For which Companies DOES IT PAY TO BE GREEN?

Master's Thesis by
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Abstract

This thesis contributes to a better understanding of how climate change affects different types of companies. Specifically, it seeks to answer the question: *What drives environmental innovation in different types of companies?* The question is answered through an investigation of the dynamics behind corporate responses to climate change, with special attention to the recently introduced European Emissions Trading Scheme.

Climate change has increasingly attracted companies' attention because they are expected to use their innovative capacity to limit carbon emissions. This thesis analyzes four companies. Two of the companies emit significant amounts of CO_2 and are technology adopters. The remaining two companies are low carbon-emitters and are innovators of low-carbon technologies. The companies all participate in industries that face major challenges from climate change, because carbon emissions occur somewhere in the added value chain. Technology innovators, with no in-house emissions potentially hold the key to a given industry's ability to reduce its carbon emissions, because of their innovative capacity. Therefore this thesis highlight some of the adopter-suppler dynamics involved with environmental innovation.

Departuring from a theoretical discussion, an analytical framework is designed, through which the companies are analyzed. The analytical framework considers: 1, the companies responses to climate change (proactive/reactive); 2, whether their core activities are climate-friendly; 3, whether the companies are exposed to significant pressure to improve their environmental performance and; 4, whether environmental regulations induce them to innovate.

The thesis concludes that there are few similarities in drivers for environmental innovation across different types of companies. As a result, the European Emissions Trading System seems unable to provide sufficient incentives for environmental innovation across the companies. The findings suggest that the demand-pull effects of the system are inefficient, given the current low carbon price and the generous allocation of free CO_2-permits to polluting companies. The analyzed companies show different responses to climate change. Companies that respond proactively have widespread opportunities to reduce the use of polluting resources; can exploit government subsidies, which reduce the risks of investing in environmental innovation; or see clear market demand for the environmental credentials of their products. Only one of the companies responds reactively to climate change. The reason for its reactive response is twofold: inadequate development of internal capabilities for environmental innovation (inertia), and weak incentives for environmental innovation, because of lax regulation and technology lock-in effects, which harm innovative activity across all levels of the industry in which it operates.

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- Peter Markussen, DONG Energy
- Tarjei Haaland, Greenpeace Denmark
- Tine Bremholm Kokfeldt, FLSmidth

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Finally, I wish to thank family and friends for their support.

Mathias Tao Agger Linnemann

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This thesis is carbon neutral

I have bought one ton of CO_2 for the sake of experimentation and to get a better understanding of how carbon offsetting works in practice. There are now fewer permits on the European carbon trading market, which reduces supply and thus raises the demand for the remaining permits. This should theoretically raise the economic incentives for companies to develop and deploy low-carbon technologies. The efficiency of carbon trading and offsetting is thoroughly discussed throughout this thesis.

CO_2
CERTIFIKAT

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CO_2-certifikat for

Mathias Tao Agger Linnemann
CO2 neutralt speciale 2010

Med dette certifikat garanterer DONG Energy, at du I perioden 2008-2012 er med til at begrænse den samlede mængde CO_2-kvoter.

Du har købt 1 CO_2-kvote(r).

Det betyder, at du har fjernet retten til at udlede 1 tons CO_2.

Vores uafhængige revisor kontrollerer årligt, at vi har annulleret mindst ligeså mange CO_2-kvoter, som vi har solgt.

Læs mere om klimapolitik og CO_2-kvoter på Miljøministeriets hjemmeside www.mst.dk.

Lars Clausen
Koncerndirektør, DONG Energy

DONG
energy

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Chapter 1 – Introduction and research questions

Science on climate change undeniably reveals that escalating greenhouse gas emissions disrupt Earth's ecosystems. Global greenhouse-gas emissions must peak by 2015 and thereafter decrease by 6,5% each year for atmospheric CO_2 levels to stabilize. The global pressure to balance greenhouse-gas emissions is therefore escalating. The world needs to act but is currently stuck in a vacuum of political inaction in the aftermath of the United Nations conference on climate change (COP15)[1] in Copenhagen, December 2009, which spurred an inadequate outcome. Expectations towards a global legally binding climate agreement have suffered, and even though COP16 in Mexico spurred some progress, such an agreement could be years ahead, if ever enforced. The weak international framework signifies the importance of highlighting profit opportunities of environmental innovation for private companies.

This thesis sets out to investigate the dynamics of corporate responses to climate change. The principal purpose is to assess what drives companies to conduct environmental innovation, in the light of changes in the regulatory and societal environment. If the dynamics of innovation between technology innovators and adopters do not function optimally, diffusion of emerging low-carbon technologies is inefficient, which narrows the scope of opportunities to improve environmental performance throughout a given industry. It is therefore imperative to develop an understanding of how climate change affects different types of companies.

This thesis takes four different companies, which participate in industries that emit significant amounts of greenhouse-gases, into analysis. The companies are first Dong Energy, a major Danish electric utility company with a long history of coal-based power generation. Second, Scandinavian Airlines, a medium sized airline, which has recently implemented a new proactive climate strategy that aims at enabling carbon-free flight by 2050. The first two companies are emitters of greenhouse gases and (soon to be) covered by

[1] COP stands for "Conference of the Parties", which is the annual meeting held between the ratifiers of the United Nations Framework Convention on Climate Change (UNFCCC). The Copenhagen Accord was agreed upon during the COP15. It is a non-legally binding agreement. It does not commit countries to agree to a binding successor to the Kyoto Protocol, whose present round ends in 2012. The agreement generally "endorses" the continuation of the Kyoto Protocol, but has been fiercely criticized for its lack of ambition and concrete action.

the European Emissions Trading System (EU ETS). They primarily function as *adopters* of climate friendly technologies. Third, Novozymes, an R&D-intensive biotech company engaged in production of enzymes and bio-solutions used in diverse and often polluting industries. Last, FLSmidth, a world leading developer and supplier of high-quality equipment and services to the cement industry. The latter two companies are *technology innovators* and have no significant in-house greenhouse-gas emissions. They supply their customers, being greenhouse-gas emitters like textile manufacturers and cement factories, with technologies that enable them to reduce emissions. They thus play a key role in enabling various industries to improve their environmental performance.

The thesis aims to answer the following principal research question:

What drives environmental innovation in different types of companies?

The research question guides the rest of the thesis, and is answered by analyzing the four case companies through three sub-research questions.

Literature on the economic dynamics of climate change, referred to as the "pays to be green debate", seems to mostly reflect the need for carbon-intensive companies to adopt proactive responses to climate change. It tends to favor these companies and overlook the role of upstream technology innovators. This leaves a gap for assessment of the dynamics of environmental innovation across different types of companies including technology innovators with few carbon emissions. This gap in the understanding of the dynamics of environmental innovation served as inspiration to the thesis and the first sub-research question therefore asks:

1. **How do different types of companies respond to climate change and which circumstances drive these responses?**

Only if profits are reachable will companies act on opportunities and take risks associated with becoming climate-friendly. If businesses are to accelerate low-carbon innovation the key is thus to make it more profitable to be "green" than "black".[2] The market alone has shown to be inefficient in providing incentives for companies to reduce greenhouse-gas

[2] Anders Eldrup, the CEO of Dong Energy consistently uses the term "black" to describe polluting production opposed to "green", describing sustainable production.

emissions. So how is the synergy between environmental and economic performance leveraged to encourage companies to take serious action? Regulation aimed at promoting environmental innovation by penalizing carbon emissions is one way to elevate this synergy. The largest environmental regulative initiative currently implemented in Europe is the European Emissions Trading System (EU ETS). The system targets polluting companies, but little attention has been given to the opportunities and challenges that the system incurs on companies throughout the value chain in a given industry. The second sub-research question therefore asks:

2. **Does the European Emission Trading System provide significant incentives for innovation across the four case companies?**

Companies can seize opportunities to reduce resource consumption, increase productivity and gain societal and political support by considering and protecting the natural environment. Markets for sustainable development and clean-tech grow as governments and consumers adopt new standards and regulations. Therefore, new opportunities for privileged companies and industries emerge from climate change. However, as shown in this thesis, companies often face great uncertainty concerning the future impact of climate change. The uncertainties incurred by climate change drive some companies to adopt weak responses to climate change and the third sub-research question therefore asks:

3. **How can companies that show reactive responses to climate change start seizing opportunities of environmental innovation?**

1.1 Structure of the thesis

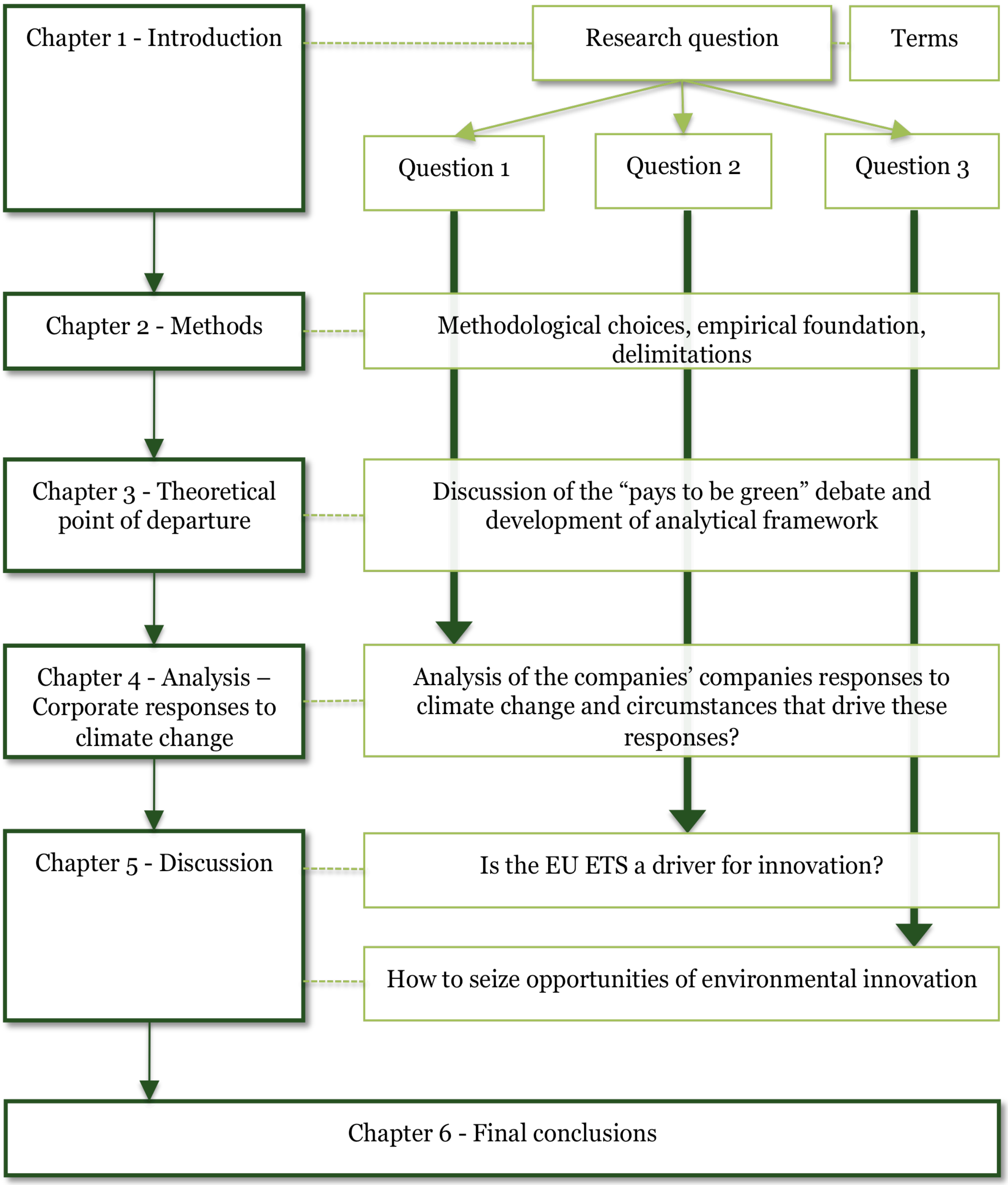

Figure 1-1. Structure of the thesis

1.2 Terms

The field of climate change economics is broadly defined, and listing the commonly used terms is therefore necessary. The following terms are essential to the research area of this thesis.

Innovation. *"Environmental innovations can be defined as innovations that consist of new or modified processes, practices, systems and products which benefit the environment and contribute to environmental sustainability… The positive environmental impact of innovation is the core element of the definition*" (Oltra, 2008, p. 2). The environmental impact may be intentional or not and is not restricted to improve environmental performance inside a given company, but can also result in reduced environmental impact from the consumption of its products or from the extraction and processing of resources used in its manufacturing operations and organizational processes (Hoffman et al., 2010).

Carbon permits. This thesis distinguishes between two types of greenhouse-gas emissions permits: *credits* and *allowances*. Both types of permits give the right to emit one ton of carbon dioxide (CO_2) equivalent gas[3] into the atmosphere.

- *Credit* is a term for a tradable certificate purchased to compensate for (to offset) an emission made elsewhere. Credits produced by reducing emissions outside of the EU ETS and are typically called Clean Development Mechanisms (CDM) or Joint Implementation (JI) credits.[4]
- *Allowances* are the inter-EU permits, which authorize the holder to emit a fixed quantity of greenhouse-gases and is, like credits, a tradable permit. Allowances are often "granted" (grandfathered) by the authorities (EU and individual member states) to companies free of charge in order to avoid an unfair competitive framework relative to non-EU competitors, which are not covered by regulation.

Carbon price: The current price of one EU allowance is 15€. The price is forecasted to reach €30 per ton in 2013 and €40 per ton in 2016. These forecasts are used in the thesis (Point Carbon, 2010, a, b).

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[3] To make calculations easy, all greenhouse gases are converted into "CO2 equivalents".

[4] JI mechanisms allow entities to exploit the lower conversion costs in other countries through the transfer of technology that reduces emissions as an alternative to reducing emissions domestically (UNFCC; 2005:31). CDM exploits the lower conversion costs in developing countries by enabling industrialized countries to invest in activities that reduce emissions in these countries.

Chapter 2 - Methods

This chapter describes how the chosen philosophy of science influences the choice of methods for data collection, processing and analysis along with some of the challenges the methodological choices imply.

2.1 Methodological choices

Research philosophy

Knowledge as a phenomenon is influenced by various contextual perceptions and variables. In this respect, a research philosophy represents a researchers perception of how knowledge is constructed and the meanings that can be drawn from this construction (Saunders et al., 2003). One can distinguish between three philosophies: positivism, interpretivism and realism. They each provide a distinctive view on how knowledge is developed. Interpretivism is chosen as the philosophical framework of this thesis. This enables the researcher to gradually establish research conclusions by exploring the topic of climate change impact on companies through critical interpretations (Ibid).

Research approach

According to the structural and procedural requirements of the social sciences, a common distinction is made between an inductive or deductive approach. This thesis takes a deductive approach, as it seeks to answer questions that are constructed on the basis of theory through case studies. In a deductive approach, the process starts with thinking or finding theories that fit the topic of interest. Building on these theories, a research question is based on hypotheses and observations are made to test the validity of the hypotheses. Lastly, it is confirmed whether the observations prove or disprove the hypothesis (Saunders et al., 2003).

Research strategy

A research strategy is how an author answers the research questions (Yin, 1994). Six research strategies can be identified: experiment, survey, grounded theory, ethnography, action research and case study (Saunders et al., 2003). This thesis investigates multiple-case applications by analyzing four companies and takes an explanatory approach, as the analysis focuses on causal explanations to answer the research questions. The causal explanations found in this thesis tend to be probabilistic, rather than deterministic, meaning that a given factor increases or decreases the probability of a particular outcome rather than determining it.

The case study as research strategy

Due to the multifaceted nature of business responses to climate change, quantitative research strategies would not thoroughly answer the present research questions fully and shed light on the company-specific complexities of the issue. Case studies enable deeper investigation of company-specific factors and allow for some degree of generalization based on the findings. However, this generalization should be taken with reservations. For instance, generalizing on sector level would require much more thorough analysis than is possible with the empirical data collected for this thesis. This might also require a more quantitative research strategy. The main reasons for choosing case studies as the body of research are summarized below (Yin, 1994).

- Case studies have considerable ability to generate answers to "why", "what" and "how" – questions. The present research questions are based on these types of questions.
- A case study strategy provides for a rich and focused understanding of complex an interlinked issues. The research in this thesis is part of the broad scientific, societal and political issue of climate change and hopefully reveals new and useful insights to the case companies, scholars and debaters.
- Case studies enable flexibility in selecting cases and interviewees and therefore maximize what can be learned. However, there might also be disadvantages related to the potentially biased relationship between the selected cases and the conclusions based on these. This is discussed below.

Criticism and limitations of the research strategy chosen

The reliability of a research project can be subject to numerous threats. The case study method is criticized for taking a small number of cases into account that do not provide the basis for establishing reliability of findings or the ability to generalize them (Saunders et al., 2003; Jaffe et al., 1995). Findings may be biased because of the selection criteria for the cases to be studied. The case study as a research strategy is further criticized for being used as an explanatory tool and not solely an exploratory tool. Exploratory research aims to find patterns, ideas or hypotheses rather than testing or confirming hypotheses, and some critics find that the attributes of case studies suit exploratory research best (Saunders et al., 2003). Nevertheless, researchers continue to use case studies as a research method, with success in studying real-life situations and problems through explanatory research. By applying solid argumentation behind the conclusions, threats to reliability are minimized. Transparency is ensured by ongoing elaboration on interviewee statements, data collected from the case companies and on the theoretical foundation of this thesis. I am convinced that, because the described research strategy has been followed and because the limitations of such a strategy have been considered throughout the writing and data collection process, solid and transparent argumentation is produced.

Time horizons

Two time horizons can be derived: longitudinal, which examines specific phenomena over a given period of time, and cross sectional, which focuses more on a specific event, such as the introduction of the EU ETS (Saunders et al. 2003). This thesis takes a cross-sectional approach, as this is recognized to be appropriate to the research aim and the researchers resources.

Data collection methods

This thesis incorporates the research strategy of case studies. The data collection methods chosen span accordingly from in-depth interviews to reports from the companies and secondary literature. Thus, the thesis is based on a combination of secondary and primary data. Figure 2.1 summarizes the methodological choices.

Figure 2.1 - Overview of methodological and analytical choices

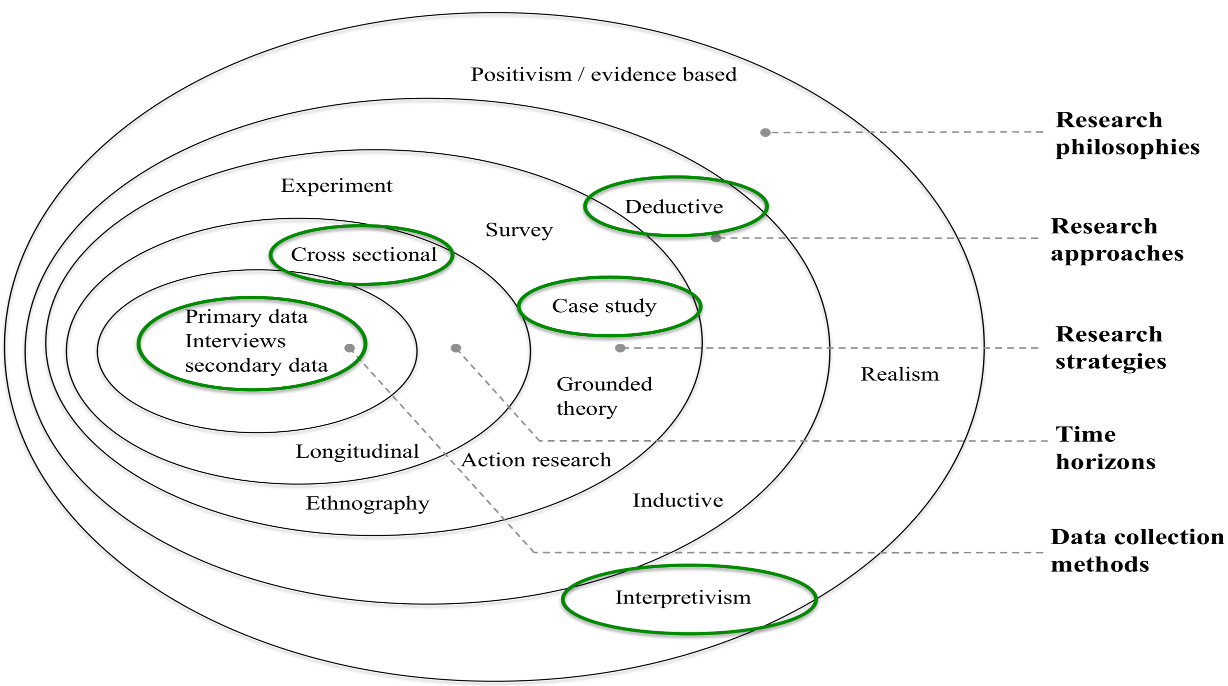

Figure 2-1. Research process "onion" - adopted from Saunders et al., 2003

2.2 Selection of industries and case companies

There is mutual dependence between technology innovators and adopters, society and politics (Kolk & Pinkse, 2009), which signifies the importance of addressing how climate change, and the regulative initiatives to combat climate change, influence not only polluting companies but also related non-polluting companies. The companies selected for this thesis operate at different levels of the value chain, are exposed differently and differ in their responses to climate change. The following criteria guided the selection of the case companies. First, the companies had to operate outside Denmark because they have to have a certain market spread to ensure that their climate change response reflects the global nature of the issue. Expectations towards the future and uncertainty about the impact of global climate policies, the EU ETS and other local and regional environmental regulations are expected to substantially influence the responses the companies have taken towards climate change. Second, the companies had to be either covered directly or become covered by the EU ETS (DONG Energy and SAS), or have substantial technological influence on downstream industries covered by the system (Novozymes and FLSmidth). Third, the companies had to be headquartered in Denmark. Denmark is historically one of the countries with the strictest and most influential environmental policies and the highest ambitions for renewable energy and environmentally sound technology development. This fact ensures that Danish companies have a history of dealing with environmental regulations and can be expected to have experience with societal and political pressure related to the natural environment. Fourth, the companies were selected based on their size, willingness to collaborate, the industry to which they belong and the expected level of responsibility and interest they show towards climate change.

