event History Analysis

5.1.1 A historical overview

In this sub-section a historical overview is presented of the development of the Spanish wind energy industry. Based on the findings from the *EHA*, the development of the industry is reconstructed. Those results are supported by interview data emerging from the AEE. The overview starts in 1984 with the first activities and ends in 2010.

1984-1997: A Slow start

The first interest in wind energy arose with the first oil crisis in the 70's (Ackermann & Söder, 2002). In the following years the Spanish government introduced an energy plan which stimulated alternative energy sources. Main beneficiaries of that plan were nuclear power and renewable sources. An opening and opportunity for a new market was identified, as more and more mini-hydraulic power stations were created throughout the country (de Otto, AEE). In the early 80's the government agreed on the first electricity law stimulating particularly renewable energy sources. With this project no distinction between the different technologies was made in terms of available subsidy. As a result, due to its relative maturity in comparison to other *RET*, the mini-hydraulic industry gained most from that law (de Otto, AEE). Nevertheless the first subsidy for *RET* was introduced in the

Spanish market. Driven by positive expectations and experiences with wind energy in California, the Spanish industry intended to pick up the US trend and started their own wind projects (Ackermann & Söder, 2000). Still, the first wind park was not to be constructed before 1984 by Energía Hidroeléctrica Navarra (EHN) in the north of Spain as an experimental and learning facility (Enrich, 2009). Even with the first experimental parks constructed early - a second one was built in 1985 on Mallorca - the industry started slowly. So far most activities were executed by the above named EHN and *Made*, a sub-division of the national energy company Endesa, who diversified their portfolio to ensure their role in the promising energy technology. With the experimental wind parks running up to their expectations and the favourable wind regimes in several regions of the Spanish Peninsula (Toke et al., 2008), expectations about the technology rose even higher. Drawn by the positive expectations in Spain, Vestas (a successful Danish wind turbine producer) intended to enter the market and approached the government in their search for a local company to cooperate with to gain more knowledge about regional characteristics and representation. The government advised a company called Gamesa, at that time a multidisciplinary company with a specialization on the construction on airplane wings, because of their experience with aerodynamics (Gamesa, 2011). The entrance of the Gamesa/Vestas cooperation in the Spanish wind energy market marks the first key event in the industry, as the later development showed. After their entrance, the first commercial wind parks were constructed between 1994 and 1995, to which Gamesa provided the necessary wind turbines (de Otto, AEE). Alongside the first wind projects, the amount of research projects remained high, especially testing material in up to that point difficult wind regimes to enhance the learning curve and increase knowledge about turbine aerodynamics were the main focus (Gamesa, 2011). Main driver here was again Gamesa, who proved to be a flexible company willing to take risk, in comparison to the only turbine competitor at that time *Made*, who was still linked and financed by Endesa. In the following years, the industry grew continuously, and the amount of research projects remained stable in the first couple of years (between 1 and 3 research projects each year in the period of 1991-1994; see figure 4). The effect of this high activity in R&D was reported in the article of del Rio and Unruh (2007), who identified that the technological development in the 90's led to a price decrease of 50% in comparison to the first projects. The positive results of those projects and the enormous price decrease of the industry further increased expectations and attracted the attention of the Spanish government, who state the first national wind energy objective in 1996, to produce 12% of all energy due to wind until 2010 (Ruiz & Bustos, 1996). The end of this long but successful start-up period was marked in 1997, when the government announced the second electricity law called PLAFER, including a 12% objective formulated in 1996, focusing especially on emerging renewable technologies (Graber, 2005; de Otto, AEE).

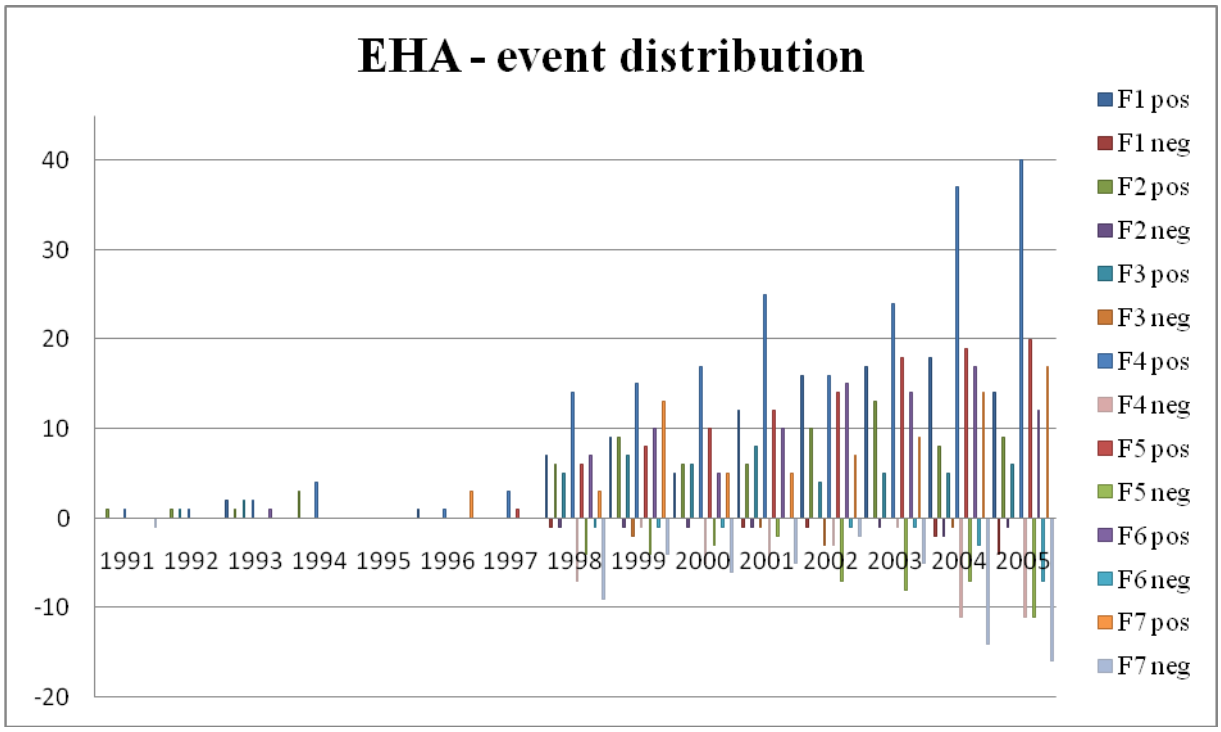

Figure 4: Event distribution on Spanish wind energy industry

1997-2003: Discovering the potential

With the introduction of the second electricity law in 1997, the government set a straight course for the support and development of wind energy in Spain. In 1999 the law was translated into the first national target for wind energy (Graber, 2005). The target was set to produce 11.400MW in 2010, which was ambitious given at that time 95 % of the renewable energy was produced by water and biomass, while wind delivered only 723 MW to the electricity mix (Martinez Montes et al., 2007; AEE, 2011). PLAFER increased entrepreneurial activities strongly, which rose immediately after the introduction, with an production increase of 100% in 1998 and 90% in 1999 (AEE, 2008). The plan included two key features in the development of the Spanish wind market. First, it obliged the Spanish electricity grid company to buy all produced wind energy at any time of the day against a fixed price set by the government (F.S., 1998; M.M., 1998), to ensure investment security for wind park developers. Secondly, decisions about the allocation and localization of wind parks were taken by the corresponding regional and local authorities (de Otto, AEE). As a result, provinces set their own energy targets and subsidy systems (El Pais, 18th November, 2001), which created a competition between the various autonomous regions to be market leader for wind energy, leading to the allocation of extra resources from local government (Fernandez, 1998; Cinco Dias, 12th November, 1998; Cenzano Logrono, 2001). Government investments into specific projects lasted until 2001, after which subsidies were limited to a fixed government dependent feed-in tariff. Despite the end of the subsidy, the gap for wind projects was immediately filled by private companies, who identified the market opportunities, due to the stable pay-back conditions (Cinco Dias, 16th June 2001, de Otto, AEE). Private investors increased the possibility of smaller and medium sized companies to enter the market, which again led to high entrepreneurial activities in the system (Cinco Dias, 23rd April 2002; see figure 4). This cycle increased itself within the first couple of years, with strong lobby activities

from out of the industry after 1999, which mainly focused on increasing creditability of the technology in the market (Molla, 1999; Cinco Dias, 20th June, 2000). Although social acceptance of the technology was and still is high within Spain (Miera et al., 2008), companies focus on society to further increase popularity. A boost to that development was the entrance of Iberdrola to the market around 2000 (de Otto, AEE). The entrance of Spain's biggest energy producer transferred legitimacy to the new technology, indicating its capabilities and opportunities for the future. After the entrance of Iberdrola, today the biggest wind energy producer worldwide (AEE, 2011), more established energy companies, like Acciona or GasNatural Fenosa, followed the example and entered the field in the following years (de Otto, AEE).