2.3 Empirical data

Primary data - qualitative interviews

As a basis of primary empirical data, I completed more than 10 hours of qualitative semi-structured interviews with relevant employees in the case companies as well as other informants who had relevant knowledge and input during the writing process. The outcomes of these interviews represent only one interpretation out of potentially many (Kvale, 1996). Taking the hermeneutical concept framework into consideration, the approach to the qualitative interviews, and the outcomes of interpretation, are socially constructed and are characterized by the researchers' scientific approach to the research issue. The interviews had the format of casual conversations and were typically guided by the interviewees, although I kept a clear idea of the interview objectives and thus made sure that all questions in the interview guide were answered thoroughly (appendix 1-7 provides the interview guides). Each interview was recorded and lasted an average of 90 minutes, and were all conducted at company sites, except for the interview with Peter Markussen from DONG Energy, which had to be carried out by phone. Follow-up correspondence was subsequently carried out by phone and e-mail. The interviewees are presented below.

Case company interviewees

- **Per Henning Nielsen, Sustainability Development Manager, Novozymes.** Mr. Nielsen works with environmental assessment of biotechnological solutions in industrial production (life-cycle assessment) and has a broad overview of Novozymes' activities related to carbon trading, innovation and sustainability.
- **Martin Porsgaard, Director, Environment & Sustainability, SAS**. Mr. Porsgaard works with developing, improving and coordinating company policies, annual reports and strategies towards sustainability and climate change, hereunder SAS' response to the EU ETS.
- **Cilla Harpsøe Clausen, Manager, CO_2 Funds & Purchases department, DONG Energy.** Ms. Clausen works closely with DONG Energy's carbon trading strategy and has a broad overview of DONG Energy's carbon credit and emissions allowance trading activities and compliance with the EU ETS.
- **Peter Markussen, Senior Manager, Strategy department, DONG Energy Power**. Mr. Markussen is responsible for business development projects and investment strategies and the operations of wind power and combined heat and power stations. Peter has a broad overview of DONG Energy's strategic activities related to EU ETS compliance and climate change innovation.
- **Tine Bremholm Kokfeldt, General Manager, FLSmidth.** Ms. Kokfeldt works with the financial structure of sales in FLSmidth and has thorough insight into cement and mineral customer demands, hereunder the impact of climate change. Further, Tine is part of FLSmidth's "Carbon Group", which is responsible for assessing climate change challenges and opportunities for FLSmidth.

To gain background information and to ensure consideration of opposing opinions to the companies' responses to climate change, the following people from NGOs have been interviewed.

NGO interviewees:

- **Martin Lidegaard**, **Chair of the board in the green think tank CONCITO.** CONCITO is Denmark's largest green network with 90 companies, researchers, organizations and individuals as members of the Council. Mr. Lidegaard is a former member of the Danish Parliament for the Social Liberal Party (De Radikale) and has thorough knowledge of the political as well as industry response towards climate change and environmental regulation, icluding the EU ETS.
- **Tarjei Haaland, Greenpeace Denmark.** Mr. Haaland has worked with climate change for Greenpeace for more than 20 years and is known as a debater and critic of governments and companies' responses to climate change. In 2006 several politicians, including former Minister for the Environment Svend Auken, nominated Tarjei for The Nordic Council's Nature and Environment Prize (Nordisk Råds Natur- og Miljøpris), for his 32 years of work on human made climate change. (Greenpeace, 2006)
- **John Nordbo, Head of the Climate Change Program at WWF.** Mr. Nordbo is well known in the climate change debate for his insightful and critical contributions on government and regional environmental initiatives, COP 15 and the link between climate change and governmental aid to developing countries. John has been with WWF since 2007 and has several years of experience with climate change and globalization from his former positions in the 1992 Group (92-Gruppen) and IBIS.

Secondary data

Secondary data has mainly been gathered from annual reports and CSR reports but also other statistical sources such as reports from the United Nations, EU-, OECD-, Greenpeace-, Point Carbon-, WWF, and research papers, market statistics, official government reports and reports and articles from relevant newspapers. A great deal of inspiration has also been drawn from the conference World Climate Solutions in Copenhagen Bella Center on September 29 and 30, 2010. Several keynote speakers from this conference including Connie Hedegaard, EU Climate commissioner and Denmark's former minister for climate and energy, Anders Eldrup, CEO of DONG Energy and Chair of the Copenhagen Cleantech Cluster, and Lord Anthony Giddens, Professor at the London School of Economics and author, have inspired this thesis.

2.4 Delimitations

Due to the comparative elements of the thesis, it balances between an inter-company perspective and a wider industry-perspective (cf. section 3.2 on outside-in and inside-out perspectives). The thesis takes four companies, in four different industries into investigation. It thus becomes a delicate matter to distinguish whether the study provides and industry/sector analysis or an inter-company analysis. However, the analysis has shown that both industry factors and company-specific factors affect the answers to the research questions, and the thesis thus takes an industry-perspective regarding some issues, whereas it is relevant to zoom to company-level when discussing other issues. The author explicitly acknowledge that the findings could turn out to be fundamentally different, had other industries been chosen. Further, different companies in the same industry can show different responses to climate change, why the company-specific characteristics of the chosen companies will greatly influence the results produced.

This thesis is general study assessing how climate change affects different types of companies in different industries. It is therefore not the purpose of this thesis to investigate one industry thoroughly, as has been done in many other studies on the subject of climate change and carbon trading.[5] Further, the thesis does not discuss issues such as ‘greenwashing”, the financial structure and design of the carbon trading markets or the natural science of climate change and its impact on Earth’s ecosystems.

[5] For instance, Hoffman (2007) on Germany’s electricity industry; Holmgren & Sternhufvud (2007) on the European Emissions Trading System and Sweden’s petroleum refineries; Blanco & Rodrigues (2008) on the European Emissions Trading System and wind energy and Demailly & Quirion (2007) on the European Emissions Trading System and the iron and steel industry.

Chapter 3 – Theoretical point of departure

If improved environmental performance pays off, why do so many companies reveal poor environmental performance? This chapter discusses the main theoretical arguments and empirical studies surrounding the trade-off between environmental and economic performance. Based on this discussion, the chapter constructs a framework used to analyze the companies in the analytical chapter.

3.1 Does it pay to be green? - What is the theory and empirical data saying?

This thesis is inspired by the debate on whether environmental performance pays – the so-called "pays to be green" debate. The main discussion point in this debate is whether increased environmental performance can lead to increased economic performance. Improved environmental performance is the result of reducing greenhouse-gas emissions and pollution, and often the use of scarce resources such as fossil fuels and energy, water and reducing the generation of toxic waste. Companies that improve their environmental performance can experience new opportunities for differentiation or cost leadership, which potentially leads to sustained competitive advantages (Orsato, 2009). Accordingly, a positive association is proposed between environmental and economic performance, which is known as the Porter hypothesis[6], win-win hypothesis or free-lunch hypothesis.

The Porter hypothesis asserts that stringent and flexible regulation, including cap & trade systems such as the EU ETS, can stimulate innovations that offset[7] the cost of complying with these regulations (Porter, 1991; Porter & Van der Linde, 1995). Regulation leads to innovation in companies because they act to compensate, or offset, the negative effects of regulation through innovation.[8] The Porter hypothesis (Figure 3.1) is the main basis for much literature on the relationship between environmental regulation, environmental performance and economic performance.

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[6] The hypothesis was first presented by Michael Porter in 1991 (Porter, 1991)

[7] The concept of offsets is central to the arguments behind the Porter hypothesis. Regulation may increase compliance cost, but "*while the potential for innovation offsets may rise even faster … the net cost of compliance can fall with the stringency and may even turn into a net benefit*" (Porter & Van Der Linde, 1995, p. 100). It is therefore the potential offsets that can result in increased competitive advantages as a result of environmental regulation.

[8] With the introduction of market-based policies such as the EU ETS, companies can also choose to compensate, rather than innovate, by acquiring carbon permits (Kolk & Pinkse, 2009).

Figure 3.1 - Schematic representation of the Porther hypothesis

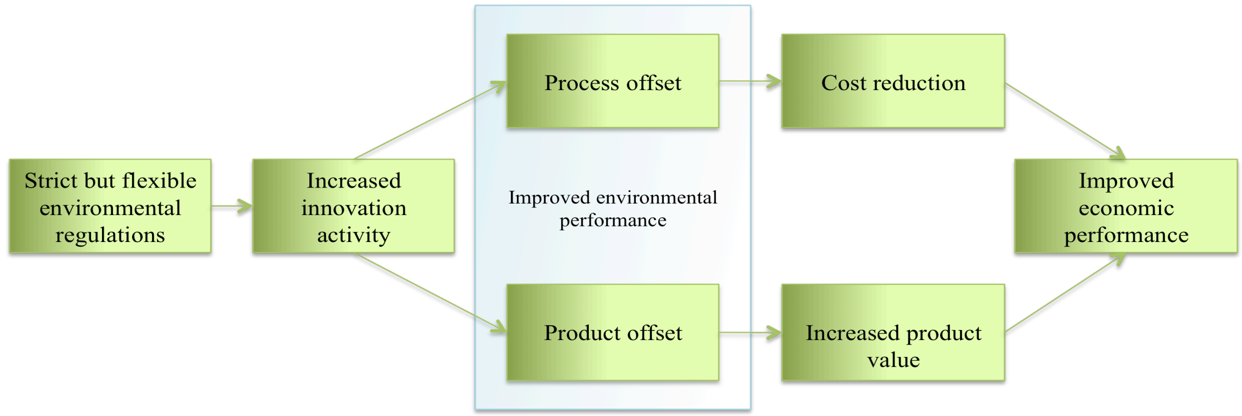

Figure 3-1, Source: adopted from Ambec & Barla (2006).

3.1.1 Discussion of whether environmental performance pays

Several studies investigate whether environmental performance pays and reflect on the premises on which the Porter hypothesis is founded. Criticism asks why environmental regulation is needed for companies to adopt environmentally sound business practices if they were feasible on economic grounds anyway (Jaffe et al. 1995). In other words, companies would not hesitate and wait for legislation to be implemented before innovating and reducing negative environmental effects if these innovations resulted in economic gains. Jaffe et al. (1995) hereby argue that the Porter hypothesis does not conform to the neoclassical concept that companies act rationally to maximize profits. However, Porter & Van der Linde (1995, p. 99) note that "*The possibility that regulation might act as a spur to innovation arises because the world does not fit the Panglossian belief that firms always make optimal choices.*" The authors here refer to the dynamic nature of competition, with rapidly changing technological opportunities and incomplete information.

The Porter hypothesis is still relevant

Almost 20 years after the Porter hypothesis was first published in Michael Porter's one-page article in 1991, the discussion is still on. Numerous studies discuss the hypothesis and provide the basis for it by taking market failures into consideration, concluding that the market has failed to consider the negative externalities of production and consumption. Legislation is hereby justified to correct these market failures and internalize the costs (Ambec & Barla, 2005; André et al., 2009; Greaker, 2003; Simpson & Bradford, 1996). These studies find positive correlations between environmental regulation and companies' economic performance and thus support the Porter hypothesis.

Numerous studies, in contrast, theoretically and empirically show that environmental regulation harms productivity and competitiveness (Jaffe et al. 1995; Mohr, 2003; Walley & Whitehead, 1994; Xepapadeas & Zeeuw, 1999). These studies generally find that complying with regulations increases costs, and that the innovation offsets do not offset compliance costs (see table 3.1). However, as Ambec & Lanoie (2007) argue, most studies examining the hypothesis generally face methodological limitations and therefore cannot fully reject or validate the hypothesis. For instance, the dynamic dimensions of the Porter hypothesis assert that companies, by implementing stricter environmental policies, will reduce inefficiencies and thereby reduce costs and possibly gain new opportunities for differentiation. These processes, however, take time before they produce economic benefits, and since most of the above-mentioned opposing studies do not analyze effects over the long term, they cannot prove that stricter environmental policies *do not* result in improved economic performance (Ambec & Lanoie, 2007; Rugman & Verbeke, 1998).

Further, studies that oppose the Porter hypothesis often fail to consider pollution and greenhouse-gases, as a costly burden, when measuring the economic effects of environmental regulation. Also, the studies have often investigated static command-and-control policies, which focus on preventing environmental problems by specifying *how* a company has to manage pollution-generating processes instead of flexible and marked-based mechanisms such as cap & trade systems that grant companies more freedom of choice. It has been shown that the compliance costs of cap and trade programs are substantially lower than the compliance costs of command-and-control mechanisms over time (Burtraw, 2000).

Many studies have further not been able to examine the reverse causality hypothesis: does increased environmental performance lead to enhanced profitability or do more profitable companies tend to invest in improved environmental performance and reduced emissions? (Hart & Ahuja, 1996). There are thus several gaps in the literature that needs to be addressed.

Table 3.1 presents the main studies discussing this issue.[9] The table briefly lists the studies, the methods applied, and the general conclusions of each study.

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[9] I explicitly acknowledge that numerous other studies examining the relationship between environmental and economic performance exist. The selected studies represent those, which I find to be most influencing on the general debate and relevant to the research purpose of the present thesis.

Table 3.1 - Overview of the debate on whether environmental performance pays

Study	Method or type of study	Conclusions and findings
Porter (1991); Porter & Van der Linde (1995) (Porter hypothesis)	Theory and hypothesis development supported by case studies	Starting point of the Porter hypothesis: Proposes a positive association between environmental and economic performance and that increased environmental regulation can be beneficial for some companies. Environmental regulation should be stringent and flexible (market-based and predictable).
Hart (1995, 1997); Hart & Ahuja (1997)	Longitudinal study - Develops a framework for assessing how environmental performance influences profits.	Introduces the natural resource-based view of the company. Constructs a staged model of three different stages that can help a company decide how competitive advantages can be gained through environmental concerns.
Jaffe et al. (1995); Jaffe & Palmer (1997)	Longitudinal study	Questions the basic elements of the Porter hypothesis and show theoretically how environmental regulation incurs costs and constrains corporations' actions.
Rugman & Verbeke (1998)	Develops a framework for assessing how environmental regulation influences profits.	Provide a resource-based view of the association between environmental regulation and competitiveness and argue that this association is context-dependent.
Reinhardt (1999)	Develops a framework for assessing opportunities for environmental strategizing. Elaboration on the relationship between environment and economy	Conclude that managers need to go beyond the question of does environmental performance pay?, and ask when does environmental performance pay? Reinhart develops different environmental strategy options and argues that companies can gain competitive advantages through differentiation, cost leadership, risk management and redefining existing markets.
Pinkse (2004); Kolk & Pinkse (2005, 2007, 2008, 2009)	Develops a framework for assessing responses to climate change and environmental regulation, including cap and trade systems	Develops several frameworks assessing companies' strategic opportunities for climate change and environmental regulation. Argue that companies can either innovate or compensate for their emissions. Innovation involves developing new environmental technologies or processes to reduce emissions. Compensation involves purchasing carbon permits in the market or such measures as relocating polluting activities to non-regulated regions. The main difference is that innovation improves a company's technological assets and competencies, whereas a compensation strategy does not incur any fundamental changes.
Orsato (2006, 2009)	Framework for assessing opportunities for sustainable strategizing	Constructs a choice model of five different environmental strategies that companies can follow: Companies can either focus on optimizing internal processes or their products, and can gain competitive advantages through reduced costs or differentiation.
Ambec & Lanoie (2007), Ambec & Barla (2002, 2005),	Review of the Porter hypothesis and empirical evidence to suggest how environmental performance can lead	Conclude that environmental performance can improve economic performance by increasing revenue through three different mechanisms: access to new markets; differentiating products; selling pollution control technologies; and lowering costs through four mechanisms: improved relationships with external stakeholders, lower cost of input materials and

Ambec et al. (2010)	to economic gains	resources, and easier access to capital and labor.
Prahalad et al. (2009)	Develops a framework for assessing opportunities for sustainable strategizing	Constructs a staged model of five different stages that can help a company decide how competitive advantages can be gained through environmental concerns. Very similar to the stage model developed by Hart (1995). Argue that top management support and skilled employees are the two most important enablers for green success.

Table 3-1. Source: Author's own creation

The magnitude of different arguments for and against the Porter hypothesis leads to the conclusion that there is no clear answer as to whether environmental performance improves economic performance. The landscape of political support, societal pressure and new technologies constantly change, and the implementation of the EU ETS has established a fluctuating price on carbon emissions for many years to come. Companies' optimal course of action depends on the internal and external factors and the opportunities and challenges it faces. As shown in table 3.1, the discussion has moved from *whether or not* environmental performance pays to *when* environmental performance pays (Ambec & Lanoie, 2007; Orsato, 2009; Reinhardt, 1999). Establishing more thorough knowledge of when environmental performance pays is key to a better understanding of innovation dynamics in the paradigm of climate change. The next section discusses companies' optimal responses to climate change from a resource-based and contingency theory perspective.

3.2 A resource-based contingency view – why there is no one best way

This thesis is founded on two strategic perspectives, the resource-based view (inside-out) and contingency theory (outside-in). The next section presents an elaboration on how resource-based theory and contingency theory can be merged to create an analytical framework appropriate to perform the analysis in chapter 4.

The resource-based view

The resource-based view is a useful addition to the discussion of company responses to climate change because it focuses on internal, company-specific resources. It proposes that competitive advantages are driven by a company's resources, capabilities and competencies, which are embedded in its organizational behavior and actions (Barney, 1991; Teece et al. 1997). The resource-based view sheds light on various resource endowments that lead companies to pursue strategies to attain competitive advantage, and innovate for climate change. Hart (1995) further articulates the association between a company's resources, capabilities and competitive advantages and the natural environment. In accordance with the resource-based view, he creates a theory of environmental strategies and argues that valuable and hardly imitable resources and capabilities should be in synergy with the natural environment. This synergy provides the key-sources of sustainable competitive advantages.

Merging the resource-based view and contingency theory

Contingency theory asserts the existence of a relationship between some aspect of organizational structure or action and some aspect of the contextual situation. Situational factors are context-dependent and are generally referred to as contingency factors. These include instability in the external environment, emerging technologies, shifting regulative and societal pressure and exposure to climate change (Chandler, 1962; Correa & Sharma, 2003). Contingency theory posits that *"…organizational performance (competitive advantage) is a result of the proper alignment of endogenous organizational design variables with exogenous context variables"* (Correa & Sharma, 2003, p. 72). It can therefore be expected that the case companies do not have the same degree of proactivity in their responses to climate change because the exogenous context variables differ. It can further be expected that the companies respond differently to contingency factors and regulative constraints, given their perceived threats and opportunities occurring from climate change and their existing technology, resources and capabilities.

3.3 Developing an analytical framework

Is has now been established that both a company's internal resources and capabilities, and the external environment influence its ability to respond proactively to climate change. A framework is now designed, which builds on a combination of resource-based theory and contingency theory. It considers key determinants of environmental innovation, given a company's role as either adopter or technology innovator. The framework first investigates whether the company has adopted a proactive or reactive response to climate change. Second, the framework investigates circumstances that drive this response. This is done by answering the following questions:

1. Are the company's core activities, technology and products complementary to climate change?
2. Does the company experience clear demand or significant external pressure to improve its environmental performance?
3. Is the company significantly motivated to improve its environmental performance because of the EU ETS or other regulation?

Figure 3.2 presents an illustration of the framework.

Figure 3.2. – Analytical framework

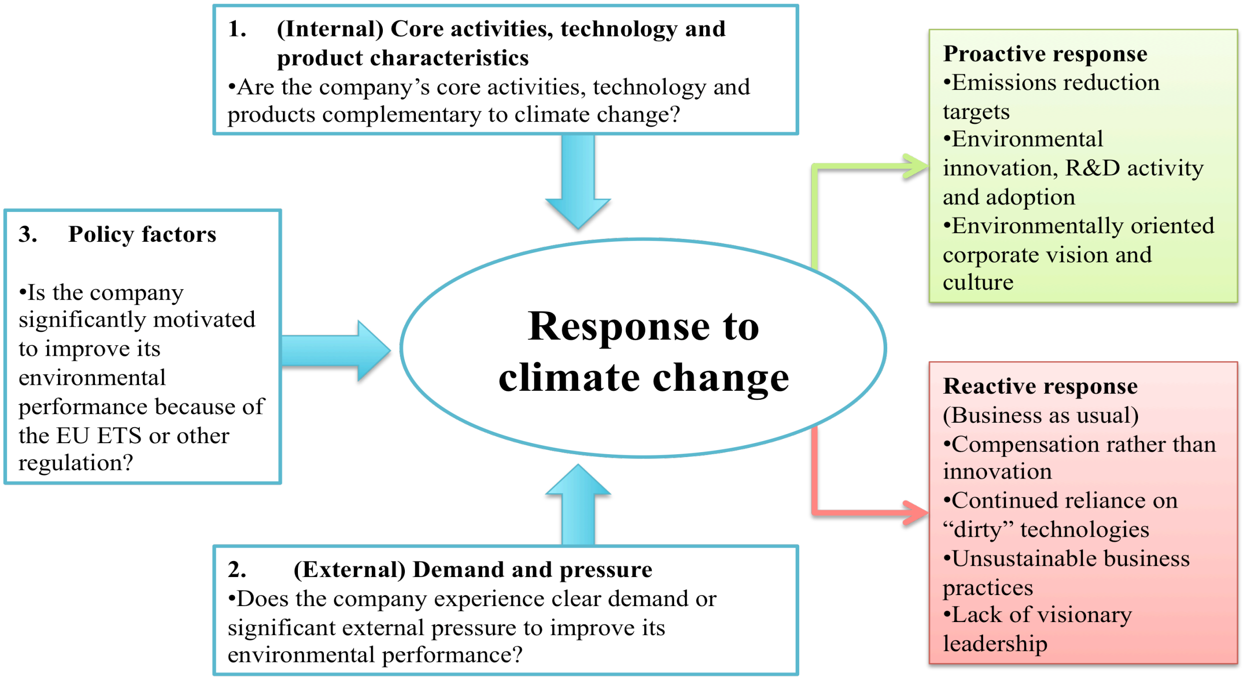

Figure 3-2. Source: Author's own creation. Inspired in part by Hoffmann et al., 2010.

The remainder of this chapter first discusses characteristics of proactive responses to climate change. It afterwards discusses causes for heterogeneity in corporate responses to climate change by assessing the factors 1-3 in figure 3.2 in consecutive sections.

3.3.1 Characteristics of a proactive response to climate change

A company will develop a proactive response to climate change if it leads to competitive advantages (Jaffe et al, 1995; Reinhart, 1999). Whether a company's response to climate change is proactive depends on the given industry-standard and the regulatory framework pertinent for its industry.

This thesis adopts the following definition of a proactive response to climate change:

Companies that respond proactively to climate change demonstrate voluntary adoption and development of technologies, processes and products with the purpose to prevent negative environmental effects, or create positive environmental impacts, beyond what is legally required or accepted as standard industry-practice. (Inspired in part by Correa & Sharma, 2003)

Prahalad & Rangaswami (2009), and Hart (1995), suggest stages through which companies typically advance on their path towards all-encompassing proactive climate strategies. The purpose of these "stage models" is to address a company's progression towards sustainable and non-polluting business practices. They assume an evolutionary path starting from weak environmental performance to high or all-encompassing environmental performance.

The typical evolutionary path ranges from first viewing compliance as an opportunity to optimize polluting production processes and reduce emissions. The next step is to make supply chains sustainable by focusing on suppliers' environmental performance and the environmental attributes of resource inputs. This leads to redesigning of products and services with a focus on reducing greenhouse-gas emissions, often in the downstream consumption of products. Lastly, companies develop new business models that build on sustainability and implement a "shared green vision", thereby embedding environmental concerns into all actions and into the very foundation and dominant logic (Prahalad & Bettis, 1986) of the company. Figure 3.3 presents Hart's (1995) model of three stages of increasing environmental performance.

Figure 3.3 – Hart's (1995) stage model of environmental progression[10]

Stage	1. Pollution prevention	2. Product stewardship	3. Sustainable development
Competitive advantage	Lower production costs, fewer emissions and lower compliance costs	Lower life-cycle costs, higher-quality products, differentiation, pre-emption	Access to new markets, improved vertical and horizontal relations, lobbying and reputation etc.
Scope	Mainly internal and upstream	Mainly internal and vertical	Internal, vertical and horizontal
Competitive focus	Production processes and operations (requiring skills such as total quality management or LEAN manufacturing)	Product design and development. Integration of the entire value chain	All business units and employees, suppliers and customers, NGOs, politicians etc. – shared green vision.

Figure 3-3. Soucre: Hart, 1995

10 As stated by Hart (1995), the stages have a sequential logic. Thus, a company cannot consistently follow a product stewardship strategy (strategy 2) without first developing capabilities and exploiting the opportunities of a pollution prevention strategy (strategy 1). Excellence in preventing pollution and in product stewardship is further required for a company to pursue a sustainable development strategy consistently and credibly.

Alternative models to assess companies' responses to climate change

The literature presents several other models that focus on *strategic choices* for gaining sustainable competitive advantages through improved environmental performance, without necessarily assuming an evolutionary path. *Choices*, for instance, refer to whether companies should aim for differentiation or low cost (Porter's generic strategies, (Orsato, 2009)) or for innovation or compensation through carbon permits as a mean to reduce emissions (Pinkse & Kolk, 2009).

Choice models assesses *which strategic opportunities* companies have while stage models assesses *how far* companies have progressed on their path towards becoming environmentally sound. The models of Orsato (2006,2009), Kolk & Pinkse (2009), Ambec & Lanoie (2007) and Rugman & Verbeke (1998) are examples of choice models. The different models are designed to analyze different situations of climate change's impact on companies and their opportunities of profiting from emerging opportunities. In this thesis, Hart's (1995) model (figure 3.3) is primarily used to determine the companies' responses to climate change. However, as the companies are different in nature, perspectives from other models are also considered in the analysis, in order to assess whether the companies have taken proactive or reactive responses.

3.3.2 Factor 1 – Core activities, technology and product characteristics

Core activities, technology and product characteristics address to which degree a company's core activities, technology and products complement the climate change paradigm (Kolk & Pinkse, 2009). Basically this factor addresses a company's ability to reliably *push* environmentally sound products and services to the market and how a company's technological base influences its response to climate change (Grubb, 2004).

The attributes of the existing technological regime determine how difficult a transition to a low-carbon technological regime is (Winter, 1984). Technological regimes are important because they constraint the pattern of innovation emerging in an industry. In the context of climate change, different technology regimes reveal different opportunities to mitigate environmental impacts. Climate change incurs competence-destroying technological change on some companies (Anderson & Tushman, 1986). Other companies rely on technology bases that are complementary to the climate change paradigm, in which case climate change incurs competence-enhancing technological change.

For come companies, the greatest potential to improve environmental performance is through optimization of their organizational processes, rather than their products and services (such as DONG Energy and SAS, which are located downstream in the value chain and where pollution occur in the production process rather than in the downstream “consummation”) (Orsato, 2009). For other companies, the greatest potential to improve environmental performance is through optimization of their products and services (Such as Novozymes and FLSmidth, which are located upstream in the value chain and generate few internal emissions, but which product’s reduce downstream emissions) (Ibid). Such products can improve environmental performance by reducing carbon emissions in the downstream application.

In summary, factor 1 in figure 3.2 addresses to which degree:

- the company’s’ *core activities* are complementary to climate change[11], hereunder;
- whether the company’s *core technology* is complementary to climate change, and;
- whether the company’s *core products* are complementary to climate change.

3.3.3 Factor 2 – Demand and external pressure

Demand and external pressure address to which degree a company is exposed to *demand-pull* effects, or pressure from society to improve its environmental performance through cleaner production processes or products (Grubb, 2004).

DiMaggio & Powell (1983) develops a framework of three types of pressures that emerge under uncertainty; coercive, normative and mimetic. *Coercive* pressures result from policy factors and are covered in section 3.3.4 below. *Normative* pressures follow from social obligations that are associated with membership of a community or society. *Mimetic* pressures result from uncertainty and emerge as the pressure to copy or model other high-performing companies’ environmental actions. A company is likely to imitate successful practices from peers or follow a certain tradition in response to uncertain or ambiguous situations. The degree to which these types of pressures influence a company’s response to climate change varies with the company’s exposure to public scrutiny, its competitive position and the degree to which social legitimacy is a prerequisite to operate (Porter & Kramer, 2006).

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[11] The expression “complementary to climate change” asserts the environmental attributes of a company’s activities, technology and products. Those which are “complementary to climate change” have positive environmental effects (Cf. section 2.1 on the definition of innovation).

In summary, factor 2 in figure 3.2 addresses to which degree:

- the company is exposed to significant external pressure or support from society to improve its environmental performance;
- the company experiences clear demand signals for environmental process or product credentials.

3.3.4 Factor 3 – Policy factors

The technological response of [environmentally] *regulated firms may strongly differ according to demand conditions, but also to technological opportunities and appropriability conditions. Thus it is very difficult to generalise about the innovative effects of environmental policy instruments since the impact of each instrument depends on the context in which it is implemented"* (Oltra, 2008, p.6)

Two categories of policy approaches to combat climate change exist. These are "market-based policies" designed to let the market decide how to mitigate pollution and "technology support policies" designed to directly support development and deployment of technologies.

Market-based policies - cap & trade systems

Market-based policies, such as the EU ETS, are designed to foster innovation by increasing the perceived payoff of improved environmental performance. These policies maximize the flexibility of compliance by letting the market decide which technological opportunities to pursue in order to reach a fixed target of emission reduction. The approach follows the "polluter-pays principle" and is characterized by penalizing the polluting a company generates. Market-based approaches create demand-pull and induce polluting companies to increase their demand for environmentally sound technologies. Market-based policies thus indirectly motivate technology innovators to conduct technology push because they reduce uncertainty as to whether investment in environmental innovation will be valuable (Porter & Van der Linde, 1995).

Box 4.3.4 – The European Emissions Trading System

The EU aims to reduce emissions to 20% below 1990 levels by 2020 by enforcing a palette of policy initiatives. The EU ETS forms the centrepiece of the centralized European action on climate change and covers more than 40% of all greenhouse-gas emissions in the EU (Grubb & Neuhoff; 2006). The system is by far the largest cap & trade system and its design is based on many years of economic research leading to theories of emissions trading and cost-effective mitigation of greenhouse-gases. The system covers emissions from large stationary sources, such as heat generators, oil refineries and installations that produce cement, ferrous metals, pulp and paper, glass and ceramics and lime (EEA, 2009).

Institutions are defined as a set of rules constraining organizations in conducting their activities (Ingram & Clay, 2000). A cap & trade system is thus an institution, which limits the quantity of greenhouse-gasses a company may emit to the atmosphere. Cap & trade systems are based on the market deciding the price of carbon permits. Companies may sell carbon permits to each other, if they innovate to reduce emissions to less than their cap, or if they have been granted an excess number of permits for free. The market therefore has a fixed (regulated) quantity (the overall number of emissions allowances (the cap) is reduced every year) but a variable, market-driven price (trade). Theoretically, this is the least expensive way of reducing overall greenhouse-gas emissions (Grubb, 2004). However, critics claim that it is an expensive and inefficient way, compared with a regular tax on carbon emissions, and there is great discussion on whether cap & trade systems actually foster innovation and reduce overall carbon emissions more efficiently than other political tools (Hoffmann et al, 2010).

Technology support policies

Technology support policies are designed to directly support the development and diffusion of environmentally sound technologies. Such policies include subsidy policies and feed-in tariffs, the development and deployment of new technologies, university research and "green public procurement". Technology support policies increase the demand pull for environmentally sound technologies when, for example, a policy is enforced that imposes certain environmental standards or promotes specific technologies in public purchasing (such as the city of Copenhagen purchasing hydrogen-powered and electrical vehicles). The approach however, often spurs technology push by directly supporting development and deployment. It is criticized for "picking winners": choosing to support some technologies over others (Jaffe et al., 1995; Porter & Van der Linde, 1995). The critique points to problems of asymmetrical information, as policy-makers cannot have the required knowledge needed to “pick winners” due to their lack of information about a given technology and its market potential. Arguably, the market has better information about which technologies should be developed and commercialized, and only these survive due to the mechanisms of a market economy (Ibid). However, this neoclassical conception is subject to heavy debate because of the market failures associated with climate change.

In summary, factor 3 in figure 3.2 addresses to which degree:

- the company is motivated to improve its environmental performance because of the EU ETS.
- the company receives subsidies or other support that diminishes the risks of developing or deploying low-carbon technologies

3.4 Conclusions to theoretical point of departure

Academic writings on the subject of environmental versus economic performance show that there is no clear answer to whether environmental performance pays. Therefore, different strategic schools of both inside-out and outside-in perspectives have been advocated to shed light on how climate change and environmental regulation impacts different types of companies and how they can benefit economically from taking the natural environment into concern. This thesis draws on two strategic schools of resource-based theory and contingency theory. The merger of these schools has designed a framework suitable to analyze companies that are different in nature, industry and value chain position, and which reveal different responses to climate change. The framework considers both external factors of societal pressure and regulation and internal factors of inter-company capabilities and technologies. The thesis now continues with the empirical chapters where the analytical framework in figure 3.2 is applied to each of the companies.

Chapter 4 – Analysis of corporate responses to climate change

The thesis now proceeds to the empirical findings from interviews and research on the four case companies. Through interviews and publications from the companies and from third parties like NGO's, and government- and industry-organizations I have gained insight into each case company's environmental strategy, their technological opportunities and their motivations to conduct (or disregard) environmental innovation. These insights are presented and elaborated on in this chapter. The chapter answers the first research question:

> **1. How do different types of companies respond to climate change and which circumstances drive these responses?**

Each company is analyzed in consecutive sections according to the framework presented in figure 3.2. Thus, the company's response to climate change is first presented and elaborated on. Second, its technological regime and the environmental credentials of its products are assessed (factor 1). Third, the nature of environmental demand and exposure to normative and mimetic pressures are assessed (factor 2) and lastly its exposure to regulations is assessed (factor 3). The chapter first analyses the two carbon-intensive companies, DONG Energy and SAS and thereafter the two carbon-free companies, Novozymes and FLSmidth.

4.1 DONG Energy

From DONG Energy, Cilla Harpsøe Clausen (CC) was interviewed on August 11, 2010, and Peter Markussen (PM) was interviewed on August 27, 2010.

4.1.1 The electric utility industry's climate challenge

Denmark is among the top 15 countries in coal use per inhabitant and coal is responsible for 35% of greenhouse-gas emissions in Denmark (Greenpeace, November 2009). This is one of the main reasons why Denmark can hardly reach the Kyoto Protocol targets of 21% reduction in 2008–2012 compared with 1990 through domestic reductions. In 2009, the top 10 EU ETS emitters were all power plants. Together, these 10 installations emitted over 10% of the total emissions due to continued reliance on fossil fuels. In Europe, however, the industry is rapidly integrating renewable power generation from wind, solar and biomass based technologies. The challenge occurs as these renewable energy sources are still not cost competitive versus fossil based sources.

4.1.2 Introduction to DONG Energy

"We basically have two reasons to go green: responsibility for nature and society and new business opportunities. The green train is leaving, and we want to be on it".[12]

DONG Energy is Denmark's largest energy supplier with yearly revenue of about €7 billion. It is a market leader in electricity generation for Denmark and has activities in Denmark, Sweden, Norway, UK, France, Germany, Iceland and Greenland[13]. It is owned primarily by the Danish government and was founded in 2006, through the merger of six utility companies. In 2009, DONG Energy emitted 12 million tons of CO2; since Denmark's annual emissions are about 62 million tons, this corresponds to around 20% of total Danish emissions.[14] DONG Energy thus has major greenhouse-gas reduction potentials and is a cornerstone in reducing Danish emissions. Since DONG Energy is owned by the state, and is the largest Danish Utility Company, it receives tremendous support to renewable investments from the government on one hand, and experiences heavy normative pressure from society to reduce emissions on the other.

4.1.3 DONG Energy's response to climate change

DONG Energy has taken a proactive response to climate change. The company has recently changed its attitude towards the natural environment by implementing a new set of ambitious emissions reduction targets. Box 4.1.3 presents Dong Energy's climate-strategy.

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[12] Anders Eldrup, CEO, Dong Energy at the World Climate Solutions Conference (September 29, 2010).
[13] This thesis does not consider DONG Energy's activities in oil and natural gas exploration.

[14] These estimates use the principles for reporting based on the Kyoto Protocol and exclude emissions from international sea and air. Denmark's emissions from international sea and air comprise to 52 million tons/year, and thus Denmark's overall emissions in 2007 where actually 117 million tons. (Statistics Denmark, 2009)

Box 4.1.3 - DONG Energy's 85/15 climate-strategy

DONG Energy's environmental strategy is divided to three pillars. The first pillar is aimed at the firm's own energy consumption from administration, travel etc. The second pillar is aimed at enabling and effectuating downstream reduction potential by helping companies and households to reduce their energy consumption. The third pillar aims to transition DONG Energy into cleaner technological regimes and was formulated in 2009 as the 85/15 plan. Currently 85% of DONG Energy's electricity generation comes from using fossil fuels and 15% from renewable sources. The plan is to reverse this relationship so that 85% of electricity is fossil fuel-free by 2040 (Dong Energy, 2009). The concrete targets are:

- To reduce the average CO2 emissions per produced unit of energy by 50% of 2006 levels by 2020;
- To further reduce the average CO2 emissions per produced unit of energy to 15% of 2006 levels by 2040; and
- To reduce emissions by 1 ton per employee by 2012 compared with 2006.

DONG energy has furthermore designed a new vision that complements its transition to renewable electricity generation: *"To provide reliable energy without CO2. This is the goal we are headed for and are working towards every day through new investments and ongoing adjustments". (DONG Energy, 2009)*

DONG Energy aims to mitigate carbon emissions by replacing fossil fuel input materials such as coal and oil with renewable sources such as biomass. *"Our new strategy represents a huge shift in the way we generate energy. We have always optimized our plants and processes and been leading in resource efficiency of coal based power generation. With the new strategy, however, we have to significantly change the way we generate energy so that carbon emissions are mitigated"* (PM).

DONG Energy has started a major transition towards deploying low-carbon technologies that differ fundamentally from its core-technological regime. It is pursuing a strategy that aims to change inputs to from "dirty" to "clean" sources, which prevents the use of polluting resources in the first place. Many electric utility companies in Europe have chosen to continue relying on coal and other fossil fuels. When these companies are addressed with accusations of poor environmental performance, they defend this decision by saying that they support the development of end-of-pipe technologies such as carbon capture and storage (Grubb & Neuhoff, 2006). *"What is appealing about CCS is that it allows carbon intensive companies to become proactive on climate change, while at the same time continue with their core business activities, even with carbon constraints"* (Kolk & Pinkse, 2009, p. 159). DONG Energy has decided not to continue developing this technology[15]. The technology is appealing, but according to Dong, not yet efficient enough to compete with other ways of mitigating emissions. Accordingly, DONG Energy aims to change pre-combustions processes and resource inputs, rather than retrofitting existing coal-based power stations to emit less carbon. This is considered a proactive response in the electric utility industry (Kolk & Pinkse, 2009).

Further, the company has adopted new policies that aim to reduce internal emissions from its own operations (similar to a *pollution prevention strategy*, cf. figure 3.3, Hart, 1995). DONG Energy's environmental activates are basically an *"insurance policy against regulatory difficulties, sour community relations, business interruptions, and related costs shocks"*(Reinhardt, 1999, p. 155). DONG Energy has also started addressing the patterns of electricity consumption by interacting and helping its customers mitigating their consumption. The company seeks to integrate the entire value chain and is establishing new relationships to suppliers of biomass, replacing coal, and producers of wind technology. DONG Energy's response to climate change is proactive as it induces fundamental changes to the way energy is generated instead of modifying unsustainable production techniques[16] (Reinhardt, 2000; Rugman & Verbeke, 1998).

4.1.4 Factor 1 - Core activities, technology and product characteristics

Seen in a 40-year perspective, during which Denmark's energy sector transitioned from oil to coal because of the oil-crisis in the 1970s, DONG Energy's core technologies has been combusting fossil fuels, and especially coal. In order to reach the intended targets

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[15] DONG Energy has experimented with carbon capture and storage in a powerplant in Esbjerg. 1/3 of the energy generated in the plant was consummated to power the carbon capture and storage-component and DONG Energy has now lowered expectations and investments to further develop the technology.

[16] DONG Energy is a large and diversified company and some divisions, including business units in oil drilling and exploration, are many years from becoming environmentally friendly and are thus currently not supportive of DONG Energy's proactive climate strategy. Thus, several factors can also be used to argue against the company following a truly proactive climate strategy, and it is therefore important to emphasize that DONG Energy is in the preliminary phases of transitioning to renewable energy generation, that will take several decades to fully implement.

formulated in the 85/15 strategy, DONG Energy has experimented with various promising technologies such as carbon capture and storage, biomass, wind, wave, solar and geothermal energy. However, few of these technologies are sufficient to generate necessary amounts of renewable electricity, and have the technological and price-related attributes required to compete with existing technologies based on fossil fuels (Pinkse & Kolk, 2009).[17] DONG Energy recently chose to narrow its focus to mainly emphasize two renewable technological paths. 1. Wind energy and 2. Biomass and waste energy along with incrementally improving the utilization of coal and natural gas (PM). The company has obtained the highest coal-fired power efficiency in Europe and is considered a market leader in utilizing coal.[18] The challenge is now to transition away from the core-technological regimes that are based on fossil fuels.

Biomass production has steadily increased since 2001 and currently account for 15% of electricity generation in DONG Energy's power plants. DONG Energy is in the process of replacing coal with biomass by for instance shutting down 990 MW of coal-based generation in Studstrup and Asnæsværket in 2010. Generation from biomass requires different techniques, skills and knowledge than burning coal[19]. However, Dong Energy does not consider these capabilities to be radically different from its existing capability foundation used to generate electricity from coal. Biomass production thus entails competence-enhancing evolution (Anderson & Tushman, 1986) *"Biomass, in contrast to wind power, has the great advantage that we can reuse much of our existing expertise. Also, we only have to modify existing power stations to use biomass instead of coal"* (PM).

The second path is wind-based power generation. DONG Energy currently has 19 wind farms operating and is constructing 6 new ones. Wind energy currently comprises 14% of DONG Energy's overall electricity generation. Wind constitutes a competence-destroying technological discontinuity and represents a technology, that DONG Energy's historical path and many of its core assets and activities do not support. Capabilities required for wind generation differ radically from those needed for fossil-based generation. *"If we are going to use wind energy efficiently in the future, a whole new supporting infrastructure with a*

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[17] Appendix 8 provides an overview of cost attributes of various energy sources

[18] Dong's power stations produce about 850 grams of CO_2 per kWh produced, compared with the industry average of 1000 grams of CO_2 per kWh (DONG Energy, 2008)

[19] Biomass can be produced from numerous natural resources and by products such as grain, straw and wood, and increasing efforts are being made to develop efficient ways to use waste products from households and industry. Biomass is considered fossil-free, because the same amount of carbon is released when it is burned as it absorbed during growth.

smart-grid and perhaps storage in electrical vehicles is needed. All these changes take a long time and we need to think of energy in a whole new way in the future" (PM). Considering DONG Energy's investment in wind-related technologies and expertise, it has committed significant resources to develop capabilities and assets that complement wind energy. An example is DONG Energy's acquisition of the offshore wind farm installation company A2SEA.

In summary, DONG Energy is in the process of transitioning to fundamentally different technological regimes comprising wind and biomass (85%) while remaining some capacity within coal and natural gas (15%). The transition is largely competence-destroying in the long-term (30 years).

4.1.5 Factor 2 - Demand and external pressure

The demand and pressure on DONG Energy to increase its share of renewable energy and thus environmental innovation is clear: *"Demand for renewable energy is rising on all our markets and consumers are willing to pay the extra cost of renewable energy*[20]. *From a demand point of view there is no doubt that green is the way forward for electricity generation. The problems are just how fast we can go "green" and how expensive it will be"* (PM).

Due to the rising levels of political and societal pressure on DONG energy's polluting activities, reputational assets are becoming increasingly important in order for the company to secure political and societal legitimacy. Environmental consideration thus becomes a "license to operate" (Porter & Kramer, 2006) and key to secure political influence and subsidies for renewable investments. Normative pressure on DONG Energy to reduce its greenhouse-gas emissions is thus substantial: *"We feel the increasing pressure from society and politicians to close down polluting activities. We hope, that with our new climate strategy [85/15 strategy], and expertise in wind and biomass, we can turn this pressure into support"* (PM). DONG Energy is a heavy emitter of greenhouse-gases and enjoys a monopoly-like status on the Danish market. It is therefore exposed to great influence from

[20] On many markets, customers have no choice not to pay the higher price of renewable electricity because the higher price is counterbalanced by government subsidies (cf. section 4.1.6) on subsidies). The "true" price of renewable energy is thus not reflected on the customer's electricity bill. Further, electricity is generally inelastic (PM).

various policies and support from politicians is key to secure DONG Energy's continuing investment in renewable energy, which leads to the last factor.