2003-2010: The economy is the limit

After the entrance of first Iberdrola and later other big energy companies, the interest from the financial sector increased even more. Although public subsidies were nearly shut down all over Spain, the existing policy measures and especially the beneficial feed-in tariff system kept investors interested in the market (Cinco Dias, 29th September 2005). The success of those investments for the wind energy companies, as well as investors, increased the positive opinion about the technology and future application (Catalan Deus, 2004). Starting in 2004, companies expanded their orientation towards the growing markets of China and the US (Muez, 2004), which led on the one hand to higher companies' stock market share values (Cinco Dias, 22nd November 2004), but on the other hand to critique on the policy of the wind energy companies to invest their, in Spain earned money, in foreign projects (Delgado, 2005). As well as the critique on the practice of the companies, the amount of resistance from locals and nature groups grew strong between 2003 and 2005 (Uriona, 13th October 2005). The problem of decreasing suitable building sites, as a result of the still strong entrepreneurial activities in the field, especially after 2002, increased the frictions between companies and local population. A new and welcome development was the possibility of off-shore installations around the southern and western part of the Peninsula, where first investigation started in 2002, with the first prototype projects built in 2003 and 2005 (Catalan Deus, 5th June 2003). Besides these new off-shore opportunities, the industry continued to increase the products quality to enable the application in even more difficult wind regimes (Catalan Deus, 17th September 2003; Cinco Dias, 14th November 2005). The leading companies in the technical development of the turbines remained Gamesa and M.Torres, which focused on the improvement of materials for turbine and tower construction (Catalan Deus, 17th September 2003). The off-shore opportunities were identified by the government, leading to national building sites proposals for off-shore parks (Espinosa, 2005). Especially the provinces of Andalucía, Galicia and Valencia welcomed the new development, as wind regimes on the sea may even be more suitable than in mountain regions (Uriona, 16th March 2005). Due to the higher share of wind energy in the Spanish electricity mix, the market faced a new, but well known problem. As wind is not a constant source of energy and the growing importance of wind in the Spanish electricity mixture, fluctuations became a big problem, leading to strong incentives for the construction of new nuclear facilities to balance those fluctuations (Fernandez, 2005; Ezquerra, 2005). In 2004, the government, supported by lobby institutions for wind and renewable energy, responded to that problem, by introducing the law 436, obliging regions to install control stations between all wind parks of the region and the electricity grid, to make sure fluctuations are kept to a minimum (de Otto, AEE). This law was, in the opinion of the AEE, another key event in the development of the industry, as it made investments in the grid more useful and purposeful, although it was not the solution to the problem. Even today fluctuations remain a serious problem in the market. Nevertheless, with a better organized energy implementation system, constant and high

investments, due to the stable policy politics of the Spanish government (Ceña, AEE), the industry kept growing fast. The development reached its first peak in the fulfilment of the in 1999 national wind energy target of 11.400 MW, five years before the official deadline. This highly positive development only increased opinions, expectations and legitimacy about the industry, motivating the government to nearly double the target up to 20.155 MW within the same time period (Graber, 2005).

The first few years after 2005, the development continued as it has been between 2000 and 2005. The strong development showed itself in 2007, when the installed capacity of the industry grew in one year with 30% (AEE, 2010). The biggest problem arose in 2008, with the appearance of the financial crisis, when it became difficult to find investors for the first time in the industry's history (Gamesa, 2011; de Otto, AEE). From the AEE as well as several companies in the field, a strong decrease of investors was indicated after 2008 (Magtel, 2011, de Otto, AEE). Although the market is recovering, the growth rate cannot be compared to those achieved in the beginning of the 21st century (AEE, 2010). Nevertheless, the increased target of 20.155 MW wind power by 2010 was achieved as well. The installed capacity of Spanish wind energy in 2010 was 20.676MW, delivering at technological peak hours, up to 54% of the Spanish electricity usage (AEE, 2010) and an average of 16.4% throughout 2010 (AEE, 2011), fulfilling the 12% goal which was formulated in 1996. In the last decade the industry grew with over 10% annually and the financial crisis in 2008 was a mayor hinder for the strong growing industry (AEE, 2011). Nevertheless the industry continues to expand, with new opportunities in off-shore parks and renovation of existing parks, the capacity of wind energy production in Spain has not reached its limits yet.

5.1.2 A functioning Innovation system

1991-1997: Science and Technology Push

Although the wind energy history started in 1984, the first eight years of valid data (1991-1997), available for the *EHA* show the characteristics of the *Science and Technology Push motor* (Suurs & Hekkert, 2009). This motor describes a dominant presence of *Guidance of the search* (F4), *Knowledge development* (F2), *Knowledge diffusion* (F3) and *Mobilisation of resources* (F6). In figure five, where all results from those years are combined to fit in one table, the dominance of F4 is most visible. With a total amount of 12 events, of which most are positive reactions to pilot projects or statements about the technology's opportunities in the future, *Guidance of the search* is the main driver behind the industry development. Although the high presence of F4 and the combination of *Knowledge development* with *Knowledge diffusion* (F2/F3), as being the second largest functions in that time period, confirm the science and technology push motor. In comparison to the definition in section 2.1.2 however, *Mobilisation of resources* (F6) is missing. This function is seen as an essential aspect of the *STP* motor, as it is the source of resources for research and development. In the history review a first reason for this gap was already

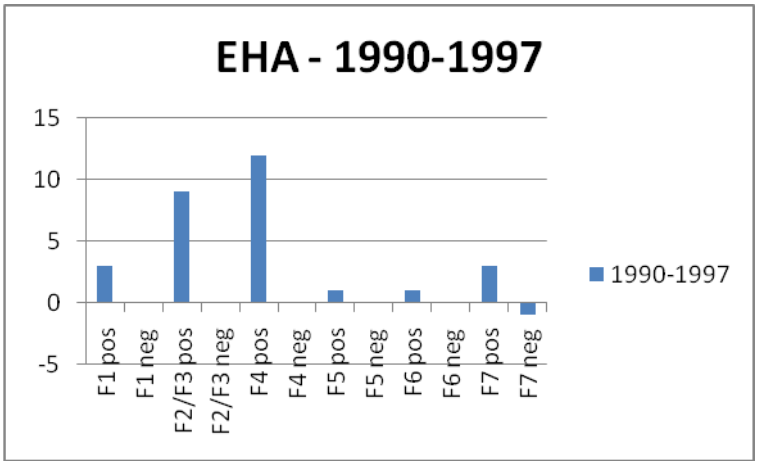

Figure 5: Event distribution 1991-1997

given. In the beginning *Made* was one of the major companies in the Spanish wind energy industry. As being part of Endesa, one of the biggest energy companies in Spain, the necessity to mobilize resources outside the own company was limited (Endesa, 2011). Farizo and Hanley (2004) verify this impression as they state that in first period of the market, the main investments came from electricity utilities, regional energy agencies or turbine manufacturers. Those investments were only possible in the case that the investor was an established company, either within the energy industry or diversified from a different industry. In the second case the company would be a new entrant to the energy market, but because of the history in a different market, they do not have the necessity to mobilize resources as much as new entrants without own assets. Besides the investments from regional agencies and electricity utilities, the small subsidy provided by the government, established in the first electricity law in 1980 mark the only investments from the outside. Private investments were not performed in the beginning of the industry and the companies had to rely on the public funding or own resources (de Otto, AEE).

1998-2003: Entrepreneurial Motor

In the motors of innovation, the second stage is also described as the *Entrepreneurial Motor*, where in comparison to the *Science and Technology Push Motor*, especially function 1 (*Entrepreneurial Activity*) and function 7 (*Creation of legitimacy*) increase. As it was seen above, the positive expectations surrounding the technology increased the amount of new projects. While in 1997 not even one new park was constructed, in 1998, news was published mentioning seven new projects and in 1999 even nine projects were started. A reason for the strong increase in entrepreneurial activities can be found in the increasing interest of medium sized energy companies. In 2001 another strong increase in entrepreneurial activity was identified, partially as a result of the entrance of Iberdrola, motivating outsiders to enter the market as well. In the following years the big companies (especially Gamesa and Iberdrola) also started their internationalization activities, driving the score even higher. For the second characteristic for the *Entrepreneurial motor*, the increase in creation of legitimacy, the first events started in 1998, where however the negative score has much higher, because of a high amount of lobby from nuclear and traditional industry. The first real increase in positive legitimacy for wind energy appeared in 1999, when a negative lobby was created about existing technologies for the first time and on the other hand, the two biggest energy companies (Iberdrola and Endesa) publicly announced their positive opinion concerning wind energy. Another detail about that period is the increase of resource mobilisation and the active participation of the private sector in the wind energy market. While in the first years of the industry, there was merely any investment from outside the companies, in 1998 the investments rose and kept rising throughout the years. The strong increase of investments was on the one hand a result of local subsidies and on the other hand the increased interest of the private sector in the industry. With the establishment of the second electricity act in 1997 a fixed feed-in tariff was established, ensuring high and stable revenues for investments in the industry (de Otto, AEE).

2003-2010: System building Motor

After 2003 the data is not that conclusive anymore. System function give (market formation) increased constantly during the previous years. Figure 4 shows that between 1998 and 2002 the amount of events for function five increased by two events annually, leading to eventually 14 events in 2002. In 2003 18 events were identified, which kept growing evenly up to 20 events in 2005, making distinguishing between motors difficult.

Besides, all other functions in the system remain rather stable. Especially within the functions *mobilisation of resources, entrepreneurial activities* and *knowledge development* as well as *knowledge diffusion*, fluctuations were minimal. In 2004 however F4 (*guidance of the search*) increased strongly. Most events concern construction or investment plans of energy companies as well as investors, concerning the future of wind energy in Spain, which increased expectations about the technology's importance for the electricity market. An increase can also be identified within F7 (*creation of legitimacy*), where the focus shifted on lobby for the creation of off-shore parks and acceptance in society. Although Miera et al. (2008) pointed out that there was little resistance and high social acceptance for wind energy after 2003, the amount of neighbourhood concerns, as it was defined an indicator for F7, increased. Alongside the *neighbourhood concerns* more lobby by pro-nuclear energy actors was identified, as well as more lobby by ecologist groups, concerned about the impact of wind parks on the regional eco-system. Clearly in the last three years of the analysis, discussion about the technology, building sites and the park sizes increased strongly. The aspect which should distinguish the system *building motor* from the *entrepreneurial motor* is the appearance of system function five (*market formation*). As this function rose constantly during the last years of the analysis, it is difficult to pinpoint the transition of the second into the third system motor.