4.1.6 Factor 3 - Policy factors

Effects of the European Emissions Trading System

In DONG Energy, a forecasted carbon price is now added to the company's cost-projections of new investments. A coal power plant with a lifetime of 30 years is thus expected to yield substantially higher lifetime costs than most alternative investments in renewable energy: *"We always consider the price of carbon in investment decisions. The current price does not threaten the profitability of "black" production very much, but we expect the price to increase in the long run and we prepare for this by moving away from "black" production over the next 30 years. In the long term "green" production will become cheaper, partly because of the added price of pollution to dirty sources and partly because these technologies will get less expensive and we will get better at using them."* (PM). In the long run, the EU ETS is therefore supportive of DONG Energy's environmental innovation in various ways[21].

However, as long as the carbon price does not rise to levels that make fossil fuels equally expensive to renewable energy, carbon emitting companies can potentially rely on dirty technologies and compensate for their emissions by buying permits in the market (Grubb & Neuhoff, 2006). This trend has been extensively investigated theoretically and seems to be relevant in the short term because too many permits have been granted for free to carbon emitting companies in the first two trading periods of the European emissions trading scheme, thus dumping the carbon price (Betz & Sato, 2006; Petsonk & Cozijnsen, 2007). WWF and Greenpeace have been fiercely criticizing DONG Energy for its lack of renewable investments until recently. *"It is peculiar that DONG Energy waited until 2009, the year Denmark hosted COP15, and thereby the year where society and politicians eyes were focused on climate change, to formulate an ambitious climate strategy*" (Personal communication, Tarjei Haaland, Greenpease, August 13, 2010). The criticism highlights that DONG Energy could have implemented a proactive climate strategy and could have started a serious transition to renewable generation many years ago.

[21] Blanco & Rodrigues (2008) for instance found that a carbon price of €40 per ton of CO_2 should be reached to counterbalance the excess cost of wind energy compared to various fossil fuel sources. According to the forecasts used here, the carbon price will reach that level in 2016.

Does DONG Energy compensate for its lack of innovative activities to reduce emissions?

DONG Energy is currently engaged in substantial carbon trading activity. The average price for each carbon credit was in 2009 about €1. EU-allowances cost about €15 in 2009 (Point Carbon, August 11, 2010). As credits are thus much cheaper than allowances, DONG Energy uses its full quota of credits to comply with regulation (CC). Both Greenpeace and WWF have criticized DONG Energy's reliance on carbon credits: *"DONG Energy postpones decisions that they eventually have to make by relying on credits. It is similar to Denmark's overall lack of emission reductions, - DONG Energy can also postpone internal emission reductions by relying on carbon credits as long as these are inexpensive enough. Politicians should therefore introduce a minimum carbon price"* (Personal communication with John Nordbo, WWF , August 30, 2010). DONG Energy responds to this by stating that the emission trading system and CDM carbon-credit markets are new and need time to mature. Further, DONG Energy refers to its 85/15 strategy, stating that it seeks to innovate instead of compensating for its emissions but that this transition takes a long time because power plants and supporting assets have long lifetimes and because deployment of renewable energy sources yield substantial costs, which leads to the role of government subsidies.

Role of government subsidies

Government subsidies play an important role in reducing the uncertainty related to investing in immature renewable technologies: *"If there were no subsidies, we would of course rely more on oil and coal until the cost of emitting CO_2 rose to counterbalance the higher cost of using renewable energy sources. Today, wind power is more expensive than coal, but the extra cost is counterbalanced by the government and also passed on to consumers"* (PM)

In Denmark, the mechanism that counterbalances the excess cost of wind energy compared with fossil fuels is a Public Service Obligations-tariff (PSO-tariff) (Djursing, 2007). When electricity prices fall, the PSO tax increases and DONG Energy is given a constant market price for its wind-produced electricity. The tariff thus reduces risks associated with investments in wind energy. Many of DONG Energy's large investments in renewable energy, especially offshore wind-farms, are launched based on political decisions and renewable energy projects can have significant value for politicians because major projects such as Horns Rev 2 create jobs and boost Denmark's green image, share of renewable energy and the supporting industries. *"In Christiansborg, climate change suddenly got* *interesting after Denmark was granted the hosting of COP15 in December 2009. As a result, money was granted to investments in renewable energy, public procurement and support for research in climate change technologies*" (Personal Communication, Martin Lidegaard, CONCITO, April 12, 2010). This political support significantly reduces the financial risks of investing in renewable energy for DONG Energy and is therefore a major driver or enabler, if not currently the single most important one.

4.1.7 Conclusion to DONG Energy

DONG Energy's response to climate change: Proactive. DONG Energy has taken a proactive response to climate change. Its new vision and its emissions reduction targets send clear signals that the company must reduce its carbon emissions by transitioning to a cleaner technology regime. However, the transition is long-term and one could thus argue that DONG Energy's electricity generation is currently not sustainable.

Factor 1: Are the DONG Energy's core activities and technology complementary to climate change? DONG Energy's core activity is generation of electricity. DONG Energy is currently operating with coal-based technologies and stands in front of a competence-destroying change process. Since its core technological regime has been surrounding coal, many of the company's capabilities, competencies, knowledge assets and much of its equipment needs to be replaced. DONG Energy has just recently started the transitional process and its core technological regime is currently not complementary to climate change.

Factor 2: Is DONG Energy experiencing clear demand or significant external pressure to improve its environmental performance? Demand and external pressure send a clear signal that DONG Energy's environmental innovation efforts within wind and biomass will pay off. This is because price-elasticity among consumers is low, which means that they are willing to pay the price-premium connected with renewable energy. Further, the general society is supportive of DONG Energy's investments in renewable technologies. Politicians therefore provide generous financial support to establishment of renewable energy infrastructure and DONG Energy in this vein operates in a highly munificent environment.

Factor 3: Is DONG Energy significantly motivated to improve its environmental performance because of the EU ETS or other regulation? Policy factors seem to further clarify why environmental innovation is economically sound for Dong Energy (in the long-term). The support from the PSO-tax and the penalization of polluting processes, reduces risks of investing in renewable technologies. The EU ETS continually reduces the future attractiveness of DONG Energy's historic technological regime based on fossil fuels.

Figure 4.1 – Drivers for DONG Energy's proactive response to climate

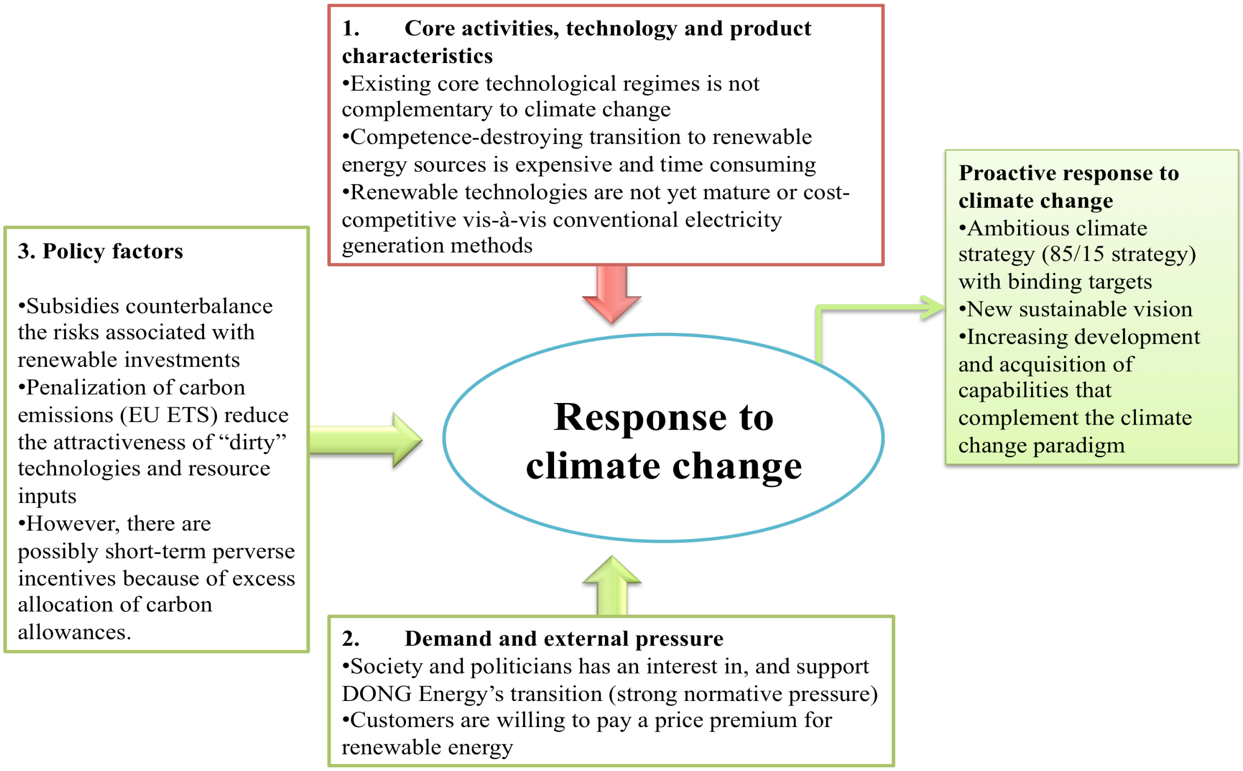

Figure 4-1.

4.2 Scandinavian Airlines System (SAS)

Martin Porsgaard (MP) from SAS was interviewed on July 7, 2010

4.2.1 The aviation industry's climate challenge

Air transport accounts for about 3% of the EU's total greenhouse gas emissions, but this number is increasing rapidly. In the EU, emissions from aviation increased by 87% between 1990 and 2006 (Europa.eu, 2010). If emissions from air transport continue to climb on the same slope, they will more than double by 2020. The rapid growth of emissions in the aviation industry is in contrasts with what has been achieved in many other industries. The EU ETS will cover the aviation industry from 2012 to achieve emissions reductions of 20% by 2020, as promised by the EU member states. The aviation industry's primary climate challenge is the lack of alternatives to polluting aircraft and fuel types. The industry (Air Transport Association (IATA)) has a goal to enable carbon-free flight by 2050 by integrating biofuel and optimizing aircraft and engine design.

4.2.2 Introduction to SAS

"Climate change will increasingly influence our company as we get covered by the carbon trading scheme and because we expect demand for green transportation to increase. We try to prepare by using less fuel, creating a green image and being on the forefront with new aircraft and biofuel."(MP)

SAS is Scandinavia's largest airline and was founded in 1946. SAS has annual revenues of about €5 billion and operates 200 aircraft to 176 destinations in more than 30 countries. In 2009, SAS carried 24.9 million passengers, which makes it the ninth largest airline in Europe. Increased competition from low-cost airlines and high exposure to fluctuating oil prices has forced SAS to reduce its costs and increase productivity. This focus on productivity and SAS' tight financial situation has motivated it to launch several initiatives to reduce fuel consumption, which also result in reduced aviation emissions.

4.2.3 SAS' response to climate change

SAS has adopted a proactive response to climate change and has formulated the following emissions reduction targets.

Box 4.2.3 - SAS' climate strategy

SAS environmental strategy is divided into four pillars: new technology including lightweight aircraft; infrastructure and flight optimization such as the single European Sky (a project that aims at integrating the national airspace borders in the EU. This will cut off unnecessary detours, saving fuel and airtime); operational measures such as fuel conservation programs and green flights; and economic instruments including emissions trading, taxes and charges (SAS, 2009). SAS' overall environmental goal, formulated through IATA, is to enable flying without greenhouse-gas emissions by about 2050. SAS has formulated several specific goals:

- 20% lower emissions by 2020 compared with 2007 including traffic growth of 4%;
- 50% lower emissions per passenger-kilometer by 2020, compared with 2007;
- being seen as the most environmentally-conscious airline in Europe (by 2011);
- having ISO 14001 certified environmental management systems (by 2011), having the industry's most effective fuel conservation program (by 2011) and being among the first airlines to use alternative fuel blends once they are approved and commercially available.

SAS's vision is: *"We want to be the preferred company for customers who wish a simple and efficient travel experience" and " …we acknowledge our societal and environmental responsibility" (SAS, 2009).*

SAS has chosen two sets of activities for improving its environmental performance. First, a set of internal measures is being implemented to reduce emissions, which does not require substantial influence from external technology innovators. Second, SAS is implementing a set of externally developed measures and technologies such as lightweight composite aircraft, improved engines, biofuel blends and optimized airspace distribution. Table 4.1 shows potential areas of optimization.

Table 4.1 - SAS options for carbon emission reductions

Initiative	Greenhouse gases reduction potential (by 2020)	Comment
Fleet optimization (acquiring new and improved aircraft)	**5–10%**	SAS anticipates that a new and more efficient generation of aircraft will be available and purchased from around 2015. SAS will continually replace old aircraft with cleaner models.
Increasing use of biofuels	**5–10%**	SAS anticipates being able to use a blend of 1% biofuel in all aircraft by 2012, 4% by 2015 and 15% by 2020. Biofuels are considered carbon-free.
Fuel conservation[22]	**5–10%**	SAS has located more than 50 ways of reducing fuel consumption. Initiatives for optimizing fuel efficiency include green landings, green takeoffs, weight optimization, balancing cargo etc.
Optimizing air traffic control	**5–10%**	Single European Sky-project aims to shorten flight routes.
Purchasing carbon permits	**Unlimited**	See section 4.2.6

Table 4-1 Author's own creation with inputs from Martin Porsgaard and SAS (2009)

SAS participates in several "green clubs" (Orsato, 2009; Pinkse & Kolk, 2009). "Green clubs" cover biofuel development activities through the Sustainable Aviation Fuel Users Group[23] (SAFUG) and Advisory Council for Aeronautics Research in Europe (ACARE), which aim to develop a strategic research agenda for green aeronautics. SAS promotes its environmental caretaking through the "green clubs". However, membership has become an industry standard (a "license to operate" (Porter & Kramer, 2006)) and is thus not a significant opportunity to differentiate (Orsato, 2009).

SAS sees potential for reducing its exposure to oil price fluctuation in the long term while improving its environmental performance by using biofuel and thus reducing emissions. *"In the long-term, biofuel is going to become a very important resource for us to go green. We try to lead in this development and we are ready to use biofuels as soon as they pass testing and are available on the market. The oil price is volatile, and if we can find a more stable type of fuel, that is also green, we see every reason to start using it as soon as possible.*"(MP).

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[22] The short-term goal of the fuel conservation program is to cut consumption by 6–7% by 2011. By the end of 2009 SAS had reduced fuel consumption by 4,3% compared with 2005. This equals about €50 millions in savings (SAS, 2009).

[23] The Sustainable Aviation Fuel Users Group focuses on accelerating the development and commercialization of sustainable aviation fuels.

In summary, SAS has taken a proactive response to climate change. According to Hart's stage model SAS is currently following a *pollution prevention strategy* (stage 1, figure 3.3, Hart, 1995) but with some of the horizontal and vertical elements that characterize the more ambitious *product stewardship strategy*. However, environmental efforts have not resulted in much more than internal cost optimizations and increased social legitimacy so far, which is why SAS, despite its efforts, has not progressed further than to a *pollution prevention strategy*. It communicates openly about its efforts and sets standards and targets that are measurable, thus raising social legitimacy (Hart, 1995) and participates actively in networks (green clubs) and with politicians, such as during the 2009 United Nations Climate Change Conference (COP15), where SAS was very active in lobbying for a global climate agreement. The main barrier to non-polluting air transport is the lack of available technologies. Accordingly, no airline would be able to adopt an environmental strategy that goes far beyond compliance and involves completely sustainable operations. Since technological innovation in the aviation industry is largely systemic, the question is whether SAS, (and other equally challenged airlines), is in a position where they can possibly do much more than they already do. Only systemic innovation of new lighter aircraft, engine types and biofuel solutions can enable carbon free flight.

4.2.4 Factor 1 – Core activities, technology and product characteristics

Today's aircraft are carbon-intensive and not climate friendly. SAS is therefore hindered by the lack of technological alternatives to fossil fuels and aircraft. However, the aviation industry is supplier dominated, and SAS is can rather easily adopt new technologies (aircraft, engines types, biofuel, wingtips etc) when they emerge. SAS has developed capabilities through strong interaction with technology innovators "green clubs" and politicians following its proactive stance on environmental issues, which are needed to implement these technologies when they emerge. However, due to the high emissions involved with SAS' core activities, these are not complementary to climate change.

4.2.5 Factor 2 – Demand and external pressure

Demand signals for improved environmental performance of SAS is unclear. This is because an airline cannot reliably offer products and services that have environmental benefits besides the option of compensating for flight emissions with carbon permits. For SAS' there is furthermore a fine balance between claiming a "green" image and being accused of "greenwashing" because flight operations are very polluting. Like most other airlines, SAS has been offering customers the possibility to purchase carbon offsets for their flights through the Carbon Neutral Company, which mainly participates in CDM projects[24]. However, only an estimated 1% of SAS' customers offset their flights (MP). This suggests that mimetic pressure is low, because all major airlines basically reveal the same environmental performance (King & Lenox, 2001) and participate in the same "green clubs".

The price elasticity in the industry is high, and there is only little capacity to collect price-premiums for "greener" flights. Nevertheless, SAS' business customers set stricter supplier requirements as they become increasingly focused on environmental issues. It is thus vital for SAS to provide a certain standard of environmental caretaking in order to maintain its market share on the business-commuter market. SAS' public ownership structure also drives environmental concerns as a prerequisite for continued political and societal support. In summary SAS is exposed to increasing normative and mimetic pressure, which, however, does not seem to be threatening its competitiveness as long as it is on par with its main competitors on environmental issues.

4.2.6 Factor 3 – Policy factors

Effects of the European Emissions Trading System

The EU ETS will cover the aviation industry from 2012. SAS will be allocated about 80% of the carbon permits it needs to comply free of charge and anticipates a compliance cost of about €40 million, or 0,8% of revenues per year, based on an estimated carbon price of €30 per ton by 2012. The emissions trading system will theoretically have positive effects on the industry's environmental performance in the long-term because it gives airlines an extra incentive to reduce emissions. However, several analyses show that the aviation industry has been able to secure extremely generous circumstances surrounding its inclusion in the scheme and that integrating aviation into the scheme will do next to nothing to reduce the industry's emissions (European Federation for Transport and Environment, 2008). Further, as the regulation impacts all airlines equally, European or not, it is not expected to have severe impacts on competitive dynamics because airlines are expected to be able to fully pass on cost increases from penalized carbon emissions to consumers (MP). Whether the impacts of the scheme will materialize in raised incentives for airlines to adopt cleaner aircraft and promote the development of biofuel is thus uncertain, especially when considering the carbon price.

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[24] www.carbonneutral.com

Currently the carbon price is about €15 per ton of greenhouse-gas emission. This might be a significant number for power plants and cement factories, but translates into an insignificant 3.8 Eurocents per litre of jet fuel. 1 ton of jet fuel currently costs about €600 and emits about 2,6 tons of CO_2 when burned (IATA, 2010). If the oil price is expected to increase with the same pace as between 2000 - 2010, the price of 1 ton of jet fuel would be €1.500 in 2016[25]. The added carbon price of burning one ton of jet fuel (€104) in 2016, then concur a cost increase of 7%. This might sound like much, but should be seen in the light of a jet fuel increase by 171% from 2000-2010 (Ibid). The increased cost of carbon emissions from the EU ETS thus seem insignificant compared to the general risks from oil price fluctuations.

Unless the carbon price increases significantly and allocation policies are made stricter, the EU ETS is thus unlikely to have significant effects on the aviation industry. It might however have some “signalizing” effects that impose airlines and consumers to increase their focus and interest in “green” aviation (Porter & Van der Linde, 1995). This potentially translates into increased normative and mimetic pressure (DiMaggio & Powell, 1983) and motivate airlines and technology innovators to scale up adoption and development efforts of low-carbon technology and biofuel (MP).

4.2.7 Conclusion to SAS

Response to climate change: Proactive. SAS’ has adopted a proactive climate strategy. Its main reason to improve its environmental performance is cost-cutting. The company engage in new ways to reduce fuel consumption and has set rather strict emissions reductions targets that are both relative and absolute, meaning that overall greenhouse-gas emissions are guaranteed to decline. So far SAS’ efforts to combat climate change have thus been driven by fuel conservation and reducing the cost of complying with the emission trading system along with some efforts to increase its reputation as an environmentally sound company.

Factor 1: Is SAS’ core activities and technology complementary to climate change? SAS’ core activity is airborne transportation. SAS is constrained by the lack of environmentally sound alternatives to polluting airplanes and fossil based fuels. The

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[25] In 2016, the cost of burning one ton of jet fuel would comprise €104 (forecasted carbon price of €40 per permit * 2,6 ton of carbon emissions from burning 1 ton of jet fuel). The price of jet fuel increased by 171% from 2000-2010, or an average of 17% per year. Following the same rate, today’s price of €600 per ton of jet fuel would thus rise to about €1.500 in 2016 (IATA, 2010).

aviation industry is supplier-dominated and SAS is not exposed to any fundamental technological discontinuity. However, SAS' core technology, aircraft and conventional jet fuel, are not currently complementary to climate change.

Factor 2: Does SAS experience clear demand or significant external pressure to improve its environmental performance? SAS is experiencing increased normative pressure and consideration of the natural environment is becoming increasingly important in order to secure continued political and societal support. However, demand for "green" flight is unclear because there is high price elasticity and thus little margin to collect price premiums for "green" flights. SAS experiences pressure from society and politicians but their possibility of sanctioning SAS for emitting carbon seems low, as no substitutes to flight exists, and because most airlines generally have more or less the same climate profile. This pressure is therefore more on the general industry and the underlying technologies and not as much on SAS.

Factor 3: Is SAS significantly motivated to improve its environmental performance because of the EU ETS or other regulation? The EU ETS has insignificant effects on SAS because of lax stringency, low carbon price and because SAS can pass on the added costs to consumers.

Figure 4.2 – Drivers for SAS' proactive response to climate change

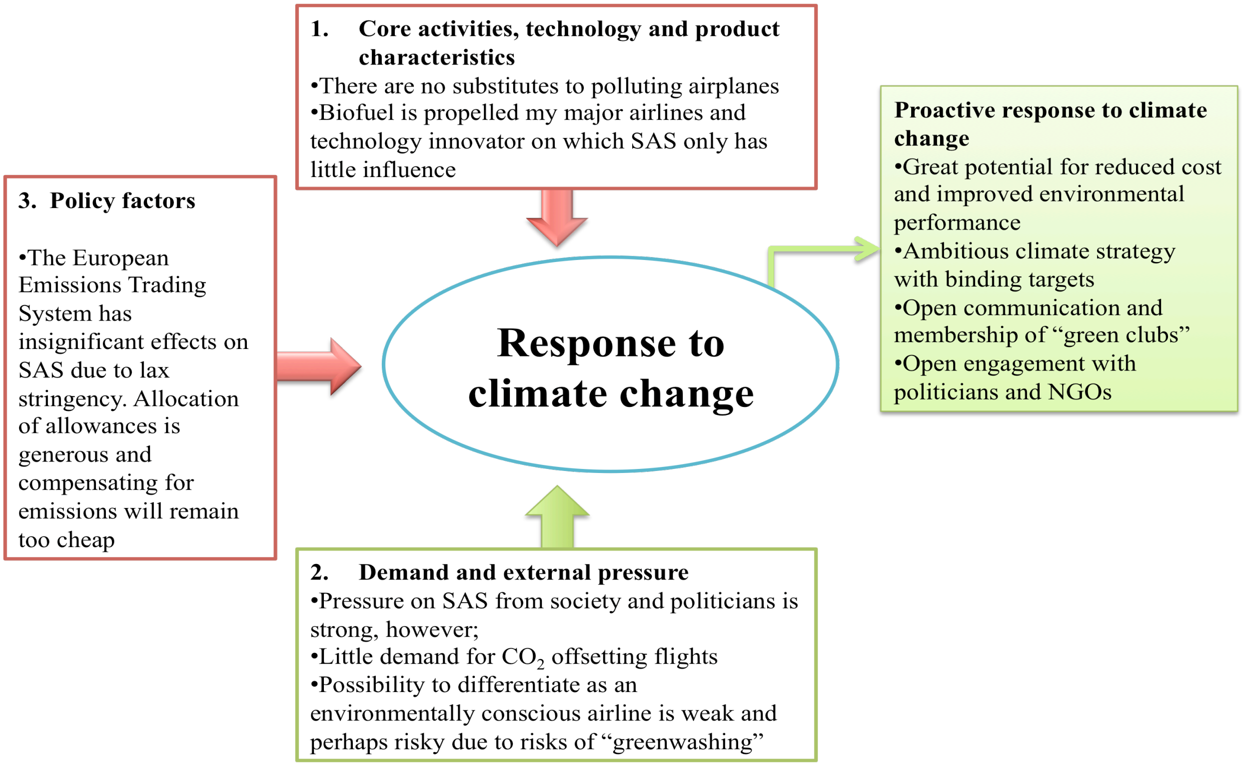

Figure 4-2

4.3 Novozymes

Per Henning Nielsen (PN) from Novozymes was interviewed on June 3, 2010.

4.3.1 The biotechnology industry's climate challenge

The biotechnology industry develops technologies and ingredients such as enzymes for various, often polluting industries. Industrial biotechnology is gaining supporters among politicians and environmentalists as a way to make significant cuts in greenhouse-gas emissions and eventually move to a society free from fossil fuels. The biotech industry for instance delivers ingredients used in biofuel production and enzyme technology is often pointed to as an enabler of the "circular economy" were waste is used to produce biogas while the remaining natural carbon is reused as natural feedstock. The emissions reduction potential of industrial biotechnology is estimated to range between 1 billion and 2.5 billion tons of CO_2 per year by 2030 (WWF Denmark, 2009). In comparison, total industrial emissions in the EU amounted to 1.9 billion tons in 2009.

4.3.2 Introduction to Novozymes

"The increasing demand for our green products reflects the rising importance of the issue of climate change and CO_2 for our customers. Our primary role is making life-cycle assessments to determine where emissions occur and to offer green products that reduce these emissions"(PN)

Novozymes is a leading biotechnology company specialized in enzymes and bio-organisms. With more than 700 products used in 130 countries, biological innovations by Novozymes improve downstream industrial performance and safeguard the world's resources by offering sustainable solutions. Novozymes had revenues of €1,1 billion in 2009 and is engaged in three business areas: enzymes (92% of revenues in 2009), microorganisms (5% of revenues), biopharmaceutical appliances (3% of revenues). This thesis focuses on Novozymes' enzymes business. Novozymes has 4.500 employees, with half located in Denmark, and in 2009, 14,3% of revenue was reinvested in R&D.

4.3.3 Novozymes' response to climate change

Novozymes has adopted a proactive response to climate change and has formulated the following emissions reduction targets.

Box 4.3.3 - Novozymes' environmental targets

Novozymes' efforts to reduce life-cycle emissions are realized by purchasing wind energy from DONG Energy and by optimizing process and resources, along with a broad portfolio of R&D projects aimed at both developing products that reduce emission in the downstream value chain and reducing in-house emissions from Novozymes' own production. Novozymes aims to be recognized as a global leader within sustainability, and its concrete targets are:

- Reducing internal CO2 emissions by 50% in 2015 compared with 2005;
- increasing energy efficiency by 50% in 2015 compared with 2005;
- using 50% renewable or CO2-neutral energy in 2020 (100% in Denmark from 2012 by purchasing wind energy from DONG Energy);
- Long-term target: enable a 75 million tons of CO2 emission reduction by 2015 through the application of its products. In 2009, Novozymes' products enabled users and customers to reduce emissions by 27 million tonnes of CO_2 compared with a scenario in which Novozymes' biological solution had not been used.

Novozymes vision is: **"***We imagine a future where our biological solutions create the necessary balance between better business, cleaner environment and better lives." (Novozymes, 2009)*

Novozymes is founded on environmental credentials and values that are pervasive throughout the company's products and incorporated into its dominant logic (Prahalad & Bettis, 1986). This is for instance evident in Novozymes' vision, its life-cycle assessment expertise and the top management's support for environmental innovation. Top management has taken numerous steps to impose environmental thinking throughout the organization by providing employees with incentives to consider the environment and by incorporating sustainability into its vision and business model.

"We basically sell sustainability to our customers. Therefore we also have to be sustainable ourselves." (PN).

Novozymes participates in several climate-related networks and activities and has won numerous prices for its achievements. It has obtained ISO14040 standard for life-cycle assessment and has published comprehensive voluntary sustainability reports for several years. Novozymes has a climate partnership with WWF and played a key role in putting pressure on politicians during COP 15, by for instance signifying the bio-industry's potential in lowering worldwide emissions, in collaboration with WWF (Novozymes, 2009, p. 26). Novozymes purchase wind energy from DONG Energy and has improved its energy efficiency by more than 50% during the past 10 years. The money saved from internal optimization is reinvested in purchasing green energy. When Novozymes saves money by reducing the energy consumption, it reinvests this money in projects (such as wind farms) that enable it to further reduce its carbon footprint. Novozymes has established the "Novozymes Environmental Awareness Team" with the aim of promoting environmental thinking within the organization.

Life-cycle assessment

Novozymes strongly emphasises the benefits of using life-cycle assessments for investigating the environmental effects of using its products and services, along with upstream emissions from suppliers. Through life-cycle assessment, Novozymes can map the environmental effects of raw material extraction, production, transportation, related services, use and disposal or recycling. Novozymes performs life-cycle assessment on a broad range of products and uses the results in its value proposition by showing the environmental and economic benefits of using its products compared with traditional or competing solutions. Novozymes further has strict requirements for global suppliers which are obligated to monitor emissions and environmental effects of their operations. *"Every Novozymes-facility and business unit have to abide with the same strict environmental requirements regardless of local regulation. We also set requirements for our suppliers so that we can track environmental impacts throughout the entire value chain"* (PN).

In summary, Novozymes has incorporated internal, vertical and horizontal measures in its response to climate change and follows a proactive *sustainable development strategy* (stage 3, figure 3.3, Hart, 1995) were sustainability is a key foundation for business and development activities. The company is furthermore founded on environmental credentials and values that are pervasive throughout the company's product development and incorporated into its dominant logic. *"Sustainability is at the core of everything we do: our solutions, our business strategy, and our performance indicators"(Web 2).*

4.3.4 Factor 1 – Core activities, technology and product characteristics

Novozymes' products generally complement the climate change paradigm. Novozymes' activities focus on reducing emissions in the various downstream industries that Novozymes supply. This reduction potential is significantly larger than the internal potential. Examples are enzymes enabling households and industry to wash textiles at lower temperatures or enzymes used in clothes-dying processes, enabling producers to reduce water consumption and the use of harsh chemicals etc. Box 4.3.4 briefly describes the climate-effect of a Novozymes enzyme product.

Box 4.3.4 - A Novozymes' product enabling downstream emissions reductions

Elemental Textiles

Elemental Textiles is the brand name of an enzyme product that enables manufacturers of fabrics for the clothing industry to replace harsh chemicals in the production process. Life-cycle assessment indicates potential savings in the production process of 70.000–90.000 liters of water and 1 - 1,3 tones of CO2 per ton of knitted fabric. The overall process time of production can be reduced by 20–25%. Savings occur because the enzymes ease the wetting process, enable bleaching at lower temperatures, enable manufacturers to remove chemicals in the same bath as dyeing and enable them to use cleaner biosoap alternatives to do the final rinses. The brand name Elemental Textiles was chosen to symbolize a sustainable win-win solution that helps protect air, water, fire and earth.

Many of Novozymes' products improve environmental performance and often increase resource optimization, thus resulting in reduced greenhouse-gas emissions downstream in the value chain. Since most of Novoymes' enzymes products have positive life-cycle impacts on the environment, they are complementary to climate change.

4.3.5 Factor 2 – Demand and external pressure

Market demand for products that have cost- and environmental benefits is the single most important driver for green innovation for Novozymes. Novozymes for instance experience clear demand signals from the EU environmental policy, as it aims to reduce greenhouse-gas emissions by at least 20% compared to 1990 and to ensure that 20% of total energy use comes from renewable sources. It has not yet been decided to include road transport in the EU ETS, mainly because of obstacles related to measuring and controlling the huge number of individual vehicles[26]. However, the EU has a goal of increasing the use of biofuel from its

[26] It is estimated that including road transport in the ETS would raise the price of allowances by 30 %. (EU Policy department, 2008)

present usage of less than 2% of overall fuels, to 25% by 2030 (Boeters et al, 2008). In summary, Novozymes experiences little normative pressure and see clear demand signals for its environmentally sound products.

4.3.6 Factor 3 – Policy factors

Effects of the European Emissions Trading System

Novozymes is a technology innovator and is directly covered by the EU ETS due to its greenhouse-gas emissions from production. However, the company does not engage substantially in emission trading except for covering its compliance obligations (PN). The direct compliance cost is less than 0.4% of revenue. Novozymes anticipates that increased stringency of the EU ETS, including rising carbon prices, will positively affect the demand for many of its products if prices increase substancially. The system has, however, not had any substantial effects so far: *"…efforts to reduce our carbon footprint are not driven by legislation or the carbon trading scheme, because there is almost no legislation in many of our markets. In the case that the carbon price does not increase much, we are preparing ourselves because of expectations of higher oil price and general resource scarcity in the world. We clearly see ourselves as part of the solution to environmental problems"* (PN). Thus, the EU ETS does not have much influence on Novozymes.

4.3.7 Conclusion to Novozymes

Novozymes' response to climate change: Proactive: Novozymes has adopted a proactive response to climate change. Through its innovative activities, Novozymes holds a key position in mitigating carbon emission in the value chains of the diverse industries it supplies with its products. Novozymes is founded on environmental credentials and values that are pervasive throughout the company's product development and incorporated into its dominant logic.

Factor 1: Are Novozymes' core activities and products complementary to climate change? Novozymes' core activities and products' are highly complementary to climate change.

Factor 2: Does Novozymes experience clear demand or significant external pressure to improve its environmental performance? Demand for Novozymes' environmentally sound products is increasing. Novozymes does not emit significant amounts of CO_2 from its production why normative pressure is insignificant.

Factor 3: Is Novozymes significantly motivated to improve its environmental performance because of the EU ETS or other regulation? Environmental regulation has insignificant influence on Novozymes. However, Novozymes experiences increased demand for many of its enzyme products with tightened regulation. Novozymes further participates in several university funded R&D projects and its activities of basic science and research are often publicly supported.

Figure 4.3 – Drivers for Novozymes' proactive response to climate change

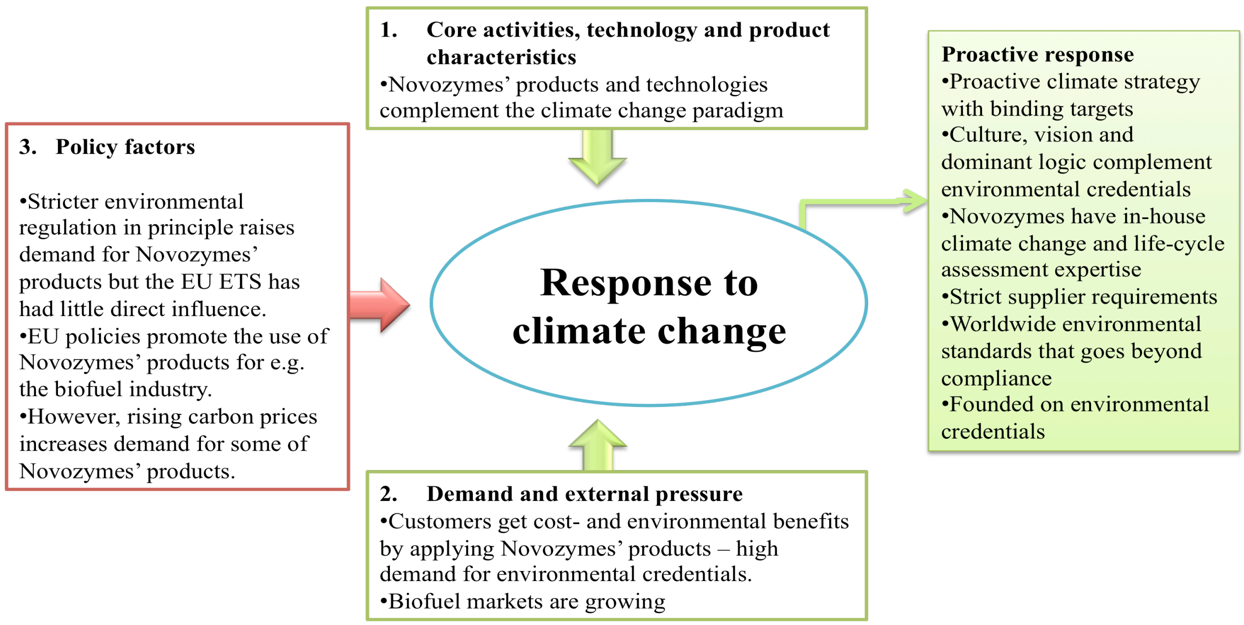

Figure 4-3

4.4 FLSmidth

Tine Kokfeldt (TK) from FLSmidth was interviewed on August 8, 2010.

4.4.1 The cement industry's climate challenge

The cement industry is responsible for 6% of human-made global greenhouse-gas emissions. By 2030, global production of cement is expected to increase to about five times higher than that in 1990. This increase will mainly occur in developing countries and significantly affect global CO_2 emissions. With the forecast use of cement, the global cement industry will be responsible for emitting more CO2 than the entire European Union by 2030 (WWF, 2008). The concept of sustainable cement is contradictory. This is because cement production poses a basic challenge: the chemical reaction that creates cement releases large amounts of CO_2. About 50% of the CO2 emissions in cement production result from conversion of limestone ($CaCO_3$) into lime (CaO). This process is also called the decarbonization of limestone and cannot be avoided unless completely different input materials are used. In addition, emissions result from the fuel combustion processes needed to yield the thermal energy (1450°C) required for decarbonization and electricity use in factories.

4.4.2 Introduction to FLSmidth

"Cement is necessary for the world, but unfortunately also polluting. There is no magic way of making it clean, but we try to optimize cement factories and processes as much as possible and enable our customers to use cleaner fuels and raw materials in the production of cement."(TK)

FLSmidth is a global engineering company founded in 1882, supplying cement producers and mineral extractors with plants, equipment, systems and services. It employs about 11.000 people worldwide and operates through several project divisions, each covering a particular geographical region. These are placed in Denmark, USA and India, but the company operates worldwide and has most of its current activities in emerging markets, where the demand for new cement factories is greatest. In 2009, revenues amounted to €3,1 billion and overall R&D-investment amounted to €40 million, equivalent to 1.3% of revenue. The company is not considered a heavy emitter of carbon, but nevertheless constitutes a cornerstone in the entire cement industry's efforts to improve environmental performance, because of its history as one of the leading innovators in the industry and its strong R&D and engineering capabilities (TK). This thesis solely addresses FLSmidth's activities within the cement business.

4.4.3 FLSmidth's response to climate change

FLSmidth is the least environmentally proactive company assessed in this thesis. It has not engaged substantially with the issue of climate change and lacks a tailored climate strategy with targets for greenhouse-gas mitigation. FLSmidth has adopted the following environmental policy.

Box 4.4.3 - FLSmidth's environmental policy

FLSmidth's environmental policy is formulated as a declaration of intent:

- Products and services supplied by FLSmidth must comply with current environmental standards.
- Products and services are to be designed so that they support the Group's image as being a responsible, reliable and professional supplier that meets the market's expectations and demands in terms of new sustainable technology.
- Products' full life cycle must be taken into account, and an effort must be made to reduce the consumption of energy and natural resources while as far as possible reducing or eliminating emissions and noise nuisance.
- FLSmidth will collect data in order to document the Group's direct environmental impact and on this basis formulate environmental goals and plans of action.

FLSmidth's vision: "*It is FLSmidth & Co.'s vision to continuously strengthen its position as the preferred partner and leading supplier of equipment and services to the global cement and minerals industries."* (FLSmidth, 2009)

FLSmidth's lack of climate focus

FLSmidth is aware that it lacks proactive environmental targets and emphasizes that it has tried to exploit opportunities to mitigate climate change impacts but that these initiatives have been difficult to make profitable. FLSmidth, in its role as technology innovator, has realized that its main potential for combating climate change lies downstream in the value chain: in the production of cement. *"Most of the Group's activities* [related to climate change] *are aimed at further improving the environmental benefits of the equipment we develop and sell*" (TK).

FLSmidth is not doing much to absorb and accumulate information about either its own or its suppliers' and customers' environmental effects. Several scholars, both within environmental economics and innovation in general, say that the process of gathering and processing information is vital to developing products that fit market needs.[27] FLSmidth does not conduct systemic life-cycle assessment to gain information on the environmental effects of its products in the downstream application. Further, FLSmidth does not provide incentives for employees to manage carbon emissions and sustainability measures have not been implemented into key performance indicators or bonus programs. FLSmidth has formulated some *local* climate change goals and has build an energy efficient office facility in Chennai, India that is supplied with power from its own wind turbine and supplied with rainwater, etc. These activities, however, do not seem to be emphasized much in FLSmidth's own publications or within the organization among employees.

Nor have similar activities been disseminated throughout the rest of the organization, suggesting that the learning from these activities is not assimilated and distributed through company headquarters. FLSmidth has established an internal "carbon group" aiming to map the opportunities and threats of climate change and carbon trading, however: *"Our responsibilities and work are not formalized in any way, because this is not an issue on which we have been able to make business so far. The uncertainty of what happens with the Kyoto Protocol after 2012 and the low prices of carbon credits do not really generate any great business opportunities as we see it"* (TK).

In summary, FLSmidth has not progressed far and has adopted a reactive response to climate change. The company's environmental actions resemble those of a *product stewardship strategy* (Strategy 2, Hart, 1995) because of its downstream focus on the environmental effects of products. However, Hart's model is supposed to have a sequential logic to it, meaning that a company has to excel in any given stage before it can progress to the next. Since FLSmidth has not excelled in *pollution prevention* yet, it can thus not have transitioned to a *product stewardship strategy*. FLSmidth has not yet been able to exploit opportunities and build internal capabilities in many of the organizational activities that are normally considered prerequisites for high environmental performance such as setting greenhouse-gas mitigation targets or gaining carbon management and life-cycle assessment expertise. FLSmidth's vision and environmental policy furthermore confirms that

[27] See for instance Cohen & Levinthal (1990) on absorptive capacity, and Pinkse et al., (2009) on the role of absorptive capacity in the process of creating environmental strategies

environmental matters are not rooted in its culture and values. FLSmidth's response to climate change is therefore reactive.

4.4.4 Factor 1 – Core activities, technology and product characteristics

When FLSmidth develops new products or improve existing products for the cement industry, it most often results in improved resource productivity and reduced emissions in the production of cement. Therefore FLSmidth's core technological know-how and industry-leading engineering capabilities are being used to develop products with environmental benefits. (cf. the definition of environmental innovation in section 2.1, Terms). Even though cement production inevitably produces CO_2, the following options to reduce the industry's life-cycle carbon footprint have been identified:

Table 4.2 - Opportunities of carbon reduction in the cement industry

Measure	Reduction potential and comments
Improve the thermal efficiency of kilns	Efficiency can be improved up to 33% by 2050.
Increase share of biomass and alternative fuels	Replacing fossil fuels with biomass and other less polluting substances can significantly reduce emissions. However, this requires a mature and efficient biomass market, which is still not in place in many regions of the world.
Increase efficiency of waste heat recovery (WHR)	Potential reduction in energy consumption of 60% can be achieved by 2050.
Develop carbon capture and storage	Sequestration of greenhouse-gases can potentially achieve 60% reduction by 2050 if the technology is further developed and deployed.
Use higher quality cement and use it more efficiently	CO_2 reductions can be achieved if higher quality cement with higher added value is used for construction. Different qualities of cement should be used for different purposes. Potential saving of 15% in the amounts of cement used.
Expand the use of additives and substitutes for cement clinker	Alternatives for clinker used in cement production can mean significant greenhouse-gas reductions. Known alternatives are fly ash which has proved feasible in coordination with electrical utilities. Green alternatives to traditional cement are also emerging. See: www.grancrete.net, and www.gigacrete.com.