Summing up what has been written at the end of each period, the first two motors of innovation, the *Science and Technology Push motor* and the *Entrepreneurial motor* were identified in the Spanish wind energy market. The presence of those motors of innovation indicates that in the start-up period of the industry a well-functioning *IS* was present. Although after 2003 the data was not conclusive anymore, the high growth rate, up to 2008 indicates that the *IS* did continue to perform well. Concluding it can be said, that the statement of Negro and Hekkert (2008), that a well diffused and developed technology requires a function *IS*, in this case proves to be true, as the well establishment of wind energy in the Spanish energy market was a result of a well performing *IS*.

5.2 Interviews

Two interviews were held in the cover organisation AEE and seven interviews were performed in the Spanish wind energy industry. From the explanatory interviews within the AEE primary results were identified, which were used as first orientation in the market of wind energy. Later in the analysis those interviews were, if necessary, applied as confirmation for the identified company strategies. Within the company[2] interviews some of the strategies, as they were defined in section 2.2.4, were identified as well as new strategies in this context. In this section the results of those interviews will be presented. This section will be organized according to the seven system function of the *IS*. For each system function the company activities are presented, if the company´s goal corresponds to the system functions characteristics.

5.2.1 Strategies for Entrepreneurial Activity

As entrepreneurial activity is the key driver behind a well-established *IS* (Hekkert et al., 2007), it was also the key objective of the Spanish wind energy companies. The construction of parks throughout Spain and the increase of installed capacity for each company was the main objective of all interviewed companies. Bigger companies had few difficulties in their construction and growth process, as they grew fast since the beginning of the start-up phase. A representative of company 4 mentioned that the availability of own assets and in addition

[2] Companies are codified from 1 to 7. A list with company characteristics for better orientation are found in Appendix B

with external financing grasping construction opportunities became quite easy. As they grew larger, around 2000 the first companies also looked beyond the Spanish market for new opportunities, which led to a high *internationalization* policy of companies, which later became a real strategy (Companies 6 & 1). Bigger companies used this internationalization focus as a strategy to receive more support and compete on a global market as they perceived the Spanish market not big enough for their ambition (Company 6, Interview). While the big companies focused on the markets beyond the domestic one, three of the smaller companies applied a different approach (Company 3, 5 & 7). While they did not possess the necessary resources themselves, nor were they able to mobilize resources as easy as the bigger ones, company 3 mentioned that they grouped up and constructed wind parks as a collective of companies (Cinco Dias, 10th January 2002). According to company 5, in the beginning those *collective actions* included not only wind operators, but also investors, who supported local companies, and later external companies from different, not related fields (Cinco Dias, 11th February 2002). Acting as a collective they were able to bundle their resources, share the risk and be able to play a part in the wind energy market.

To pursue the construction of wind parks, two major differences were identified. While the bigger companies applied an *internationalization* strategy to spread beyond the Spanish market, the smaller companies applied *collective action* to be able to penetrate the market. As a result the sizes of wind parks mainly depended on the available resources. This led to a situation in which small and medium sized companies focused on smaller projects, while large companies directly constructed wind parks, operating at the maximum of the allowed capacity (50MW).

5.2.2 Strategies for Knowledge development

For an emerging technology the development of knowledge and improvement of existing techniques is a key element (Hekkert et al., 2007). In the history section (5.1.1), it was mentioned that in the Spanish market the costs of projects decreased 50% in the 1990's only (del Rio & Unruh, 2007). To achieve such a cost decrease, a high amount of R&D activities would be expected. However within the interviewed company, only the technological developer company 6 did apply direct *R&D activities*, meaning research and pilot projects to gather and develop more knowledge. These projects especially focused on application of wind turbines in single projects or small wind parks, in regions, which until that point were argued to be too complex and risky for wind turbines. Although the wind turbines had indeed a rather short life-cycle, the information gathered was valued highly important for the further development of the wind industry (Company 6, Interview). The marketing director of company 6 mentioned that R&D activities were the key driver for their competitive advantage in the world market of wind turbine producers. Their focus on risky and customer oriented projects helped by developing specific technology for lower production costs. While this company was a very active player in the turbine knowledge development, the other companies did either do nothing at all or participated in the development process in form of financial support. But none of the other six companies applied any R&D activities, although all companies indicated the development of turbine technology as being helpful and very welcome in the construction process. Within the three smaller companies who did apply financial support for knowledge development, company 2 focused on public research institutions and companies 3 and 1 financed private turbine developer.

Nevertheless, the development of knowledge in the Spanish wind energy industry was highly influenced by the few turbine producing companies existing. For those companies the challenge of having the best technology was the main driver. Public research facilities played only a minor role in this process (de Otto, AEE).

5.2.3 Strategies for *Knowledge diffusion*

The diffusion and spread of knowledge is, next to knowledge development, essential for an emerging technology (Carlsson & Stankiewicz, 1991). To achieve diffusion it was said that the willingness to spread this information is a key condition. In the Spanish industry such willingness was merely identified (de Otto, AEE). The only ways in which knowledge was diffused from the point of view of the large players, was though *company take-overs*. By purchasing smaller companies, large national and international players tried to incorporate knowledge about specialized products and tacit skills as well as knowledge about local conditions into the company (companies 1, 2 & 5). From the point of view of the small companies, a different strategy was applied. Company 7 mentioned that they intended the *corporation with those large, established players*, hoping for knowledge spill-over. Corporation was especially looked for with companies which were better positioned in the market and operated on a national scale. One of the big players, company 4, indicated as well that these options of small companies were useful and therefore welcomed cooperation between large and small companies. They saw the opportunity for specialized geographical knowledge and the access to a local representative as an opportunity for which they were willing to share technological knowledge.

As verification, the AEE also indicated that cooperation between large players merely appeared in the market. Cooperation between large and small companies was, although not a usual activity, applied within the start-up period. The best example of knowledge diffusion between a large company and a new comer, leading to knowledge diffusion, was the cooperation between Vestas and Gamesa. As initially Gamesa had nothing to do with wind turbines, due to the cooperation they gained a high amount of knowledge about wind energy, leading them to be one of the biggest players in wind turbine technology worldwide.

To achieve the diffusion of knowledge, two strategies were identified. On the one hand, mainly applied by larger companies was the *take-over* of smaller companies. While it was also used to enter the market, the incorporation of knowledge was a welcome and sometime intended side effect. The second strategy, applied especially by smaller companies, was the *cooperation with established and better positioned players* in the market. While small companies hoped for knowledge spill-over, the large companies were willing to cooperate to gain local and specialized information about geographical characteristics and project representation in local communities.

5.2.4 Strategies for Guidance of the search

For this function, the companies in this investigation applied various strategies. To receive more attention from the government, four companies looked for *cooperation with the government* (companies 4, 5, 6 & 7). As the companies saw their chances higher by cooperating on a local and regional scale, cooperation on national level was left to the AEE. This division of government approaches were appreciated by all companies, which did maintain contacts with regional governments, as it enabled them to focus on company benefits only (company 5, Interview). Another goal pursued with such cooperation was to receive the government's support for the local community, as they promised themselves that a supporting regional government would lead to a supporting population (company 4, Interview). While the cooperation was one option, another applied strategies focused more on the creation of a positive opinions surrounding the technology. The bigger companies, like company 4,

indicated that the *development of regional investment and construction plans* helped also with increasing positive statements over the technology in regional and national newspapers. They promised regions a stable investment plan over the coming years, ensuring the region of economic benefits on the long-term. Furthermore, to create more positive thinking about wind energy within the population, three companies *created a context* surrounding the technology focusing on the theoretical benefits of the technology. This strategy took place in platforms about wind energy technology in general, the introduction and explanation of the working mechanisms of a wind park, and potential environmental benefits, for climate and region (companies 2, 4 & 5).

As a result three strategies were identified with the purpose to shift research endeavours into the direction of wind energy. First the *cooperation with the government* was looked for, where the focus was on the regional and local levels. Second, companies *developed regional investment and construction plans* to increase interests in the region, due to an ensured investment scheme. Finally, with *putting the technology into a context* the companies underlined the benefits and increased positive statements about the technology.

5.2.5 Strategies for Market formation

To stimulate markets, five companies looked for the *cooperation with the government,* once more on a local level. The range of intended goals however differed between the companies. Besides receiving certification for new projects, a spokesman of company 4 said that they used this cooperation in combination with a regional investment plan to create interests for application in regions, which so far were not approached with the application of wind energy. Company 6 looked for that cooperation for research projects, as they combined governmental cooperation with another strategy of producing *specific technological improvements* for complex regional wind regimes. A spokesman of that same company said that they developed specialized knowledge to create new markets, a necessity for certain regional characteristics. The last activity was however limited to the turbine producing company, as it was already the case with R&D activities (Ceña, AEE). The capacity of the industry as a whole, to expand their activities and construct wind turbines in difficult regime regions were of high value for the Spanish market, as some parts of the landscape are not as easily entered as in Denmark or the Netherlands (Toke et al., 2008). To further stimulate the market, companies *invested in green electricity demanding technologies* like the electric car or hydrogen storage research to ensure a stable demand in the future. An investment in hydrogen storage as a way to store overproduction during the night was mentioned by company 5, as well as company 1 to be a solution for the overproduction of wind electricity in night hours. The companies' goal was to ensure a stable market, which expands further than purely home usage of green energy.

Three strategies were thus mentioned by the companies to be performed with the purpose to create markets. To expand construction sites and possibilities for application, the companies encountered the local and regional government with periodic meetings. To increase opportunities companies invested in the specialization of technology for entering more complex production regions. Finally, to ensure future demand for green electricity, companies invested in projects like the e-car and hydrogen storage.

5.2.6 Strategies for mobilisation of resources

The mobilisation of resources was of great importance for all companies involved in the Spanish wind energy market in their start-up period. All companies were forced to identify and mobilize financial resources to support their activities. The only strategy, which was applied throughout all company sizes within the industry, was the *mobilisation of allies*. Companies from the outside, like banks or investment firms, who were interested in wind

energy were looked for. Allies were approached on a project basis (Ceña, AEE), allowing the companies to remain the central player in their activities and to remain flexible for each project without the dependency on one specific financial institutions. Company 4 and 1 attracted investors with investment plans for regions and showing the financial benefit resulting from such investments. Besides the simple investment-pay-out model, against a certain % of revenue, company 5 offered the investors participation in the wind park and therefore image increase. In some cases, especially in the later start-up phase, it was indicated that no activity was performed to mobilize resources, as investment companies were that eager to enter the market that they came looking for investment opportunities themselves (Cinco Dias, 16th June 2001; company 1, Interview).

As indicated by the companies, the AEE confirmed that the financial support for projects was high until 2008 (Ceña, AEE). Companies were willing to invest and looked for opportunities to enter the market and to pick their share of the favourable policy regime, making mobilisation endeavours from the companies less needed in this process.

The only way companies actively looked for support in terms of resources, was by the *mobilisation of allies*. Fixed revenues, participation or long-term interest rates on a project basis were the key elements of that strategy.

5.2.7 Strategies for Creation of legitimacy

The creation of legitimacy for the technology was for most companies the main objective. As a result the amount of strategies applied in this context is diverse and company depending. In total five different approaches were found, on how the companies created legitimacy and especially social acceptance. A difference in approaches due to company size was only identified in one strategy. As it was introduced in section 2.2.4, *using company assets* is only possible if the company possesses these assets. Smaller companies are therefore unable to apply these. The three companies, who did possess those assets, applied these. The main assets were the companies' names and image, as they were all either established players in the national or the international market (companies 1, 4 & 5). The goal was to convince the local inhabitants that, because they were successful in other regions, would be well qualified to use the technology and construct wind parks in their specific region as well. Two other companies who did not possess a well-established name yet, used *green marketing* to reflect the technology´s image upon the company (companies 2 & 7). They identified themselves with being a green technology oriented company, with purely renewable energy technologies in their portfolio, as they applied advertising with a 'green' focus in the regions of production and construction. A third strategy applied by three companies was the earlier mentioned *action in context* approach, in which environmental and social benefits are put into a context, understandable for all local population. According to spokesmen of companies 4 and 5, approaches were discussion platforms, information days and the inviting of all inflicted persons within the construction radius. With platforms the companies tried to become familiar to the local population and provide a human face to the anonymous company. For that purpose those platforms were only applied in the region of activity rather on a national scale. A different strategy which comes close, but goes a step further towards the local population was the *involvement of users* in the planning process. Company 2 assumed that with the involvement of the user, in this case the inflicted population, resistance to parks would decrease, as they had a voice in the planning and allocation process. The main aspect in this cooperation was an agreement about building sites for wind parks (companies 1 & 5). For this purpose companies approached especially those locations, where resistance to the project's execution was high. The last strategy found, to legitimate the

technology and gain societal support, was the *presentation of regional benefits*. Main focus of those benefits was the establishment of jobs. Companies lobbied with the offer that with the construction of each wind park a certain amount of jobs will be created, helping the local society. Spokesmen of different companies mentioned that those offers varied between promises on a certain amount of jobs for each wind park, as with each wind park a service facility was constructed, or local economic benefits like for example dinning coupons and ensured restaurant visits.

Even with an already high support from society, companies continued to lobby for the technology, their companies and their activities. The AEE indicated that those activities on a national scale were not necessary, as social acceptance for the technology was high (Ceña, AEE). A local opinion was however not provided by the AEE, as they purely focused on the national scale of wind energy implementations.

To create legitimacy the companies applied the five strategies mentioned above: *Using company assets*, *Green marketing*, *action in context*, *user involvement* and *one hand helps the other* with the establishment of labour.

5.2.8 New strategies

During the investigation five new strategic approaches were identified in the industry. As some show an alternation of an already introduced strategy, the differences to the existing and the new strategies will be summarized and elaborated upon briefly.

Internationalization

The first strategy which was encountered was that of *internationalization*. Although it is not a strategy which directly increases the amount of application in the home market, the company's main goal was to spread beyond the countries boundaries and become a major player in the global wind energy market (company 6, Interview). The internationalization of the company can result in a higher company value (Agmon & Lessard, 1981). Announcing orientation abroad implies expansion of the company and therefore the opportunity to benefit and grow from new international markets. This strategy can be seen as a totally new direction, but also a specific form of the mobilisation of allies, as it is a strategy which makes investments more interesting for external companies. Therefore it can be applied as a way in which allies are mobilised, this would however not correspond with the goal of expansion towards a global market. Therefore this strategy of internationalization is considered a new strategy in this concept.

Company take-over

In the results the second new strategy is company *take-over*. Besides being a mean of acquiring knowledge (Teece, 1986), take-overs can also be used to enter a specific market or industry. In the Spanish case, take-overs occurred in high amounts after the self-sustaining capabilities of the market in the beginning of the 21st century. Companies operating in the market since several years were bought by national or international companies, to respectively expand their market share or to pick a piece of the pie (company 3 & 5). In both ways, whether as a mean to enter a market or acquire knowledge, company take-over can be useful in increasing the company's competitive advantage on national and international scale.

Investment plans and regional benefits

Encountered third in the results is the *development of regional investment and construction plans*. This strategy may appear new on first sight, but it is the practical application of action in context. As the original strategy, action in context, focus on theoretical benefits of the technology for the environment and society, the practical application is found in *investments plans and regional benefits*. In the first, the company shows what could be the result of an application, while the second presents real plans, including numbers and specific benefits for the inflicted region. Either with the development of investment plans or with the creation of jobs, due to service or construction facilities, the companies indicated that the promises and eventually creation of jobs in the regions ensured social support and spread the word throughout the country, increasing the company's image, trustworthiness, and the technology´s legitimacy.

Table 4: Identified relations between system functions and applied strategies in differences to table 1[3]

System function	Strategy
SF1: Entrepreneurial activity	Market Entrance Collective action Internationalization
SF2: Knowledge development	Mobilisation of allies R&D Activity
SF3: Knowledge diffusion	Mobilisation of allies Collective action Company take-over Cooperation with established player
SF4: Guidance of the search	Action in Context Cooperation with the government on local level Investment plans and regional benefits
SF5: Market Formation	Action in context (Standardization) Cooperation with the government on local level Investment in demand increasing projects Small scale projects due to technology specialization
SF6: Mobilisation of Resources	(Green) Marketing Mobilisation of allies
SF7: Creation of Legitimacy	Action in context (social scale) Collective action Cooperation with established player Developing a discursive strategy Green Marketing Investment plans and regional benefits Mobilisation of allies User-involvement Using company assets

[3] Strategies written in red are not identified in reality, green strategies are new relations identified and black colour strategies are expectations which were also identified within this research.

Small scale projects due to technology specialization

The fourth strategy encountered which so far was not described in such detail is the *specialization of the technology* for small scale application. This strategy can be linked to two earlier mentioned strategies, *R&D activity* and *Market entrance*. Some regions of the Spanish landscape demand a high amount of specialized technological improvements, due to specific terrain and wind characteristics (Ceña, AEE). As specialization towards specific wind regimes is only possible if the technology is sufficiently developed for the new regions, the linkage with R&D activities is obvious. While this is true for technological improvements, the development of specialized equipment for difficult terrain is not sufficient. The willingness for a small scale market entrance and application of this technology in those difficult regions is a strategic choice, linked to the strategy of market entrance. So *specialization for small scale projects* is a result and detailed application of two earlier defined strategies. Nevertheless this specific application brings benefits, in the form of higher capacity, knowledge production and market expansion.

User-involvement

The last strategy which was not encountered before, also a specialisation of action in context is *user-involvement*. The involvement of user, or in this case the inflicted population, is a detailed method to apply action in context. Although most user involvement focused on an agreement about building sites for wind parks, the used platforms in the strategy can also be used as a working group, in which construction and application problems are discussed. This goes further than merely information provision, as here an active cooperation between company and population is looked for. If users feel involved in a process they accept the changes faster, because they have a voice in the process (Lundvall, 1985; Toke et al., 2008). This strategy can therefore be very useful in the case of wind park construction.

In the above sections it was established that the *IS* of wind energy in Spain did perform well, at least in the first two motors of innovation. Whether this trend continued can only be speculated, based on the further well-performing of the system in the Spanish market. Furthermore it was identified in the second section that the applied companies' strategies did have an influence on the fulfilment of the system function (hypothesis 1). Concerning hypothesis 2 one can identify that there were indeed differences between small and bigger companies with respect to the applied strategies. In five cases a difference was identified. While the bigger companies used *action in context, using company´s assets*, and *internationalization*, more often in the start-up period, the smaller companies applied more *collective action* and *mobilization of allies*. For the last strategy a difference need to be made between early and late application of the strategy. While in the beginning all companies depended on the mobilization of allies, the bigger companies achieved self-financing earlier, making only smaller companies dependent on external financing. Based on the difference within those five strategies, hypothesis 2 can be verified, assuming different strategies are applied between small and big companies.

6. Analysis

In the previous chapter the results of the two-folded investigation were presented, with in the first sub-chapter a reconstruction of the *IS* and in the second, the identified strategies allocated to the corresponding system

function. Based on that allocation, table 4 was create, which is in form and content similar to table 1 at the end of the conceptual model, representing the expected influences of strategies on each system function in the *IS*.

From the results of the *EHA*, it can be identified that the *IS* of Spain did indeed perform well. This conclusion can be reached due to the presence of the motors of innovation defined by Suurs and Hekkert (2007). Especially the first two motors of innovation were visible in the *EHA*. Although the last two motors were not identified in the available data, the development of the industry between 2003 up to 2005 indicated the rise of a system building motor even without verification in the *EHA*. The strong industry growth up to 2010 let assume a further positive development in that direction.