Table 4-2. Source: WWF International, 2009

FLSmidth is marketing and conducting R&D within many of the potential areas of optimization shown in table 4.2 and has business units within "alternative fuels", developing and selling products that enable cement factories to use materials such as biomass and used car tires instead of oil; "air pollution and emission control", which retrofits factories with flue gas cleaning; and, "waste heat recovery", which enables factories to re use excess heat from production.

Many of FLSmidth's product lines and services could thus potentially be labeled climate friendly because of the synergy related to improving fuel and energy efficiency and reducing CO_2 emissions: *"The good thing for us is that when we invent technologies to reduce energy* *consumption and increase efficiency in our customers' factories, we also reduce CO2 emissions as an added bonus"* (TK). In this vein, one could argue that the company is currently deploying its key engineering capabilities to innovate for climate change. FLSmidths products reduce customers' production costs while improving environmental performance. However, as discussed below, the company has not been exploiting very many opportunities emerging from climate change.

One reason for this lack of exploitation of opportunities of environmental innovation is that FLsmidth's products can hardly challenge the basic problem that the production of cement is energy intensive and emits greenhouse-gases (TK). Both FLSmidth and third-party statements express the controversy surrounding "green" cement and the lack of potential for environmentally sound production in the industry: *"We of course recognize that cement production pollutes and we therefore encourage imposing a price on CO_2 emissions and a global climate agreement. It will send a clear signal about where we should aim our innovation and products. But as of now, emerging markets demand inexpensive cement, and the environment seems to be a low priority in most of these markets"* (TK).

4.4.5 Factor 2 – Demand and external pressure

The challenges for FLSmidth are that environmental regulation and cost competition press for lower costs and improved environmental performance at the same time in established markets. In booming and unregulated markets in Asia, Latin America and Northern Africa, operational costs, and the importance of quick establishment of large-scale production often diminish the importance of environmental concerns and factory lifetimes. These market characteristics can be turned into an opportunity if FLSmidth is able to reliably market products that, despite having a higher initial purchase costs, reduce the life-cycle costs of cement factories. The key for successfully profiting from environmental innovation is thus to develop products that are cost effective and improve environmental performance at the same time (Orsato, 2009).

FLSmidth, however, experiences mixed demand signals from different markets. Developing markets seem to demand less expensive factories and accept shorter lifetimes and poorer environmental performance. The worldwide production capacity is increasing significantly over the next 20 years, especially in developing countries. FLSmidth experiences increasing demand for low-carbon technologies from western markets and from customers that are either located in highly regulated regions or invest in long-lived, high quality factories, retrofits and equipment. Therefore, demand signals for low-carbon technologies fluctuates with regional differences in regulation.

The market situation thus complicates environmental innovation for FLSmidth. In Europe there is currently a quasi-oligopoly situation with five large cement producers sharing the European market. This market situation is likely to limit the development and deployment of more radical innovative initiatives that propels the diffusion of clean technologies. The interdependence between the cement producers and their established technology innovators and plant manufacturers (FLSmidth and its competitors) is typically strong, which makes it difficult to let possible outsiders implement new and cleaner technologies (routinized technology regime). These interdependencies, along with generally long investment-cycles in the industry create lock-in effects and technological path dependencies that do not support transition to radically different low-carbon technologies. These factors also lower mimetic pressure against FLSmidth to improve its environmental profile. Further, the company is located upstream in the value chain and is seldom pointed to as a polluting company that has a responsibility towards climate change. This reduces the normative pressure on FLSmidth and in summary, neither demand or pressure seem to provide significant incentives for environmental innovation for the company.

4.4.6 Factor 3 – Policy factors

How the European Emissions Trading System affects the cement industry

The EU ETS should theoretically raise the demand for environmentally sound technologies in the European cement industry. Producing 1 ton of cement costs €40 and emits roughly 1 ton of CO_2. With forecasted carbon prices of around €40 per ton in 2016, cement would double in price by that time. A doubling of the cement price would seem to have some disruptive effects on the cement business and industry profitability because substitutions would become relatively more attractive than cement. So how have European cement producers responded to the expected penalization of carbon emissions? Part of the response of the cement producers is to simply relocate to unregulated regions outside the EU ETS. Relocating to escape carbon regulation is called “carbon leakage”.

Carbon leakage in the cement industry

Carbon leakage is the displacement of emissions from inside to outside the geographical scope of the EU ETS, as a result of market distortions caused by the system. Carbon leakage constitutes a problem because emissions potentially will not decrease on a global level but rather be displaced and possibly increase due to the additional emissions from more transportation. There is a strong trend of carbon leakage from Europe since 2005 (Boston Consulting Group, 2008) and, according to FLSmidth, cement producers are investing in facilities abroad with the intention to export cement back into Europe, even though transporting cement is expensive. The risk of carbon leakage largely depends on the expected price of carbon and the share of permits that gets auctioned to carbon emitting companies versus given away for free. From 2013, 20% of allowances will be auctioned, and the share of auctioning will increase linearly up to 100% by 2020. Boston Consulting Group (2008) estimates that, if 100% of allowances are auctioned to the cement industry in 2020, up to 80% of European producers will relocate at a carbon price of €25 per ton. This could seriously affect rising emissions due to increased transportation, but also the European labor market, where an estimated 35.000 jobs are at stake, and supplying industries like FLSmidth, (Tennbakk et al, 2009; Boston Consulting Group, 2008).

"With the current CO_2 price and environmental constraints currently enforced in Europe, no new factories are being built here. Our customers establish factories in North Africa and the Middle East to avoid legislation and then ship finished cement to Europe. We saw this trend starting five years ago" (TK). The problem of carbon leakage will be difficult to eliminate as long as regulation is not enforced globally: *"Until international legislation is enforced, we see few reasons for cement producers not to escape regulated regions"* (TK). The market circumstances on the European market suggests that the increased demand-pull for new low-carbon technologies spurred by the EU ETS is diminished because the industry is exposed to carbon leakage and locked in to a technological path that is expensive and timely to transition away from.

4.4.7 Conclusion to FLSmidth

Response to climate change: Reactive. FLSmidth has not adopted proactive response to climate change. FLSmidth lacks a formulated climate strategy and binding emission reductions targets, and its environmental scope seem narrow and to be only focusing on its products. Little attention has been given to climate change, besides its "green" facilities in Chenai, India and picking some low hanging fruits such as shutting off lights and computers. FLSmidth does not systemically map downstream emissions through life-cycle assessment, and lacks strict environmental supplier requirements. This lack of climate related initiatives evidence that FLSmidth has not yet accelerated on its evolutionary path towards high environmental performance

Factor 1: Are FLSmidth's core activities and products complementary to climate change? FLSmidth's core activities and products are on one hand complementary to the climate change paradigm because they improve environmental performance of cement factories. On the other hand its products are not complementary because they are being applied in carbon-emitting processes. There is thus a positive influence of FLSmidth's products on the carbon-intensity of cement production, but a negative absolute environmental effect from the production of cement.

Factor 2: Does FLSmidth experience clear demand or significant external pressure to improve its environmental performance? Demand for environmentally sound products and solutions is diminished because growth markets are unregulated. Factories in these markets only demand environmental credentials when the result is improved resource productivity. Established markets are characterized by low-innovation and technological lock-in effects that reduce the demand for new and improved low-carbon technologies.

Factor 3: Is FLSmidth significantly motivated to improve its environmental performance because of the EU ETS or other regulation? Regulation seems to disrupt the market for low-carbon technologies because of carbon leakage and lax stringency. Cement producers are willing to take great effort to avoid strict regulation.

Figure 4.4- Drivers for FLSmidth's reactive response to climate change

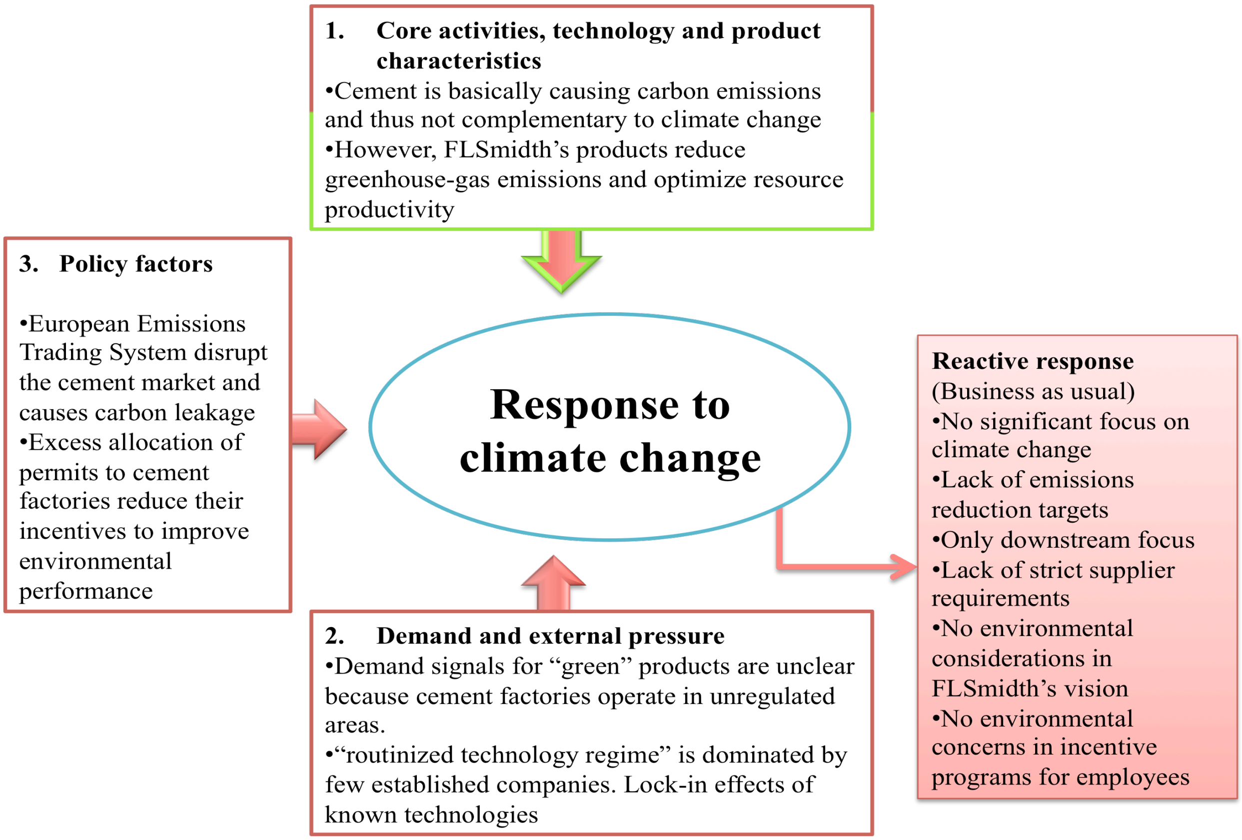

Figure 4-4

4.5 Conclusions to corporate responses to climate change

This sub-conclusion summarizes the findings from the analysis and provides an answer to the first research question:

1. **How do different types of companies respond to climate change and which circumstances drive these responses?**

The four companies' have responded differently to climate change. Their responses differ in target-setting, time scale, ambitiousness and whether efforts to reduce carbon emissions are internal, vertical, horizontal or all-encompassing throughout all the companies' activities (Hart, 1995). As shown in the analysis, no simple answer can be given to whether environmental performance pays. It depends on numerous inter-company factors and situational contingencies. Figure 4.5 presents an illustration of how the companies have responded to climate change and which circumstances cause these responses?

Figure 4.5 - Overview of the companies' strategic responses to climate change

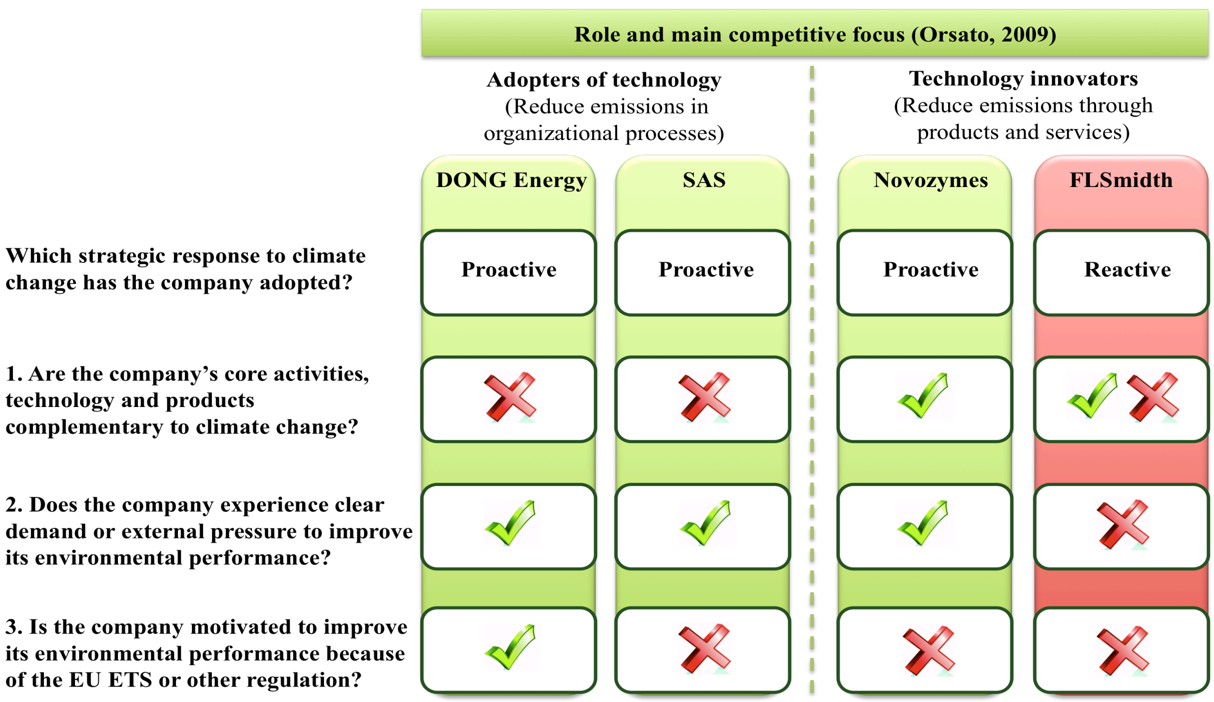

Figure 4-5. Source: Author's own creation. Partly inspired by Orsato, 2009 and Hoffmann et al., 2010.

Departuring from the analytical framework, figure 4.5 divides the companies into adopters (DONG Energy and SAS, which reduce emissions internally in the organizational processes) and technology innovators (Novozymes and FLSmidth, which reduce emissions through their products and services). It further illustrates the companies' responses to climate change, and how the different factors influence their response.

DONG Energy and SAS both emit significant amounts of greenhouse-gases and have adopted environmental strategies, which focus on internal optimization of organizational processes. Internal optimization is achieved by substituting polluting resources with non-polluting types (e.g. biofuel instead of conventional jetfuel or biomass instead of coal), or by transitioning to technologies that are fundamentally cleaner such as wind.

DONG Energy face several barriers on its path towards renewable power generation. Low-carbon technologies are technically complex and involves systemic innovation. Implementation is timely and requires substantial government support before critical mass is reached, and economies of scale and learning efficiencies make them cost competitive with conventional technologies. The instrument that enables DONG Energy to surmount these barriers is government subsidies and the main driver for DONG Energy's proactive response to climate change is political pressure. Further, social legitimacy is vital to DONG Energy's competitiveness since the company plays a key role in securing the electricity supply in Denmark. If DONG Energy fails to meet social and political expectations to transition to renewable energy generation, its existence is threatened because the government will allocate subsidies to more environmentally competent companies.[28]

SAS has adopted a proactive response to climate change and its efforts to reduce emissions have a dual effect – they save fuel and reduce emissions, which reduces costs and further reduces the costs of complying with the EU ETS. The mitigation of emissions, as a costly output (waste product), is granted value due to the penalization of carbon emissions from the EU ETS and due to the growing importance of a "green image". SAS' strategy is considered proactive, but ultimately, an airlines' potential to reduce emissions is limited because of technological constraints on airplanes, engines and fuel types. The main driver for SAS' proactive response to climate change is widespread opportunities of cost reduction through fuel conservation.

Novozymes' business model has basically always complemented the paradigm of combating climate change. Novozymes considers greenhouse-gas emissions in a life-cycle perspective and takes responsibility for the environment as a public good. The company "sells sustainability" and emphasizes that internal reduction and strict supplier requirements are important to build capabilities and spread confidence that Novozymes is a truly sustainable

[28] This argument is rooted in a Danish context. However, DONG Energy's investments in renewable energy outside Denmark are also supported with subsidies. DONG Energy's offshore windfarm, Gunfleet Sands in the UK is, for instance, subsidized by the British government (Web 6).

company, to both internal and external stakeholders. The main driver for Novozymes' proactive response to climate change is demand for the cost-saving attributes and environmental effects of its products.

FLSmidth's lack of environmental targets is peculiar and suggests that climate change is not an important issue among either its customers or other influential stakeholders. Although FLSmidth emphasizes that its main potential to reduce emissions lies in developing technologies that enable downstream mitigation, customers' overall emissions have not been systematically mapped in the same way that Novozymes and many other companies with high environmental performance does. FLSmidth's lack of formulated emissions reduction targets further evidence that the company has taken a reactive response to climate change. The driving forces behind FLSmidth's reactive response are twofold: poor development of internal capabilities for environmental innovation, and weak incentives for environmental innovation because of technology lock-in effects and lax regulation, which harm innovative activity across the cement industry.

The main finding of the analysis is thus that there are few similarities in drivers for environmental innovation across the companies. The causes for choosing proactive responses differ and no obvious pattern can be mapped according to figure 4.5. The only commonality across the three proactive companies is that environmental caretaking seems to be a "license to operate" (addressed in factor 2, figure 4.5): First, DONG Energy can hardly defend its position as the leading Danish utility company, if it fails to deliver the expected environmental results of policy makers and the general society. In such a situation, government would potentially withdraw its ownership and allocate subsidies to more environmentally competent electricity providers. Second, SAS can neither secure its position as a leading and responsible airline, especially among business customers with environmental preferences if it fails to adopt a certain minimum of environmental caretaking. Third, for Novozymes, sustainable business practices is also a "license to operate". The company "sells sustainability" and it would face credibility problems if it did not display considerable environmental caretaking.

Besides factor 2 in figure 4.5, there are few similarities in the drivers for environmental innovation across the companies. This suggests that different companies value the natural environment disparately, according to their perceived opportunities to profit from environmental innovation, and might explain why the market has failed to provide sufficient incentives for environmental innovation for some of the companies. In light of these findings, the next chapter discusses the impact of the primary regulatory instrument designed to combat climate change in Europe, the European Emissions Trading System.

Chapter 5 - Discussion

The discussion is divided in two parts. The first part discusses the role of the EU ETS and whether the system provides significant incentives for innovation across both technology adopters and innovators. The second part of the discussion takes a closer look at causes for inaction towards environmental innovation and uses examples from the analysis to suggest how companies can start seizing opportunities of environmental innovation.

5.1 Impact of the European Emissions Trading System

The EU ETS is designed to provide ample incentives for environmental innovation. However, the incentives for innovation provided by the system do not seem to be sufficient across the companies analyzed in this thesis. Therefore, the second research question asks:

2. **Does the European Emission Trading System provide significant incentives for innovation across the four case companies?**

The findings from the previous chapters indicate that it is next to impossible to design regulatory frameworks that efficiently induce innovation in all stages of the added value chain in a given industry. The context-specificity of the impacts of climate change on the companies causes the EU ETS to provide weak incentives in some industries and strong incentives in other.

The EU ETS influences the companies differently, as some emit greenhouse-gases, thus directly targeted, and some are technology innovators without significant emissions, thus only indirectly affected though the scheme's demand-pull effects (see figure 4.5). For DONG Energy, the EU ETS is a major driver to transition away from fossil fuels. Investment cycles of DONG Energy's technology are long and the increasing penalization of carbon emissions raise the attractiveness of renewable investments in the long-term. In the aviation industry, the penalization of carbon emissions has little impact because all airlines are impacted equally and can thus pass on the added costs to consumers. Further, the carbon price is unlikely to reach critical levels and harm the attractiveness of aviation as a mode of transportation compared to other means of transportation (e.g. trains). In the cement industry, the EU ETS causes carbon leakage in the European market and thus seems to be a barrier for environmental innovation. The system's geographical scope does not reach the cement industry's growth markets and has no effect outside Europe.

The EU ETS is designed to primarily cover supplier-dominated industries, which conduct little internal innovation of abatement technologies (Grubb, 2004). Technological innovation typically occurs upstream (e.g Boeing and Airbus) which means that the companies that emit greenhouse-gases are different from the innovators. However, if adopters are different from innovators, uncertainties related to the economic returns of innovation rise under carbon trading schemes as opposed to other regulatory means where the level of penalization (the carbon price) is fixed, like regular pigouvian taxes (Taylor, 2008).

Innovators like Novozymes and FLSmidth have to make R&D-investments, which have uncertain technical and economic outcomes. These companies need to include allowance price-expectations in their investment calculus, which have shown to be difficult. It is easier for a company to predict total rewards under conditions of fixed carbon prices (carbon tax) than it is under the fluctuating carbon prices that occur in an emissions trading system. Less environmentally sound investments might thus be chosen, because it is easier to predict economic returns of these. This suggests that cap & trade systems are less effective than other policy instruments (with fixed prices) if the carbon price is too low, and if the innovators are distinct from the polluting companies, which is evident in the case companies in this thesis.

Figure 5.1 – Price of EU emissions allowances 2005-2010 (€/ton CO_2)

Figure 5-1. Source: eex.com (Web 4)

As shown in figure 5.1, the price of EU allowances has been highly volatile in the period 2005-2009. Since 2009 the price has been somewhat stabile at €15. As already discussed, this price level is not high enough to drive innovation in many sectors. According to the system design, the price should increase steadily over time, but has failed to because European production, and thus emissions, fell during the *financial crisis. Unfortunately, the emissions allowance bought to offset this thesis (p. 3) seems not to have had any positive effects on innovation-incentives.*

The EU ETS is enforced late in the production chain and often targets companies that have few R&D capabilities (supplier dominated companies, Pavitt, 1984), like SAS and DONG Energy. The pressure from regulation should generate demand-pull and induce upstream technology innovators to develop new technologies.