The data from the interviews brought some new strategies to the light. It was seen that for the applied strategies three options were possible. First, strategies were identified in the way they were expected to be performed, second, expectations were formulated which were not identified in the results and third, influences occurred which were not expected, because the link was new or the applied strategies were unknown in the beginning of this investigation. In the following the differences between table 1 and table 4 are discussed. The analysis of the results is structured according to the type of company that is applying the strategy. For this purpose a difference is made between small and large companies. Another sub-chapter is included, dealing with those strategies applied by both types of companies. Within each sub-chapter, the according strategies are elaborated, whether reality corresponds with expectations and if the intentions of the companies with the applied strategy are in line with the functionality of the *IS*.

6.1 Small companies

In this research two strategies were identified that were applied especially by small companies in the start-up phase of the industry. Those three strategies were *collective action* and *cooperation with an established player*.

6.1.1 Collective action

In table 1 this strategy was expected to be applied with two purposes; first, to diffuse knowledge (F3) and second, to increase legitimacy (F7). Both expectations proved to be not existent within the Spanish case. In spite of the absence of the strategy for those purposes, it was applied to achieve entrepreneurial activity. As for small companies the availability of own resources is limited and the mobilisation of resources from the outside is more difficult than for large companies, a solution was found in the cooperation of small companies with similar problems which pursue the same goal. The need to work together to construct wind farms, was especially important in the beginning of the industry. At a later point in time, more and more companies found independent financial support and worked more on their own (company 5, Interview). One of such projects was a cooperation of 16 local companies working together to construct one wind park in their region. The magnitude of this strategy showed itself in 2004 (Cinco Dias, 10th January 2002), when it was stated in the newspapers that 50% of the market was dominated by small companies who entered the market due to collective projects (El Pais, 18th July 2004). The intended goal of creating wind parks through collective action therefore showed its influence on the fulfilment of function one of the *IS*, and is therefore considered influential.

6.1.2 Cooperation with an established player

The expected relation between the *creation of legitimacy* and the *cooperation with established players* could not be proven. Although the entrance of established players in the field had a great influence on the development of

the technology's legitimacy, influences on the creation of legitimacy by cooperation between small and large companies was not identified.

Although expectations were different the *cooperation with an established player* was applied within the industry. As smaller companies are not able to develop specific knowledge themselves, due to limited resources or skills, they looked for such cooperation with established players, as a mean to learn (company 7, Interview). The frequency of such cooperation, leading to success, was however impossible to identify and the data indicates that such cooperation was quite few. Nevertheless, a cooperation between small and large players bared benefits for both sites as it was seen in chapter 5 and thought the example of the Vestas/Gamesa cooperation. Small companies were able to grasp knowledge which was outside their own opportunities and large companies were able to use local companies for geographical knowledge and as a representative towards the local population. An influence of such *cooperation with an established player* and the diffusion of knowledge can thus assumed to be true on function 3 (*Knowledge diffusion*). Elamti and Kathawala (2001) support that conclusion as they mention in their article that the cooperation with an established player can be the source of knowledge and an insurance of competitive advantage.

6.2 Large companies

Three strategies were identified to be applied by especially large companies. Those three strategies are *company take-over, internationalisation* and *using company assets.*

6.2.1 Company take-over

As this strategy is new in this research, meaning not integrated in the initial conceptual model, no expectations were formulated concerning its influences on the fulfilment of system functions. Nevertheless it was mentioned within this investigation as a mean to gather and diffuse knowledge.

This strategy should be approached with much caution. Although the companies indicated that they applied *take-overs* to gather knowledge in the field (company 1, Interview), it does not mean that this strategy is positive and stimulating for the *IS*. The idea of knowledge diffusion embarks from knowledge share, the creation of standards for better communication and a participation of all players in the system (Hekkert et al., 2007). Individual companies however who buy smaller ones cannot be considered stimulating, as they bundle the knowledge instead of diffusing it. Teece (1986) mentioned the possibility of buying assets as a way to complete a project or product. This idea is applied from the company´s point of view. They acquire assets in form of knowledge, to increase their own level of understanding. So with increasing purchasing activities by large companies, the knowledge within the field would be centralized in few companies. If this way of thinking is combined with the limited willingness, of the companies, to share their knowledge, which is seen as competitive advantage, company *take-over* result in the exact opposite of knowledge diffusion. Therefore this strategy should not be considered stimulating for the market, rather hindering to the overall development process of the industry. Nevertheless, the Spanish wind energy industry showed a high amount of function three (*knowledge diffusion*), which can be traced back to the idea that a high amount of those events were conferences concerning wind energy, and *RET,* on national and after 2000 on international scale. Concluding the influence of *company take-over* on the fulfilment of function three (*knowledge diffusion*) will not be considered in the final results and therefore is excluded in table 5, at the end of this chapter.

6.2.2 Internationalisation

As the previous one, *internationalisation* is new in this context and does not possess any expectations concerning influencing appearances. Companies applied this strategy as a mean to increase their activities in the field and increase their market share in the global wind energy competition.

As the name implies, the companies looked for opportunities beyond the country´s borders. The strong internationalization of the Spanish wind energy companies in European, Asian and American markets increased the amount of wind turbine application. One may argue that this does not stimulate the national *IS*, as Spanish investments are taken to other countries, but this is not entirely true. By expanding beyond the country's market, a company gains image on national as well as international level, increasing the available cash flow towards the company and increase the learning curve, due to more application and learning by doing (Arrow, 1962). The pursuit of the company to go international is therefore an important strategy in expanding their influence on the market. Besides grasping new opportunities in often untouched market, it does also increase competitive capabilities (company 6, Interview). With a higher competition on global scale, competing with big producers from Denmark or Germany the demands for the company's competitive advantage increased. While the expansion towards the global market can be considered the intended goal of this strategy, in relation to the *IS* a second positive influence was identified.

The *internationalization* strategy of some companies in the Spanish market positively influenced the mobilization of resources. Although it was not a company objective, but the financial opportunity of an international oriented company in comparison to an only national operating one, makes investments more interesting. In other words, the perspective to invest in a company, which has activities beyond the domestic market offers the possibility to receive revenues from a company that is not only dependent on one system, but spreads its risk over different countries. In the cases that the company is stock market listed, an activity in a foreign market can increase the share value, leading to more financial support (Agmond & Lessard, 1981). Especially in the last five years of the *EHA* several events of this function were connected to the international activities of a company. In some cases the announcement alone was sufficient to increase the share value (Cinco Dias, 22nd November 2004).

In comparison to table 4, in table 5 this strategy will thus be mentioned twice; first, to be influential on entrepreneurial activities and second, on the mobilisation of resources. In one case the influence is according to the company's intention and in the other case, it is an unintentional influence, which however had a high influence on the resource mobilisation in the *IS*.

6.2.3 Using company assets

In the conceptual model it was already indicated that this strategy may mainly be applied by large companies, as they have a higher probability to possess the necessary resources and that the purpose of this strategy is to create legitimacy for the innovation.

The assumption that there is a relation between company size and strategy application proved to be existing as well as the initial expectation that this strategy is applied to *create legitimacy*. In comparison to the initial expectations however, the companies especially used their image and name, rather resources, skills or critical knowledge (company 4, Interview). The intentions also correspond with the eventual influence of the strategy.

Companies applied those assets to get the support from the local population or companies, and to receive contracts from regional governments for their endeavours. Besides a higher social acceptance for the companies, the utilization of a well established company name in the energy market, for a new technological development *creates legitimacy* for the innovation. This correspond with the indicator for function seven (*creation of legitimacy*), used in this research and formulated by Bergek et al. (2008), that established companies can transfer their legitimacy, which can be understood as their image or name, to create support for the innovation. Either way *using company's assets* was executed by the companies to increase the innovation's legitimacy and social acceptance within society. The relation between *using company assets* and *creation of legitimacy* will therefore remain in table 5.

6.3 All companies

Besides the five strategies identified above, to be applied by either small or large companies, there exists a variation of strategies which were or were not applied by both types of companies. In total ten strategies are discussed

6.3.1 Action in context

For this strategy initially three expectations were formulated in table 1. It was expected that action in context would be of influence on the fulfilment of *guidance of the search, market formation* and *creation of legitimacy*. After the interviews it turned out that this strategy was indeed applied for function four (*guidance of the search*) and function seven *creation of legitimacy*). The utilization for function five was however not identified, as this strategy was only applied on the social level. As it emerges from the interviews, the companies did not do any activity concerning the establishment of industry standards or norms. In one case it was even indicated that standards were perceived as being hindering to the development, because it would limit development opportunities towards one direction.

Although a relation with *market formation* was not proven, the other two expectations were found in the results. In both cases the focus was on the social level of the strategy. While in the conceptual model the expectation was formulated that the establishment of standards may have beneficial influences on function four (*guidance of the search*) as well, here the social scale was the only level of application. Companies used the strategy to create a positive opinion surrounding the technology, raising expectations in society which then reflects itself towards the government and help in the establishment of national targets. So although one part of the strategy was not performed, a social orientation was applied, leading to higher expectations for the technology in their purpose of replacing the traditional energy system.

The second confirmed expectation is in place between *action in context* and the creation of legitimacy. As it was applied in system function four, to create expectation and positive ideas about the technology, here it is applied to create social acceptance. While the companies applied this strategy on regional level only, with people that are in direct contact with the wind park, no difference was made between projects supporters and opponents. Lobbying for the technological and social benefits of the technology therefore increased social acceptance and legitimacy of the industry. Consequently two relations are integrated in table 5.

6.3.2 Cooperate with the local government

For this strategy two expectations were formulated in the conceptual model. Both expectations, relations between the strategy with *guidance of the search* and *market formation* were identified in the research. One remark needs to be made, although the initial expectation was that the cooperation with the government would be on national level, the link, in both relations, was identified on the local and regional level.