"…the governing principle should be to regulate as late in the production chain as practical, which will normally allow more flexibility for innovation there and in upstream stages". (Porter & Van der Linde, 1995, p. 111).

However, neither of the non-polluting technology innovators (Novozyme anad FLSmidth) have seen significant demand-increases for their low-carbon technologies spurred from the EU ETS. *"We cannot see any dramatic increase in the demand for energy consultancy services or sales of "clean" equipment in Europe as a direct consequence of the implementation of the carbon system in 2005"* (TK, FLSmidth). Novozymes states that "*More regulation on carbon emissions has positive effects on our sales",* however, *"We cannot see a direct correlation between our business growth and the implementation of the EU ETS. A global climate-agreement would matter but until now, the EU ETS has simply been too weak to dramatically scale up, for instance, the European biofuel market or any other of our primary markets"* (PN, Novozymes). Thus, companies with strong innovative capacity do not seem to have been significantly motivated by the system.

Novozymes, Greenpeace and WWF have expressed that they would like to see a "carbon floor price"[29] enforced to ensure that prices do not fall back to 2006-levels. Suggestions of floor prices are widespread from NGOs and environmentally proactive companies, but has nevertheless been disregarded: *"If the objective of the ETS was to drive abatement of CO_2 emissions at the lowest cost, we can't by definition have a price floor,"* (Michela Beltracchi of the International Emissions Trading Association (IETA)[30], Web 4). Nevertheless, as shown in this thesis, the EU ETS might fail to provide significant incentives for innovation, unless a price floor is established and the carbon price increases significantly.

[29] A "carbon floor price" is a minimum carbon price guaranteed by the authorities.
[30] IETA is an organization that represents international carbon market participants, traders and investors.

Observed effects of the EU ETS:

- The system *increases* long-term demand for low-carbon technologies in the electric utility industry as it becomes more expensive to compensate than innovate in the long-term.
- The system fails to provide significant incentives for airlines to push technology innovators to scale up environmental innovation.
- The system *increases* the value of information of a company's, and its value chain's, environmental performance, as more and more companies adopt proactive environmental strategies and set stricter requirements to their suppliers on the basis of the system. This raises normative and mimetic pressures.
- The system possibly *decreases* short-term demand for low-carbon technologies due to excess allocation of free permits and a low carbon price. This makes it cheaper (or free) to compensate than innovate in heavy polluting industries like electrical utilities and cement production.
- The system fails to provide equal incentives for environmental innovation across the different industries it covers. While a carbon price of €40 (forecasted in 2016) is sufficient to drive innovation in the electric utility industry, it is not sufficient to raise similar incentives in the aviation industry.
- The system possibly increases greenhouse-has emissions in industries that are exposed to carbon leakage because of relocation and longer transportation routes.

To summarize, the EU ETS has had a weak start with low carbon prices due to excess free allocation of permits and the emergence of the global financial crisis[31]. However, seen in a 100-year perspective, in which the subject of global CO_2 emissions is relevant, a five year startup and "test" period for a large legislative system like the EU ETS could be a mere trifle. – One could on the other hand argue, that science on global warming has been clear for more than 20 years. Further, global greenhouse-gas emissions must decline from 2015 if a temperature increase of max 2°C is to be reached. Five years wasted due to an inefficient trading scheme between 2005-2010 thus represents a serious defect. In conclusion, the EU ETS seems to have weak impact on most of the companies. In its quest for assessing drivers

[31] The EU ETS further has several design gaps and flaws, which has led to incidences of fraud where companies sell carbon credits more than once. The latest incident involves accusations of illegal trade of carbon credits within the EU worth more than €5 billion (Politiken International, November 30, 2010).

for environmental innovation, the thesis now moves on to the final discussion. It seeks to highlight ways in which companies can seize opportunities for gaining competitive advantages trough environmental innovation, despite the weak incentives provided by regulation. As highlighted in the introduction and shown in the analysis, companies will only take action if profits are reachable. The next section therefore proposes how reactive companies can start seizing profit opportunities of environmental innovation.

5.2 Why a history of involvement with climate change is important!

This section sets out to propose how companies can gain competitive advantages from environmental innovation, even though regulation fails to provide significant incentives. The section discusses the last research question:

3. **How can companies that show reactive responses to climate change start seizing opportunities of environmental innovation?**

Almost all literature which argues that environmental performance pays, puts strong emphasis on the value of information about climate change. It argues that a company must develop capabilities and knowledge which complement climate change, before it can truly discover business opportunities of the climate change-paradigm (e.g. Hart, 1995; Orsato, 2009; Reinhardt, 1999). A company's future direction is a function of its current position. This position is shaped by the path of the past (Teece et al., 1997). Therefore, a company's path and history of involvement with climate change, shape its future abilities to build and deploy capabilities for climate change. A company will thus not be able to see the true value of, and seize opportunities of climate change if these are conflicting with path of the past and the existing business model (Chesbrough, 2003, 2010; Kolk, & Pinkse, 2004,a & b; Lanoie, & Tanguay, 2000). This leads back to observations made by Prahalad & Bettis (1986) and their findings on *dominant logic*. They point out that companies filter out new knowledge, if the new knowledge is not well-integrated into the dominant corporate logic and complementary to the values that has historically driven the company to success. New and important knowledge thus "emerge under the radar" (Christensen, 2005). As a result, companies can be caught in a "cognitive trap" due to ambiguity and uncertainty about the consequences of transitioning to a proactive environmental path.

Companies which business models do not complement climate change have difficulties of first spotting opportunities to profit from environmental innovation, and further exploit these opportunities. As argued, FLSmidth could, without changing current practices much, start collecting data, set corporate targets for emissions reductions and communicate on its environmental efforts and benefits of its products in the same way that Novozymes does. *"…if one company should take on a greener profile in the industry it would probably be us. I would say that we already have the greenest profile among our competitors, due to the fact that our products are of the highest quality related to energy-usage, productivity and lifetime, but it is true that the industry may not seem to have a very green profile overall"* (TK, FLSmidth).

Innovation in the cement industry has been incremental since the Romans first described how they used burnt lime to bind building materials together. FLSmidth has 120 years of history in which its business model has more or less proven to be successful: *"There are tremendous sources of inertia inside all companies, and successful companies develop even greater inertia because of their previous success"* (Chesbrough, 2010 p. 208). FLSmidth can be caught in a state of inertia due to its previous success. It therefore perceives its path ahead to be narrow when it comes to pursuing profit-opportunities of environmental innovation.

So what can a company do to overcome this self-reinforcing state of inertia, where a successful business model produces a dominant logic that makes it unable to absorb and act on important information?

Suggestions can be found in Chesbrough (2010) where he argues that companies should experiment with new business models with the purpose of learning about opportunities and threats: "*companies should strive to develop processes that provide high fidelity as quickly and cheaply as possible, aiming to gain cumulative learning from (perhaps) a series of "failures" before discovering a viable alternative business model"* (Chesbrough, 2010, p. 360). Companies might navigate in environments characterized by such uncertainty that they will have to act without having enough data to know exactly *how* to act. This blind-folded experimentation process is called *effectuation*. *"In effectuation processes, actors do not analyze their environment so much as take actions that create new information that reveals latent possibilities in that environment… Without action, no new data will be forthcoming"* (Chesbrough, 2010, p. 360-361). Accordingly, a company has to move outside its "comfort zone" in order to absorb the information it needs to navigate and strategize in an uncertain environment.

Due to the uncertain circumstances surrounding climate change, rational analysis is most likely to reveal that it is difficult to profit from environmental innovation. As shown in figure 4.5, it is common that companies are exposed to weak normative and regulative pressure and unclear demand for low-carbon technologies. For companies like FLSmidth, it is easy to justify their weak response to climate change with rational analysis. Climate change undoubtedly creates a chaotic environment for FLSmidth, because cement production is fundamentally a CO_2-emitting process, and because the impact of regulation is weak.

Nevertheless, the carbon-intensive cement industry is likely to experience increasing regulative and normative pressure to transition away from polluting technologies and processes in the future. – If, as argued earlier, cement cannot become substantially "greener", completely new building materials may start to disrupt the cement market, leaving many of FLSmidth's capabilities obsolete (Christensen, 2002). A British company has for instance developed a kind of cement that can absorb CO_2 by using magnesium silicate instead of calcium carbonate (Web 3). This alternative material does not emit CO_2 when it is manufactured, and it absorbs greenhouse gases as it ages. To the author's notion, FLSmidth is not significantly engaged in developing new and radically different types of cement and seems to be locked-in to its existing technological regime. Companies that are first to develop and market carbon-free cement might however create new "blue ocean" markets and avoid being left in the pond with those that continue on the unsustainable path.

In conclusion companies should experiment with new business models, technologies and products that are complementary to climate change. Even if they cannot spot any profit opportunities from conducting (passive) analysis, they are likely to start spotting opportunities once they reach a certain state of environmental proactivity. A history of involvement with climate change is thus essential in order to be able to seize opportunities of environmental innovation. One could for instance ask why FLSmidth, a world-leading technology innovator within the cement industry, is not the first company to market carbon-free cement?

Chapter 6 – Final conclusions

What started as a simple claim that it pays to be green has turned into a lively field of debate. Today, 20 years after the Porter hypothesis emerged in 1991, the debate is still on. In light of the recent introduction of the EU ETS and the escalating need to combat the problem of climate change, it has more relevance than ever. The debate seems to have favored a focus on companies that are carbon-intensive. This leaves a gap for assessing the dynamics of environmental innovation across different types of companies including technology innovators with few direct carbon emissions. Industries are left unable to reduce emissions if the dynamics of innovation between innovators and adopters are inefficient. On this basis, the principal purpose of this thesis was to offer a contribution to the "pays to be green debate" by investigating how different types of companies are motivated to conduct environmental innovation.

The research was guided by the following research question:

What drives environmental innovation in different types of companies?

To answer this question a framework was developed, which considers the key determinants of environmental innovation. The framework combines resource-based perspectives and contingency perspectives of strategy and considers both external factors of societal pressure and regulation and internal factors of inter-company capabilities and technologies. Through the framework it has been analyzed how different types of companies respond to climate change, and the circumstances that cause these responses. Accordingly, the first sub-question asked:

1. How do different types of companies respond to climate change and which circumstances drive these responses?

The analysis showed that there are surprisingly few similarities in the drivers for environmental innovation across the companies. They pursue different types of competitive advantages through environmental innovation and have not progressed equally far on their path towards becoming sustainable.

Carbon-intensive companies (DONG Energy and SAS) respond proactively by preventing emissions and thus reduce costs. Besides incremental optimization of their operations they replace polluting resource inputs with clean ones or adopt new technologies that are fundamentally cleaner. Carbon-intensive companies generally respond proactively if they have widespread opportunities to optimize resource productivity, can reduce normative pressure to not threaten their existence, are exposed to severe penalization of their greenhouse-gas emissions or receive subsidies which give them the opportunity to gain first-mover advantages by adopting emerging technologies before competitors, and thus raise entry barriers. Common to these companies are that their core activities and technology do not complement the paradigm of climate change. The circumstances that foster the companies' responses differ. DONG Energy is mainly acting on the basis of a political agenda, whereas SAS' prime motivation is to obtain cost leadership. Both of the carbon-intensive companies are exposed to significant normative pressure, whereas regulation only seems to be influential on DONG Energy.

Non-polluting companies (Novozymes and FLSmidth) respond by differentiating their products. They can reduce emissions by developing products that incur environmental benefits and can collect price premiums if they can reliably communicate the "green" credentials of the products. Novoymes is able to foster synergies between reduced costs and environmental benefits by developing products for various carbon-emitting industries. However, non-polluting companies take reactive responses to climate change if there is unclear demand for environmentally sound products from customers. FLSmidth is navigating in a highly inconsistent environment, as the demand for low-carbon cement factories is low on growth markets. Further, a routinized technological regime and lock-in effects harm the demand for innovative solutions in the cement industry. This market situation has not motivated FLSmidth to develop capabilities for environmental innovation.

2. Is the European Emission Trading System providing significant incentives for innovation across the four case companies?

The EU ETS seems to have failed in providing significant incentives for innovation in all the companies but DONG Energy. A given carbon price does not necessarily drive innovation across all industries. A prices that drives adoption of low carbon technologies in the electric utility industry, might not provide any significant incentives in the aviation industry. Companies' responses to climate change are thus probably more context-dependant than the EU ETS can cope with. Both of the technology innovators have not experienced increased demand as a result of the system, which suggests that the demand-pull effects do not function optimally. Reasons are that the EU ETS has over-allocated free allowances, spurred low carbon prices and send weak signals of its future stringency. It furthermore has disruptive effects on industries that are exposed to risks of carbon leakage. In conclusion, carbon-emitting companies can choose to compensate, rather than innovate, and technology innovators chose investments, which economic returns do not depend on the highly volatile price of carbon permits.

3. How can companies that show reactive responses to climate change start seizing opportunities of environmental innovation?

The prospects of profiting from environmental innovation are weak in many companies. However, a company is not able to spot the true potential for gaining competitive advantages from environmental innovation, before it has come to a certain point on the evolutionary path of becoming "green". A company that has no history of involvement with climate change issues and that is not actively engaged in exploring emerging opportunities is not able to assess the future market potential of environmental innovation. Companies, which business models are successful but not complementary to climate change, get caught in "cognitive traps" and filter out information that might be vital for their strategizing. Since such companies lack information on opportunities of climate change, they cannot assess the profit potential of a "green" strategy. Companies should move outside their "comfort-zone" and experiment with new business models, products and new types of collaborative activities. Only when they reach a certain point on the evolutionary path towards all-encompassing sustainability will they start to see opportunities to profit from environmental innovation.

"…in the real world, $10 bills are waiting to be picked up"[32]

[32] (Porter & Van der Linde, 1995, p. 99)

The title of this thesis is: ***For which companies does it pay to be green?*** The analysis showed that it pays to be "green" for companies that:

- Have widespread opportunities of cost reductions from process improvements or reduction of polluting inputs (DONG Energy and SAS)
- See clear market signals of growing demand for the environmental credentials of their products (Novozymes)
- Receive subsidies and political support that diminish the risks of investing in low-carbon technologies. (DONG Energy)
- Are significantly exposed to normative pressure (DONG Energy and SAS)

In contrast, it pays to a lesser extent to be "green" for companies that:

- Experience uncertain demand for the environmental credentials of their products (FLSmidth)
- Experience market distortions from carbon leakage and growth in unregulated regions. (FLSmidth)

6.1 Implications for further research

It was necessary to draw some demarcations in the writing process. Several interesting issues have therefore been left out of the thesis and the following shortly addresses some avenues for future research.

Research strategy

The conclusions drawn in this thesis are highly influenced by the choice of case companies and research strategy. Different conclusions would likely emerge if the analytical framework designed for this thesis had been applied on a larger sample of companies. A larger sample, and thus a more quantitative research strategy (cf. section 2.1), might show a clearer trend of the causal mechanisms behind environmental innovation. Further, analysis of a single company, or several companies from a single industry, would likely reveal some entirely different causal mechanisms. Further research on the supplier-adopter dynamics of environmental innovation could essentially point policy makers to weaknesses in the existing policy response to climate change.

Global regulation and beyond

At the latest United Nations negotiations (COP16) in Cancun, Mexico, a climate deal was agreed on. It took four years of negotiations to reach and should lead to less deforestation, transfer of technology to developing countries and the establishment of a €75 billion-a-year fund to aid developing countries in adapting to climate change. However, no date was included in the agreement by when countries must peak their emissions. This is considered essential to avoid serious climate impacts in the future, and in practice means that no emissions reductions can be guaranteed. In light of The United States' and China's unwillingness to commit to a legally binding climate agreement, private companies' innovative capacities need to be mobilized to combat the climate challenge. Further research aimed to uncover profit potentials from environmental innovation is thus key, if businesses are to act with no global regulation to enlighten their path.

Literature references

- **Ambec**, S & Barla, P. (2002), "A theoretical foundation of the Porter Hypothesis", Economics Letters 75(3), pp. 355-360.
- **Ambec**, S & Barla, P. (2005), "Can Environmental Regulations be Good for Business? an Assessment of the Porter Hypothesis", Cahiers de recherché, 505
- **Ambec**, S., Cohen, M., Elgie, S., & Lanoie, P. (2010), "The Porter Hypothesis at 20: Can Environmental Regulation Enhance Innovation and Competitiveness?", CIRANO Working Papers 2010s-29.
- **Ambec**, S., Lanoie, P. (2007), "When and Why Does it Pay to be Green?", CIRANO Burgundy Reports 2007rb-03, CIRANO
- **Ambec**, S., Lanoie, P., Laurent-Lucchetti, J. & Johnstone, N. (2007), "Environmental Policy, Innovation and Performance: New Insights on the Porter Hypothesis", CIRANO Working Papers 2007s-19.
- **Anderson,** P. & Tushman, M. (1986), "Technological Discontinuities and Organizational Environments", Administrative Science Quarterly, 31, p. 439-446
- **André**, F., Gonzlez, P. & Porteiro, N. (2009), "Strategic quality competition and the Porter Hypothesis," Journal of Environmental Economics and Management, Elsevier, 57(2), pp.182-194

- **Barney**, J. (1991), " Firm Resources and Sustained Competitive Advantage", Journal of Management, 17(1), pp. 99 -120
- **Betz**, R. & Sato, M. (2006), "Emissions trading: lessons learnt from the 1st phase of the EU ETS and prospects for the 2nd phase", Climate Policy, 6(5), pp. 351-359
- **Blanco**, M. I., Rodrigues, G. (2008), "Can the future EU ETS support wind energy investments?", Department of Economic Analysis, Faculty of Economics, University of Alcalá
- **Boeters**, S., Veenendaal, P., Nico van Leeuwen & Rojas-Romagoza, H (2008), "The potential for biofuels alongside the EU-ETS", CPB Netherlands Bureau for Economic Policy Analysis.
- **Burtraw**, D. & Cannon, M. (2000), "Heterogeneity in Costs and Second-Best Policies for Environmental Protection", Discussion Paper, Resources For the Future

- **Chandler**, A. D. (1962), "Strategy and structure: Chapters in the history of the American industrial enterprise". Cambridge, MA: MIT Press.
- **Chesbrough**. H. (2003), "Open Innovation – The new Imperative for Creating and Profiting from Technology", Ch4 "The Business Model", pp63 – 91. Boston, Harvard Business School Pub.
- **Chesbrough**. H. (2010) "Business model innovation: Opportunities and barriers", Long range planning, 43 pp. 354-383. Elsevier
- **Christensen**, C. (2002), "The Innovator's Dilemma", Boston, MA: Harvard Business School Press.
- **Christensen**, J.F. et al. (2005), "The industrial dynamics of Open Innovation- Evidence from the transformation of consumer electronics", Research Policy, 34, pp. 1533-1549.
- **Cohen**, M., Fenn, S., & Naimon J. (1995), "Environmental and Financial Performance; Are they Related?", Vanderbilt University: Nashville, TN.
- **Cohen**, W. M. & Levinthal, D. A. (1990), "Absorptive Capacity: A New Perspective on Learning and Innovation, Administrative Science Quarterly, 35(1), pp. 128-152.
- **Correa**, A. & Sharma, S. (2003), "A contingent resource-based view of proactive corporate environmental strategy", Academy of management review, 28(1), pp. 71-88.

- **Demailly** & Quirion (2007), "European Emission Trading Scheme and competitiveness: A case study on the iron and steel industry" Energy economics
- **DiMaggio**, P. J. & Powell, W. W. (1983), "The Iron Cage Revisited - Institutional Isomorphism and Collective Rationality in Organizational Fields", American Sociological Review, 48(2), pp. 147-160
- **Djursing**, T. (2007), "Vindmøller fik kunstigt åndedræt for 2,4 milliarder", Ingeniøren, October 10, 2007. Avaiable at: http://ing.dk/artikel/82165-vindmoeller-fik-kunstigt-aandedraet-for-24-milliarder

- **Esty**, D. & M. Porter. (2001), "Ranking national environmental regulation and performance: a leading indicator of future competitiveness?", The Global Competitiveness Report 2001-2002, Oxford University Press.

- **Greaker**, M. (2003), "Strategic environmental policy: Eco-dumping or a green strategy?" Journal of Environmental Economics and Management, 45(3).

- **Greaker**, M. & Alfsen, H. (2006), "From natural resources and environmental accounting to construction of indicators for sustainable development", Discussion paper, Research department of statistics, Norway
- **Gonzales**, P. (2007), "The empirical analysis of the determinants for environmental technological change: A research agenda", Ecological Economics, 68(3).
- **Grubb**, M. (2004), "Technology Innovation and Climate Change Policy: an overview of issues and options", Keio Economic Studies 41(2), pp. 103-132.
- **Grubb**, M. & Neuhoff, K. (2006), "Allocation and competitiveness in the EU emissions trading scheme: policy overview," Cambridge Working Papers in Economics 0645.
- **Grubb**, M., Neuhoff, K., Matthes, F. & Tse, M. (2006), "Auctioning of EU ETS Phase II Allocations: How and Why?" Climate Policy, 6(1), pp. 135–158.