For the purpose of function four this strategy was thus identified to be applied. The cooperation was looked for on a lower level, as in comparison with other countries decisions about building sites and licences distribution are taken bottom-up instead of top-down (de Otto, AEE). The local and regional authorities have the decision power about the construction and certification procedures, while the national government focuses on the broad lines of the industry and the establishment of national policies, which are lobbied for by the AEE. The company intention of such cooperation was on discussing regional problems and project application. Although not intentional those interactions can persuade the government, to increase the focus on those technologies and set more industry specific targets. Interactions of that kind may have a direct benefit for the company, but may also show the regional government limitation of the amount of project's regulations is necessary to ease up the construction process for new endeavours. In that case the eventual result can differ from the initial company objective. The possibility that the achieved goal differs from the initial objective is a beneficial side effect of this strategy. Nevertheless the effect on the *IS* remains the same, as both result in an increase of function four, *guidance of the search*. Discussing problems with regional authorities has therefore a positive influence on the government actions concerning the technology.

As mentioned above, the second expectation was found in the interviews. Here as well it was the cooperation on a regional and local level rather he national one which was intended. Companies mentioned the cooperation with the government to solve local problems and communicate about construction sites for wind parks. Such an approach is assumable, as companies may have a better view on suitable construction sites and more individual interest in new construction opportunities. As the government works with limited capabilities, incentives from the private industry can in this case increase the about of new opportunities if they cooperate and present their opinion. This incentive was identified quite often in the *EHA*, where for example on the 6th of November in 2003, a company proposed to the local government the construction of two new wind parks in a specific area, which were in their opinion suitable construction sites (Cinco Dias, 6th November 2003). The *cooperation between the company and the local government* for new construction sites shows that by using this strategy, companies can influence the *creation of markets* and opportunities for themselves.

6.3.3 Developing a discursive strategy

The absence of this strategy from the entire investigation is rather surprising. The expected influence on the *creation of legitimacy* as suggested in the conceptual model can therefore be neglected as well. The total lack is surprising, because in literature this strategy is formulated to be a key move in establishing the innovation in a dominated market (Leca et al., 2006). The expected relation between a *discursive strategy* and the creation of legitimacy is therefore assumed to be non-existent.

6.3.4 Investment in demand increasing projects

The investment in demand increasing projects is, as it was explained in section 5.2.8, a new strategy. As earlier, due to its appearance during the research, a beforehand expectation does not exist. The identified influence of the

strategy on market formation, as indicated in table 4 is therefore the only relation between this strategy and the *IS*.

Even though this strategy was formulated to be applied by companies to increase demand and create new markets, in the analysis it is allocated to function four; *guidance of the search*. With *investing in demand increasing projects* the companies in question intended to increase demand for wind energy and green energy in general. With projects like the electric car or hydrogen storage for over-production of wind energy during the night, companies applied a strategy which could, on the long-run, solve the problem of over-production and ensure a continuous high demand. The creation of a market for electric vehicles, for example would rely on the provision of green energy, which would be stimulating for companies to enter the market, because of the ensured energy implementation and constant high demand for green energy. The influence of this strategy on system function five can however not be identified in the *EHA*. A reason for this can be found in the temporal difference between applied strategy and intended function. While the investments are made today the market is not created on the short-run. What can be argued to be influential on short term is a relation between the strategy of *investment in demand increasing projects* and system function four, *guidance of the search*. With the investments in such projects, the expectations about a growing market in the future increase. With more perspectives in the future, the search process is guided towards the technology that is able to provide the rising demand. In this case the wind energy industry is stimulated to grow, because on the long-run the establishment of the, i.e. electric car provides an enormous industry, in which the technology is needed and has a potential big market. This strategy therefore is intended to increase the market on the distant future but in relation to the *IS*, it has a positive influence on *guidance of the search* and will therefore be moved from function five in table 4 to function four in table 5.

6.3.5 Investment plans and regional benefits

Investment plans and regional benefits are new in this research, do not have to fulfil to any expectations but show influences on two system functions. Earlier this strategy was described as a variation of action in context, which can be supported in this section as the influenced functions are equal to those stimulated by action in context.

In this purpose the strategy implies the creation of regional development plans. Those plans stimulate local governments to increase their endeavours to situate companies in their area, to gain the planned investments. Plans for investments or constructions do not only stimulate the government to enhance their guidelines, but they may also motivate regional governments to formulate targets to attract even more investors and operators to their communities. Furthermore does is increase expectations in society surrounding the technology, as it provides a stable economic situation in less fortunate regions of Spain. The relation between the strategy and the appearance of the system function is one of the most prominent in the field. The amount of presented investment plans, or in some cases construction plans, increased rapidly after 2000. The stable conditions for investments and ensured payoffs made such plans a secure activity. The importance of this new link between the development of the *IS* and the strategy, leads to the assumption that the strategy *investment plans and regional benefits* positively influences the appearance of system function four.

A second application of this strategy was identified for the purpose of *creating legitimacy*. Companies built service centres, construction facilities or offices in the region in which they intended to create a wind park. By

creating jobs and increasing the value of the region, the local population welcomed the technology easier than in regions without job creation. As in some regions of Spain, unemployment rates are quite high this brought along a high level of support for the companies actions if they are to create jobs. The initial intention of most companies was to have maintenance and control station as close as possible to the constructed wind parks, where especially in the start-up phase technical and operational problems appeared. The eventual effect therefore differs from the initial goal. The creation of jobs, due to supporting facilities, became a mean of justifying and receiving support. As a result the application of this strategy changed from unintentional side-effect to key method for social support. These offers of job creation were however taken quite serious as, for example in the 31st of March 2005 a newspaper published that the construction of 125 new parks in the region of Andalucía will lead to 17.000 new jobs (Cinco Dias, 31st March 2005). With such opportunities, support within society, industry and the local authorities were gathered quite easy (Miera et al., 2008). Thus, by *creating working opportunities and economic benefits* in the construction region, the companies increased social acceptance and *created legitimacy* for their action within the population.

6.3.6 Green marketing

Beforehand marketing or green marketing was expected to be influential on the *mobilisation of resources*. This relation was however not to be established within the results. Although the strategy was used, application remained on a limited. It was indicated earlier that *green marketing* was especially used by those companies who did not possess company assets like company image or name. One may therefore assume that this strategy was mainly applied by small companies, which also emerges from the interview data. The *EHA* however suggests a different idea. In 2005, two of the in total four events for green marketing can be allocated to large companies (Cinco dias, 10th June 2005; Cinco Dias, 15th March 2005). The strategy is therefore placed within the activities applied by both company sizes, as it is useful for both and within both their capabilities.

The intention was to use *green marketing* for company purposes to provide a green view on the company and therefore create social acceptance for the company's activities. This intention reflects itself in for example the two above mentioned events, when Iberdrola, at that time the biggest energy producer of Spain, joined the EWEA (European Wind Energy Association), although most energy was still produced by traditional methods (Cinco dias, 10th June 2005), or Gamesa joined a social responsibility fund (Cinco Dias, 15th March 2005). Although from the *EHA* not many events were allocated to the application of *green marketing*, the events did leave a mark in the *creation of legitimacy*. Nevertheless the application of *green marketing* on the appearance of system function may not be neglected

The combination of *green marketing* and the *creation of legitimacy* are new in this research as well. Companies applied their green image, as long as they had one, to create social acceptance for their projects. They applied this strategy to show the environmental benefits their company would provide to the region. Application was mainly found in the bigger companies. One example of such an application was found in 2005, when.

6.3.7 Market entrance

Another strategy which has to be rejected entirely to be influential is *market* formation. While it was initially expected that it would have an influence on entrepreneurial activities, a clear line in this strategy was not identified. The market entrance was dependent on the capabilities and available resources and therefore not a strategic choice. As a result it was not used as a method to increase activities, due to smaller parks, or lower the

function through bigger park construction. One limitation to that strategy is a regulation in Spain, which contains that newly constructed wind parks may not be extend further than 50MW. The entrance is therefore limited by resources, capabilities and regulations. No relation to any function was identified.

6.3.8 Mobilisation of allies

Four expectations were formulated in table 1 concerning the relation between *mobilisation of allies* and the *IS*. Three of those four expectations were not identified in this research. The only confirmed relation was between this strategy and the *mobilisation of resources* (F6).

With respect to *knowledge development*, the *mobilisation of allies* was not a strategy applied. Although some of the companies indicated that they provided contribution to research projects, the developing company did not indicate looking for allies in their research activities. The provision of resources came out of own interest for better technology, rather an especially applied mobilisation process. Similar for function three (*knowledge diffusion*), no relation was identified with this strategy. In how far such cooperation would be useful can be questioned, as from the amount of external knowledge only little may be beneficial for the wind energy industry. The last rejected expectation is with the *creation of legitimacy*. M*obilisation of allies* was in none of the interviewed companies used to create legitimacy beyond the industry boundaries. Although not intended, such a relation can also appear, as the entrepreneur gathers support in local communities and by doing so convince them of the innovation's benefits. But even in the second case, the relation was not identified in the *EHA*. One remark has to be made in this context. Only direct cooperation between companies is taken into account. Benefits for companies, not directly cooperating but situated close to project sites, and therefore supporting projects as a result of their beneficial situation, are not incorporated in this

In table 1, two strategies were expected to be influential on the appearance of function 6. While marketing needs to be neglected, the second expectation that the *mobilisation of allies* leads to the mobilisation of resources was identified in the investigation. Looking for alliances as sources of resources was indicated as a possibility by Hitt et al. (2001) and in this research this relation is verified. Throughout the years the mobilisation of partners from outside the field were mentioned as being essential for projects. As it was seen in the industry overview in chapter 5.1 the availability of private investors remained high and easy to find until the beginning of the financial crisis in 2008. The potential of private investors revealed itself in 2002, when public subsidies for specific projects ended and the private sector took over the entire financing part. Various companies indicated that this transition from public to private funding went very smooth and that activities were to be pursued as usual, despite the change of financial origin. Reasons for this active participation in the wind energy industry can be found on the one hand in the stable policy measures of the Spanish government (Bocard, 2010) and the resulting stable revenues for investors and on the other hand the industry's growth potential (Chow et al., 2003).The mobilisation of allies as a mean to gather resources for projects, may therefore be once more an important strategy for the Spanish wind energy industry.

6.3.9 R&D activities

R&D activities, as a sub-strategy of cost-reduction, were expected to appear as a strategy for knowledge development. This research confirms the initial expectation.

Although only one company appeared to apply R&D activity in the Spanish market, a relation between the two concepts can be assumed. From the interviews held with the AEE, as well as the according company, the image of an active R&D industry appeared. In the case of the interviewed company, R&D activities were the main focus in the start-up phase and remained the key activity. The analysis showed furthermore that function two, *knowledge development* often appeared as a result of technological improvements or a started research project. This idea is also supported in a newspaper article from the 22nd of November in 2004, stating that the Spanish wind turbine industry invest an average 11% of their revenues in R&D, while the country's R&D average is about 1% (Delgado, 2004). This relation is in line with the theory of Hekkert et al. (2007), who imply that R&D projects are an indicator for this system function. Doubts can be formulated in this context as only one of the interviewed companies did apply R&D activities, but it needs to be said, that of the two types of wind energy companies, developers and operators, only one developer did participate in the investigation. As the other companies were merely wind park operators, they did not possess the knowledge, skills or capacities to singlehanded improve the technology. Whether the centralization of research helped the development process, as research is focused in few but very capable companies and the invested money was used more efficient, remains unclear. It could be a good approach to research, because the industry indicated a strong technological improvement during its history.

Table 5: Final strategies allocated to system function

System function	Strategy
SF1: Entrepreneurial activity	Collective action Internationalization
SF2: Knowledge development	R&D Activity
SF3: Knowledge diffusion	Cooperation with established player
SF4: Guidance of the search	Action in Context (social scale) Cooperation with the government on local level Investment plans and regional benefits Investment in demand increasing projects
SF5: Market Formation	Cooperation with the government on local level Small scale projects due to technology specialization
SF6: Mobilisation of Resources	Mobilisation of allies Internationalization
SF7: Creation of Legitimacy	Action in context (social scale) Green Marketing investment plans and regional benefits User-involvement Using company assets

6.3.10 Small scale entrance due to technological specialisation

The last strategy identified in this investigation is *small scale entrance due to technological specialisation.* In comparison to the initial expectation of the conceptual model, this strategy is expanded with the detailed information that the small scale entrance is made possible due to technological specialisation.

Instead of using 'normal' wind sites, this strategy applied a combination with technological improvements and more specialized products, to enter regions which are not useful for large-scale standard projects. The basic idea however remains the same. Niche markets were created, using specialized products for the particular regions, which so far were not penetrable by any industry. Although this influence did not appear in the *EHA* before 2002, the development increased after the best building sites in Spain were occupied. The wind turbine producer indicated in their interview that specialization of turbines to the various demands of the Spanish countryside was one of the main drivers of their current success. Therefore *technological specialization* and the resulting capabilities of small scale projects increased the formation of niche markets within the country.

6.3.11 User-involvement

With no prior expectations, this strategy is applied for the *creation of legitimacy*. Especially in the case of wind energy this strategy can provide benefits. With various sources of resistance, like the local population, who see the technology as visually disturbing and irritating in terms of noise, and ecologist groups, who see the construction of a wind park as a destruction of the regional ecological system and the idyllic countryside, the incorporation of those groups in the allocation and decision process bares high advantages. The local population feels more involved in the decision making process, lowering barriers and increasing acceptation (Lundvall, 1985). The incorporation of the user in the construction and site designation process can, and in the view of the developers, does influence the local community to cooperate in the constructing the wind park.

7. Discussion

The first aspect of discussion is related to the character of this research. As this is an explanatory research for the combination between *Innovation System* and *Entrepreneurship*, the amount of available literature on correlations and influences between those two theories is very limited. On the one hand there exist lots of information about the *IS*, the system function, motors of innovation and methodology. On the other hand, the literature about *Entrepreneurship* is extensive and quite difficult to grasp as a whole. Despite this huge pile of information, a linkage between those two theories was not established yet. The initial expectations were therefore established based on pure logic and interpretation of possible relations. This approach led to various expectations which did not match with reality found in the research, as the high amount of not identified relations indicates. By showing that so many expectations are not true, this research concludes that an expected link, based on argumentation, does not exist. Without a preliminary research such correlations are easy to be taken for granted. The rejection of more than 50% of the expected relations therefore shows the necessity for combining the strands and erase wrong expectations on the correlations. While the high amount of rejections showed the necessity of this combination, the formation of eventually 16 correlation between the *IS* and entrepreneurial strategies indicates the existence of a link between those two theories. The lack of literature may be a problem in the overall reliability of that linkage; nevertheless it is a stepping stone in understanding the importance in combining *Innovation Systems* and *Entrepreneurship*.

With respect to the gathered results, some doubts should be formulated. First, the total absence of the strategy *development of a discursive strategy* is quite surprising, as the literature formulates this strategy to be a key strategy for institutional entrepreneurship. Even when asked for this particular strategy, companies responded with a clear denial of such an application. If this turns out to be true, because the companies do not want to admit

such actions, remains unclear. Although accordance with entrepreneurial literature this would be unexpected, it could be possible that the strategy was indeed not applied during the start-up period. An explanation could be found in the special situation of the Spanish wind energy market, as most wind energy companies are also large energy companies using traditional methods (Stenzel & Frenzel, 2008), like Iberdrola, Acciona, Endesa or GasNatural Fenosa. Developing a discursive strategy would mean undermining the framework upon which the rest of the company is working, therefore questioning themselves.

Another aspect is the relation between knowledge diffusion and *company take-over*. As the companies indicated that they acquired knowledge due to company *take-overs* it has to be mentioned. But the idea behind diffusion of knowledge is the developed knowledge is spread throughout the market, available for each participant. Buying companies and incorporating the tacit knowledge within only one company would in that case not count as knowledge diffusion, as it is bundled instead of spread. For this reason the relation between those two concepts was erased from the final results. Although it may hold benefits for the individual company, as Teece (1986) pointed out. But in the greater interest of the *IS*, buying companies is not a stimulation for the system's development.

The last doubtful relation is between the *guidance of the search* and the strategy *action in context*. As action in context is applied to create a positive opinion concerning the technology, and technological application, it can also be interpreted as increasing social acceptance, or legitimacy. It can be argued that a positive opinion in society and newspapers is then a result of an increasing social acceptance. If this is the case, action in context on a social scale would not be a strategy to increase guidance of the search, but legitimacy. Nevertheless, applying action in context on a social scale increases the amount of positive statements. Whether it is result of increasing legitimacy or not should not be regarded here. Neglecting the strategy would therefore not be advisable, as it appeared to be very useful in the context of creating a positive public opinion.

One more point of discussion about the context of this research, is the assumption that the well-functioning of the *IS* is a result of the strategy application. As this is the key aspect of this research, it is the most important assumption taken. If doubting this relation between strategies and the performance of the *IS*, this research would lack foundation. On the other side however, no knowledge exists about the possible performance of the system, if the strategies were not applied. Meaning, the neutral situation with a development free of strategies is not known. With that aspect in mind, the linkage between the strategies and the positive development of the *IS* remains a correlation, which can be truthful but it could also be pure coincidence. For that purpose verification of the findings in other countries', as well as in other industries is necessary to confirm that the relations found here are not purely coincidence, but in fact a mean to increase implementations speed of an innovation.

In earlier chapters it was indicated that there were big differences in the amount of data available between the *EHA* and the conducted interviews. While for the market analysis information was gathered in over 1400 articles, the data collection concerning the companies' strategies was rather limited. For the *EHA* the problem presented itself in too much information. After 1998 the amount of articles for interpretations increased rapidly, which, as there was only one researcher available for the interpretation, became a difficult challenge. The possibility exists that this led to a one-sided interpretation of the articles and that another investigator would have encountered similar, but different scores.

While within the *EHA* there was too much information available, the company interviews lacked behind. Despite the intended goals of three companies from each market segment, and also three interviews within each company for internal data triangulation, the mobilisation of interview partners was much more difficult than expected. As it was said in the methodology, only 7 of the 48 contacted companies were willing to participate in this investigation. The problem from this limited amount of information was that sometimes it was unclear whether a certain strategy was performed in the fullness of the market. In some cases only one or two companies mentioned a specific action, a conclusive result was therefore difficult to find. Despite a long investigation period of nearly four months and contacting companies through various methods, a better result was not achieved. Approaching the companies even longer was not possible due to the limited time frame of this research. This is a clear limitation on the generalizability of the results, as those would be more conclusive with higher company participation. As between the companies no communication took place, they were not able to help expanding the amount of possible interviewees either. Despite this data limitation in the case of interviews, the results gathered have their foundation in at least one company and are verified by either the AEE, other companies or newspaper articles found during the *EHA*. Therefore, although the limited participation of companies was a problem in the interpretation of the results, the validity loss is limited.

The last aspect of this discussion, focus on the limitation of this research on entrepreneurial strategies only. As the entrepreneur is an actor with high interests in the well development of the *IS*, it was the main focus of this investigation. As a result the identified strategies emerge purely from the entrepreneur and do not include interest of other actors in the field. Certainly the entrepreneur bares most risks, but gains most in a well-functioning system as well. Nevertheless the possibility should not be neglected, that other players, as the financial system or research facilities, have interests too. The focus on the entrepreneur and the entrepreneur only, was a necessity to be able to complete this investigation within the timeframe and with the available resources. Including other actors in this research would increase the research value, as with more strategies, a more detailed analysis would be possible about the relation between appearance of system functions and applied strategies.

7.1 Recommendations for further research

To continue this line of research some recommendations can be made. One of those is the verification of the results for wind energy only. The verification on the theoretical link, as it is presented here, between *IS* and *Entrepreneurship* should be tested more often. An idea of this test could be the utilization of the correlations in different countries to investigate to expand the single case study towards a multiple case study for wind energy only. With the verification of the identified correlations, this method would not only be developed further, may it be in a way of verification or in rejection, but it also focuses more attention on the link between the two strands, which so far have experienced too little attention in innovation science. With the investigation of more cases concerning the influences of the entrepreneurial strategies on the performance of the *innovation system*, more knowledge is produced about how to stimulate and improve technological implementation. A different recommendation for further research is to expand this line of research upon more players within the *IS*. This research focused on entrepreneurial strategies and the influences of the entrepreneur on the performance of the *IS*, but there are more players in the field, which's influences on the system should also be investigated. Therefore more research should be conducted on those other players in the field.

A second aspect in which further research could be applied is by testing the generalizability of the results. Some of the concepts in this research, like *neighbourhood concerns*, are very specific for wind energy and would not appear in other technologies. Nevertheless, most of the identified relations should be applicable in other cases as well. For this purpose the rather general definition for an entrepreneur was chosen, as well as a general idea about strategies. The capability of this research to be generalized would also lead to an increase in scientific value. To test whether this research has a high generalizability beyond the wind industry market, the results need to be applied in different fields. Here a similar approach is suggested as with an international comparison, where the conceptual model at the end of the analysis is tested with respect to the new scientific field. As it can be seen, there is still a lot of work to do in this direction. Knowledge about the combination between *IS* and *entrepreneurship* has just been scratched at the surface. More research is needed on how those two theories interact in different fields.

8. Conclusion

The strong growth of wind energy in the Spanish electricity market within the last decade and the well-performance of the *IS* suggest, that wind energy implemented itself fast within the Spanish market. With the neutral state, without any applied strategies, unknown, this research assumes the fast industry growth occurred for some part as a result of the applied company strategies. Therefore hypothesis one, *Entrepreneurial strategies have an influence on the fulfilment of system functions in the IS*, is found to be true. The results in table 5 are the identified relations between the two strands of theory. The second hypothesis, that a *difference exists in the performance of strategies between smaller and bigger companies involved in the IS*, is to be found true as well. In chapter 5, the description of the results from the interviews show a difference between applied strategies of small and large companies in the market. The strategy in which this difference is the strongest is collective action. With both hypotheses found to be true, answering the research question, as formulated in the introduction is the next step.

Which strategies did Spanish wind energy entrepreneurs apply to increase their technology's implementation speed, by creating a sustainable Innovation System?

In total 14 applied strategies were identified during this research. In chapter 5.2 these identified strategies were ordered according to the intended goal and the influence they have on the *IS*. Those strategies are the answer to the first part of the research question. However as the technology's implementation speed depend on the functionality of the *IS*, the applied strategies need to correspond to the according technological phase. Mentioning the strategies is therefore only the first part of answering the research question. The second part is much more interesting. The key is to apply the right strategies at the right point in time. To determine the point in time, in which a strategy needs to be applied, the motors of innovation are used.

To know which strategy should be applied at which point in time, table 5 presented 17 correlations, which were identified to be influential strategies on the seven system functions. But not all strategies were performed by all companies in the field. As suggested by hypothesis two, in six strategies differences were identified between bigger and smaller companies. In the first phase of the Spanish wind energy industry, companies applied *R&D activities*, *cooperation with established players*, *action in context*, *cooperation with the government on a local level*, *develop investment plans*, *invest in demand increasing projects* and *mobilisation of allies*. The application

of the strategy depended on the company's capabilities. Not all strategies can be applied by all companies as it was identified earlier. In the second phase it was found that in addition the companies used *collective action*, *internationalization*, *green marketing*, *investment plans and regional benefits*, *user-involvement* and the *use of company assets*. Here the different capabilities become even clearer as for some strategies basic assets are necessary to be applied. In the third phase, this list of strategies should be expanded with two more strategies, *the cooperation with the government* for new building sites and the creation of *small scale projects due to technological specialization*.

9. Strategy recommendations

The strategies applied need to be chosen according to the industry phase. As the motors of innovation suggest, in the development of a technology, the innovation process runs through different phases. In each phase the necessary functions for a well-functioning of the system are different (Suurs & Hekkert, 2009). In the following the recommendations are made about which strategies should be applied in accordance to the state of the art of the technology. From the research in the Spanish wind energy industry entrepreneurial recommendations can be formulated. These recommendations should however be approached with caution, as this research alone is not sufficient for a generalization of the results. To harden the evidence and recommendations more research is needed. Nevertheless, this approach is a first step in that direction.

In the first period of the industry, the *Science and technology push* motor is necessary, in which expectations about the technology should be high, knowledge development as well as diffusion needs to be present and sufficient financial support should be available (Suurs & Hekkert, 2009). As an entrepreneur to fulfil those characteristics for a good start, different strategies could be applied. From the investigation in the Spanish wind energy industry, it was identified that various strategies are beneficial for those four functions. In the beginning the entrepreneurs should apply a high amount of *R&D activity*, to stimulate *knowledge development* and the *cooperation with established players* in the field should be looked for to try and learn as much as possible, without investing in already existing knowledge. To increase *guidance of the search*, companies can apply several strategies. First, they should put the technology into a *social as well as environmental context* and underlined the benefits it has, to create a positive social opinion. Second, one should start to *cooperate with the local government* and discuss practical problems as well as application opportunities. This can, depending the national system, be more beneficial on local and regional scale than on national scale. Third, one should *developed long term regional investment plans*, to stimulate licences distribution and governmental attention. Finally, *investments in long-term, demand increasing projects* is a good plan to create a perspective for the technology to grow towards. As a result expectations and positive statement about wind energy increase, concerning the technology in society as well as science. To stimulate the mobilisation of resources, a strategy should be chosen according to the company's capabilities. As in the beginning resources are needed independent the size, *allies beyond the field should be mobilized*. If the company's capabilities are sufficient more investment opportunities would be provided. This can be achieved by *internationalize* the company's activities.

After the technology is pushed into the market, the industry changes and other system functions become important. With the appearance of the entrepreneurial motor, the amount of *entrepreneurial activity* and *creation of legitimacy* should be increased (Suurs and Hekkert, 2009). To achieve that, companies can use, in the first

case, *collective action* and an *internationalization* strategy. The first enables smaller companies to enter the market as well, because of shared risks and more available resources, while the second strategy helped the company to spread their activities beyond the country, increasing learning curve, financing and image. To increase legitimacy, a wide range of strategies can be used. Once more *putting the technology in a context* is useful to increase social acceptance. Furthermore *green marketing*, as a way to reflect the green image of the technology upon the company projects to receive more support as being an environmental friendly company, can result in more legitimacy. The third strategy helpful is the stimulation of the regional economy. One company formulated this strategy as ´one hand helps the other´. With the establishment of *investment plans and regional benefits*, support is gained, as jobs are created in the project regions, to increase social acceptance even further. One more strategy for social acceptance is the *involvement of users*, or in this case the inflicted population, who did not agree and resist the planned projects, into the planning and construction process. By involving those parts of the population, a dialogue is created between developers and population finding a consensus on the projects, which serves both parties. A final strategy which is mainly used to create legitimacy, rather social acceptance is the *utilization of company assets* as i.e. the company's name, resources or expertise. The combination of those strategies lead to a strong entrepreneurial motor bringing the innovation to the edge of the next motor: the *system building* one.

As this research did not experience the whole period of the *System Building Motor* in the Spanish wind energy market, recommendations concerning this motor should be taken with caution Nevertheless, the motor necessary for further implementation of the technology into the system, would require a strong increase in system function five (*Market formation*). Although the motor was not identified, companies can apply two strategies which stimulate the formation of markets on the short term. The first is the *cooperation with the local government* to deal with local problems, and propose application or, technology depending, suitable construction sites. Furthermore, the creation of small markets in the region can help to develop niches to learn and diffuse. This can be achieved by establishing *small scale projects due to technological specializati*on, enabling the developers to apply the innovation in markets or regions, which were not penetrated by any technology so far. Furthermore does this strategy increase the amount of technological knowledge, leading to a higher competitive advantage as well as the company's capabilities.

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Appendix

Appendix A: Interviewed companies

Company Name	Company Type	Interviewee	Company position	Potential in 2010 in MW (AEE, 2011)
AEE	Lobby	Alberto Ceña	Technical Director	------
AEE	Lobby	Sergio de Otto	Director of external relations	------
Anonymous	Operator	--------	--------	>800
E.On Renovables (VIESGO)	Operator	Christina García Forguet	Communications	321,33
ENEL Green Power (ENDESA)	Operator	Christina Puerta Suarez	External relation and communication	807,51
Eolia Renovables	Operator	Angel Hernandez	Director of Investments	367,74
Gamesa	Developer	Juan Diego Diaz Vega	Marketing Director	280,95
Magtel	Operator	José Juan Robles	Project Engineer	<100
RWE Innogy (AERSA)	Operator	Patricia Louis	Strategy and Development Manager	390,69

Appendix B: Codified companies' characteristics

Company Number	Company Type	Current Nationality	Nationality start-up	Wind section size start-up	Company origin
1	Operator	ES	ES	Big	Established energy company
2	Operator	DE	ES	Small	Established energy company
3	Operator	ES	ES	Small	Various new entrants
4	Operator	IT	ES	Big	Established energy company
5	Operator	DE	ES	Small	Investment company
6	Developer	ES	ES	Big	Diversified producer
7	Operator	ES	ES	Small	New entrant