- **Hart**, S. L. (1995), "A natural-resource-based view of the firm", Academy of Management Review, 20(4).
- **Hart**, S. L. & Ahuja, G. (1996), "Does it pay to be green? An empirical examinations of the relationship between emission reduction and firm performance", Business strategy and the environment, 5, pp. 30-37.
- **Hart**, S. L. & London, T. (2004), "Reinventing Strategies for Emerging Markets: Beyond the Transnational Model", Journal of International Business Studies, 35, pp. 350-370.
- **Hoffman**, A. J. (2006), "Getting Ahead of the Curve: Corporate Strategies That Address Climate Change", The Pew Center on Global Climate Change.
- **Hoffmann**, A. J & Schneider, M; Rogge, K. S. (2010), "The innovation impact of EU emission trading – Findings of company case studies in the German Power Sector, DRUID, Fraunhofer, Working Paper Sustainability and Innovation, S/2
- **Hoffmann**, V.H., (2007), "EU ETS and Investment Decisions: The Case of the German Electricity Industry". European Management Journal, 25 (6), pp. 464-474.
- **Holmgren**, K. & Sternhufvud, C. (2007), "CO2-emission reduction costs for petroleum refineries in Sweden", IVL Swedish Environmental Research Institute Ltd, Sweden, Journal of cleaner production

- **Ingram**, P. & Clay, K. (2000). "The choice-within-constraints new institutionalism and implications for sociology", Annual Review of Sociology, 26 pp. 525-546

- **Jaffe**, A. B., & Palmer, K. (1997), "Environmental regulation and innovation: A panel data study", The Review of Economics and Statistics, 79(4).
- **Jaffe** A. B., Peterson, S. R., Portney, P. R., & Stavins, R. N. (1995), "Environmental regulation and the competitiveness of U.S. manufacturing: What does the evidence tell us?" Journal of Economic Literature, 33(1).
- **Jaffe** A. B., Newell, R. & R. Stavins, R. (2004), "A tale of two market failures: Technology and the environment", Discussion paper, Washington DC.
- **Jaffe** A. B., Newell, R. & R. Stavins, R. (2003), "Technological change and the environment", Handbook of Environmental Economics, 1, pp. 462-516.

- **King**, A. A. & Lenox, M. J. (2001), "Does it Really Pay to be Green? An Empirical Study of Firm Environmental and Financial Performance", The Journal of Industrial Ecology
- **Kolk**, A. & Levy, D. (2004), "Multinationals and global climate change: issues for the automotive and oil industries", Lundan S. Multinationals, environment and global competition. Oxford: Elsevier.
- **Kolk**, A. & Pinkse, J. (2009), "International Business and Global Climate Change", European Academy of Business in Society, 1st edition, Routhledge, Oxon.
- **Kolk**, A. & Pinkse, J., (2004a), "Market strategies for climate change", European Management Journal 22 (3).
- **Kolk**, A. & Pinkse, J. (2004b) "The evolution of multinationals' responses to climate change", (Paper presented at Second International Conference on International Corporate Responsibility, Carnegie Bosch Institute/Amsterdam graduate Business School, Amsterdam 18-20 June 2004).
- **Kvale**, S. (1996): Interviews: an introduction to qualitative research interviewing, Thousand Oaks, California, Sage Publishing

- **Lanoie**, P., & Tanguay, G. (2000), "Factors leading to green profitability: Ten case studies", Greener Management International, 31, pp. 39-50.

- **Mohr**, R. (2002), "Technical change, external economics and the Porter Hypothesis", Journal of Environmental Economics and Management, 43(1) pp. 158-168.

- **Mohr**, R. & Saha, S. (2008), "Distribution of Environmental Costs and Benefits, Additional Distortions, and the Porter Hypothesis", Land Economics, 84 (4), pp. 689-700
- **Murty**, M. & Kumar, S. (2002), "Win–win opportunities and environmental regulation: testing of porter hypothesis for Indian manufacturing industries", Journal of Environmental Management, 67(2), pp.139-144.

- **Oltra**, V. (2008), "Environmental innovation and industrial dynamics: the contributions of evolutionary economics", University Montesquieu Bordeaux IV
- **Orsato**, R. (2006), "Competitive environmental strategies: When does it pay to be green?", California Management Review, 48(2)
- **Orsato**, R. (2009) "Sustainability Strategies: When Does It Pay To Be Green?", 1st edition, Palgrave Macmillan,

- **Palmer**, K., Oates, W. & Portney, P. (1995), "Tightening environmental standards: the benefit-cost or the no-cost paradigm?", Journal of Economic Perspectives, 9(4), pp. 119-132.
- **Pavitt**, K. (1984), "Sectoral patterns of technical change: towards a taxonomy and a theory", Research Policy, 13, pp. 343–373.
- **Petsonk**, A., & Cozijnsen, J. (2007), "Harvesting the Low-Carbon Cornucopia: How the European Union ETS (EU ETS) is Spurring Innovation and Scoring Results".
- **Porter**, M. & Linde, C. V. d. (1995), "Green and Competitive - Ending the Stalemate", Harvard Business Review, 73(5).
- **Porter,** M. (1991), "America's green strategy", Scientific American, 264(4), 168.
- **Porter**, M. & Kramer, M. R. (2006), "Strategy & Society. The Link between Competitive Advantage and Corporate Social Responsibility", Harvard Business Review.
- **Prahalad** C, K. & Bettis, R. A. (1986), "The Dominant Logic - A New Linkage Between Diversity and Performance", Strategic Management Journal, 7(6), pp. 485-501.
- **Prahalad** C, K., Rangaswami, M, R. & Nidumolu, R. (2009), "Why Sustainability Is Now the Key Driver of Innovation". Harvard Business Review; 87 (9), pp. 56-64

- **Reinhardt**, F. L. (1999), "Environmental product differentiation: implications for corporate strategy", California Management Review, 40(4).

- **Reinhardt**, F. L. (2000), “Down to earth: Applying business principles to environmental management”, Cambridge: Harvard Business School Press.
- **Rugman**, A. M., & Verbeke, A. (2004), “A perspective on regional and global strategies of multinational enterprises”, Journal of International Business Studies, 35.
- **Rugman**, A. M., & Verbeke, A. (1998), “Corporate strategies and environmental regulations: an organizing framework”, Strategic Management Journal, 19.

- **Sanyal**, P. (2007), “The effect of deregulation on environmental research by electrical utilities”, Journal of regulatory economics, 31.
- **Saunders**, M., Lewis, P. & Thornhill, A. (2003), “Research Methods for Business Students”. 3rd ed. Harlow, Prentice Hall.
- **Sharma**, S. & Vredenburg, H. (1998), “Proactive corporate environmental strategy and the development of competitively valuable organizational capabilities”, Strategic Management Journal, 18, pp. 729-753.
- **Simpson**, R. & R. Bradford (1996), “Taxing variable cost: environmental regulation as industrial policy”, Journal of Environmental Economics and Management, 30(3), pp. 282-300.

- **Taylor**, M. (2008), “Cap-and-Trade Programs and Innovation for Climate Safety”, Working paper, University of California, Berkeley.
- **Teece**, D. J., Pisano, G. & Shuen, A. (1997), “Dynamic capabilities and strategic management”, Strategic Management Journal, 18, pp. 509–533.
- **Teece**, D. J. (1986), “Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy”, Research Policy, 15(6), pp. 285–305.
- **Tennbakk**, B., Sinner, F. & Nysæther, J. (2009), “EU EmissionTrading – Economical Effects of Emission Auctions”, TemaNord, 582.
- **Tushman**, M. L. & Anderson, P. (1986), “Technological Discontinuities and Organizational Environments”, Administrative Science Quarterly, 31(3), pp. 439-465.

- **UNITED NATIONS** FRAMEWORK CONVENTION ON CLIMATE CHANGE (2005), “text of the convention”, United Nations.

- **Wagner**, M. (2003), "The Porter Hypothesis revisited: a literature review of theoretical models and empirical tests", Centre for Sustainability Management, Lüneburg University, CSM Working Paper.
- **Walley**, N. & Whitehead, B. (1994), "It's Not Easy Being Green". Harvard Business Review, 72(3)
- **Winter** S.G. (1984), "Schumpeterian Competition in Alternative Technological Regimes", Journal of Economic Behaviour and Organization, 5, pp. 287-320.
- **Winter**, S, (1987), "Knowledge and competence as strategic assets", In D. Teece (Ed.), The competitive challenge.' 159-184. Cambridge

- **Yin**, R. (1994), "Case study research: Design and methods", 2nd edition, Beverly Hills, CA: Sage Publishing.

- **Xepapadeas**, A. & Zeeuw, A.J.(1998) "Environmental Policy and Competitiveness: The Porter Hypothesis and the Composition of Capital", Discussion Paper 1998-38, Tilburg University, Center for Economic Research.

7.1 Reports & articles

- **Air Transport Action Group** (ATAG). (2010), "Intermodality 2010".
- **Boston Consulting Group**, (2008) "BCG, ASSESSMENT OF THE IMPACT OF THE 2013-2020 ETS PROPOSAL ON THE EUROPEAN CEMENT INDUSTRY".
- **DONG Energy**, (2008) "Sustainability Report, 2008".
- **DONG Energy**, (2009) " Biomass and waste for power production".
- **EEA**, (2009) "Greenhouse gas emission trends and projections in Europe 2009".
  Energistyrelsen (2010), "Afregning og tilskud til vindmøller".
- **European Federation for Transport and Environment**, (2008), Including Aviation in the EU's Emissions Trading Scheme (EU ETS),
- **Europa, eu** (2010), "Climate change: Commission proposes bringing air transport into EU Emissions Trading Scheme"
- **EU Policy department**; economic and scientific policy; Workshop, future of the EU ETS, May 15, 2008
- **FLSmidth** annual report (2009). Available at www.flsmidth.com
- **FLSmidth** Carbon Disclosure Report (2009). Available at www.cdp.com
  Greenpeace, (2006), "Tarjei Haaland indstillet til Nordisk Råds Natur- og Miljøpris 2006",

- **Greenpeace**, (2009) " Den danske regerings klima- og energipolitik på hjemmebanen er kulsort".
- **IATA** (2010), jet fuel price monitor, entered on December 1, 2010. http://www.iata.org/whatwedo/economics/fuel_monitor/Pages/index.aspx
- **Novozymes** annual report (2009). Available at www.novozymes.com
- **Novozymes** Carbon Disclosure Report (2009). Available at www.cdp.com
- **Point Carbon**, a Thomson Reuters Company (www.poointcarbon.com), (2010), Entered on September 27, 2010.
- **Point Carbon (**2010) http://www.pointcarbon.com/aboutus/pressroom/pressreleases/1.1130832), (2010),
- **SAS** Annual Report and sustainability report (2009)
- **Statistics Denmark**, (2009), "Greenhouse-gas Emissions From the Danish Economy".
- **WWF Denmark**, (2009), "Industrial biotechnology - More than green fuel in a dirty economy?"
- **WWF International** (2008), "How to turn around the trend of cement related emissions in the developing world?"
- **WWF International** (2009), "A blueprint for a climate friendly cement industry – How to turn around the trend of cement related emissions in the developing world".

7.2 Websites

- **Web 1**: Accessed on June 3, 2010. http://www.nytimes.com/2007/10/26
- **Web 2:** Accessed on December 14, 2010. http://www.novozymes.com/en/sustainability/Pages/default.aspx
- **Web 3**: Accessed on November 3, 2010. http://sustentator.com/blog-en/2009/10/a-non-polluting-ecological-cement-that-absorbs-greenhouse-gases/
- **Web 4**: Accessed on December 10, 2010. http://www.eex.com
- **Web 5:** Accessed on November 13, 2010. http://www.euro-correspondent.com/eco-doom/news-and-analysis/little-support-for-carbon-floor-price/
- **Web 6:** Accessed on Decebmber 3, 2010. http://www.repp.org/repp_pubs/articles/issuebr14/04Britan.htm

Appendixes

8.1 Appendix 1 – Novozymes Interviewguide

– Per Henning Nielsen

Company specific questions

- Have you formulated a strategy on how to deal with climate change and your internal emissions?
  - What does this strategy say about:
    - Compensation?
    - Innovation?

- Have you put together a team responsible for EU ETS compliance and climate change?
  - If yes, what are their responsibilities?
  - If yes, What are their positions within NZ?
  - If no, why not, and where is the responsibilities then placed?

- What are your reasons for using LCA analysis for measuring lowering CO2?

- Have you considered (or done) moving any form of production to unregulated locations since the anticipation of initiation of EU ETS?

- Why do you not set targets beyond 2015?

- Which effects has participation in EU ETS had on your innovative capabilities?
  - Have you initiated projects/product directly on the basis of possibilities occurring after the introduction of the EU ETS?

- To which degree do you consider the EU ETS important in relation to other national/regional/international schemes?

- In how many of your products do environmental issues play a role in your value proposition to customers?

- How is pressure and expectations from society influencing your business?

- In the CDP report your latest data on emission are from 2008 – why?

- Does NZ environmental policies cover all international NZ operations in all countries?

Regulatory uncertainty

- How does the political uncertainty after COP15 affect your investment decisions regarding CO2 reducing innovations?

  - Do you speculate in the post 2012 EU ETS allocation policies?

- Have you done any political lobbying in order to have influence on policy?
  - Have you formulated a strategy for lobbying?
  - EU / Denmark / internationally?

- To which extent do you consider political uncertainty in your long-term decision-making?
  - do you only stick to the fact that you are covered by EU ETS?

- How does the environmental performance of your organization compare to other organizations in your sector?

- Would you consider NZ to go beyond compliance?
  - If yes, is this because you want to lower your risk related to new international regulations?

Additional questions

- Has environmental regulation done anything to enhance your economic performance directly or indirectly? (do they go hand in hand?)

- Which incentives has EU ETS given you to make innovations
  - Process
  - product

- Do you think you have gained easier and cheaper access to capital because of your environmental efforts?

- Do you think you have gained *access to new markets* because of your environmental effort (eg. Public Green Purchasing)

- Do you think you have better access to *skilled labor* because of your environmental efforts?

- Have you been able to *sell any pollution control technologies* invented to lower emissions or protect the environment?

- Has your *purchasing power* over suppliers improved as a consequence of your environmental policies?

- Has your environmental policies improved your relation to any other relevant stakeholders?

8.2 Appendix 2 - SAS Interviewguide

– Martin Porsgaard

Company specific questions

- **Have you formulated a strategy on how to deal with the ongoing compliance to EU ETS?**
    - What does this strategy say about:
        - Compensation?
        - Innovation?
    - Have you quantified whether it is cheaper for you to conduct innovations or to compensate via emissions allowances?
- **Have you put together a team responsible for EU ETS compliance?**
    - If yes, what are their responsibilities?
    - If yes, What are their positions within SAS?
    - If no, why not, and where are the responsibilities then placed?
- **How does the environmental performance of your organization compare to other organizations in your sector?**
- **Would you consider SAS to go beyond compliance?**
    - If yes, is this because you want to lower your risk related to new international regulations?
- **Has environmental regulation done anything to enhance your economic performance directly or indirectly? (do they go hand in hand?)**
- How is pressure and expectations from society influencing your business?

Innovation and economic value:

- **Which effects has participation in EU ETS had on your innovative capabilities?**
    - Have you initiated projects/product directly on the basis of possibilities occurring after the introduction of the EU ETS
- **Which incentives has EU ETS given you to make innovations?**
    - Process
    - Product

Business model & Regulatory uncertainty

- **In how many of your products do environmental issues play a role in your value proposition to customers? (how many customers offset their flight? Percentage)**

- **How do you incorporate this knowledge about innovations and economic value into your business model**
    - Has your business model changed in the recent years – to what?
- **In the CDP you mention that aviation will play a big part in worldwide mitigations. Can you explain this further?**
- **How does the political uncertainty after COP15 affect your investment decisions regarding CO2 reducing innovations?**
    - Do you speculate in the post 2012 EU ETS allocation policies?
- **To which degree do you consider the EU ETS important in relation to other national/regional/international schemes?**
- **To which degree do you consider the EU ETS important in relation to other factors influencing your business, for example the price of oil?**
    - Is the price of oil also a reason for you to navigate away from fossil fuels?
    - Is regulatory compliance only a "bonus" that you get in your effort to get independent on fossil fuels?
- **Have you done any political lobbying in order to have influence on policy?**
    - Have you formulated a strategy for lobbying?
    - EU / Denmark / internationally?

8.3 Appendix 3 - DONG Interviewguide

– Peter Markussen and CIlla Harpsøe Clausen

Company specific questions

- **How come you do not participate in the CDP?**
- **Why have you not set any emissions reduction targets?**
- **Have you formulated a strategy on how to deal with the EU ETS?**
    - What does this strategy say about:
        - Compensation?
        - Innovation?
    - Have you quantified whether it is cheaper for you to conduct innovations or to compensate via emissions allowances?
- **Have you put together a team responsible for EU ETS/carbon trading compliance?**
    - If yes, what are their responsibilities?
    - If yes, What are their positions within FLS?
    - If no, why not, and where are the responsibilities then placed?
- **Has environmental regulation done anything to enhance your economic performance directly or indirectly? (do they go hand in hand?**
- **Successful exploitation of the EU ETS is contingent on which factors?**
- **Which investments have you not undertaken and why? (coal powered stations in germany and England)**
- How is pressure and expectations from society influencing your business?

Innovation and economic value:

- **Which effects has the climate agenda had on your innovative capabilities?**
    - Have you initiated projects/product directly on the basis of possibilities occurring as a result of demand for greener products?
- **Which incentives has the climate agenda given you to make innovations?**
    - Process
    - Product

Business model & Regulatory uncertainty

- **In how many of your products do environmental issues play a role in your value proposition to customers? (how many customers offset their flight? Percentage)**

- **How do you incorporate this knowledge about innovations and economic value into your business model**

  - Has your business model changed in the recent years – to what?

- **How does the political uncertainty after COP15 affect your investment decisions regarding CO2 reducing innovations?**

  - Do you speculate in the post 2012 EU ETS allocation policies?

- **To which degree do you consider the EU ETS important in relation to other national/regional/international schemes?**

- **To which degree do you consider climate change important in relation to other factors influencing your business, for example the price of oil?**

  - Is the price of oil also a reason for you to navigate away from fossil fuels?
  - Is regulatory compliance only a "bonus" that you get in your effort to get independent on fossil fuels?

- **Have you done any political lobbying in order to have influence on policy?**

  - Have you formulated a strategy for lobbying?
  - EU / Denmark / internationally?
- How come you have only set relative targets and not absolute?

  Info: dong expects to half their emissions pr produced amount by 2020.

8.4 Appendix 4 - FLSmidth Interviewguide

- Tine Kokfeldt

Company specific questions

- **How come you are still not participating in the CDP?**
- **Why have you not set any emissions reduction targets?**
- **Have you formulated a strategy on how to deal with the EU ETS?**

    - What does this strategy say about:
        - Compensation?
        - Innovation?
    - Have you quantified whether it is cheaper for you to conduct innovations or to compensate via emissions allowances?

- **Have you put together a team responsible for EU ETS/carbon trading compliance?**

    - If yes, what are their responsibilities?
    - If yes, What are their positions within FLS?
    - If no, why not, and where are the responsibilities then placed?

- **How does the environmental performance of your organization compare to other organizations in your sector?**

- **Has environmental regulation done anything to enhance your economic performance directly or indirectly? (do they go hand in hand?)**

- How is pressure and expectations from society influencing your business?

Innovation and economic value:

- Which effects has the climate agenda had on your innovative capabilities?
- Have you initiated projects/product directly on the basis of possibilities occurring as a result of demand for greener products?
- Which incentives has the climate agenda given you to make innovations?
    - Process
    - Product

Business model & Regulatory uncertainty

- In how many of your products do environmental issues play a role in your value proposition to customers? (how many customers offset their flight? Percentage)
- How do you incorporate this knowledge about innovations and economic value into your business model
- Has your business model changed in the recent years – to what?

- How does the political uncertainty after COP15 affect your investment decisions regarding CO2 reducing innovations?
- Do you speculate in the post 2012 EU ETS allocation policies?
- To which degree do you consider the EU ETS important in relation to other national/regional/international schemes?
- To which degree do you consider climate change important in relation to other factors influencing your business, for example the price of oil?
- Is the price of oil also a reason for you to navigate away from fossil fuels?
- Is regulatory compliance only a "bonus" that you get in your effort to get independent on fossil fuels?
- Have you done any political lobbying in order to have influence on policy?
- Have you formulated a strategy for lobbying?
    - EU / Denmark / internationally?

8.5 Appendix 5 – CONCITO interviewguide

- Martin Lidegaard

- Hvad ser du som den største udfordring i forhold til virksomhederne og klimaet?
- Hvad ville gøre min opgave/analyse interessant for concito, virksomhederne og den offentlige debat? – hvad mangler man mere at vide på feltet?
- Hvordan er interrelationen mellem det politiske spil og virksomhedernes intentioner om at profitmaksimere?
- Hvad hører du er virksomhedernes begrundelse for ikke at sænke deres udslip mere end de gør?
- Hvad mener du at virksomheder der ikke nødvendigvis har nemt ved at sænke deres udslip kan gøre?
- Findes der helt konkrete beviser på, at øget investeringer i klimavenlige teknologier ikke går negativt ud over konkurrenceevnen på lang sigt?
- Hvordan synes du virksomhederne skal anse den usikkerhed der findes omkring lovgivning?
- Hvordan håndterer man fra politisk side usikkerheden omkring lovgivning og klimaforandringer og hvad forestlår Concito?

8.6 Appendix 6 - Greenpeace (GP) interviewguide

- Tarjei Haaland

1. What is GP's role in Danish climate debate?
2. The companies covered in the thesis are FLS, Dong, SAS and NZ, which of these have you investigated?
3. What is your comment on the Danish industry's effort towards mitigating CC impact?
4. What is your thoughts on the EU ETS design and purpose? – do you believe that CTPs is the best solution?
5. What is your thoughts on the PH?
6. What would be the ideal response from your point of view for each of the case companies??
7. Can you please explain the DONG HFC23 investment incident.
8. Which issues related to my thesis subject do you think would be interesting to shed more light on?
9. In the general debate, which issues do you think is being neglected from industry and political side?
10. If any, what do you think the reason for this neglecting is?

8.7 Appendix 7 - WWF Interviewguide

- John Nordbo

1. What is WWFs role in the Danish climate debate?
2. Politically
3. Related to private firms
4. The companies covered in the thesis are FLS, Dong, SAS and NZ. Which of these do you have knowledge on related to their response to climate change?
5. What are your comments on the Danish industry's effort towards mitigating climate change impact?
6. What are your thoughts on the EU ETS design and purpose? – Do you believe that cap and trade systems are the best solution?
7. How could the design of EU ETS be improved, and
8. Which other political tools could be used?
9. What are your thoughts on the Porter Hypothesis?
10. What would be the ideal response from your point of view for each of the case companies??
11. Which issues related to my thesis subject do you think would be interesting to shed more light on from an NGO perspective?
12. In the general debate, which issues do you think is being neglected from industry and political side?
13. If any, what do you think the reason for this neglecting is
14. Do you have any knowledge or insights you would like to share
15. In politiken you mention a report form WWF stating that the Danish emissions are actually 20% higher than official statistics. – Ca you tell me about that and where can I find the report?

8.8 Appendix 8 – Overview of costs of different energy sources

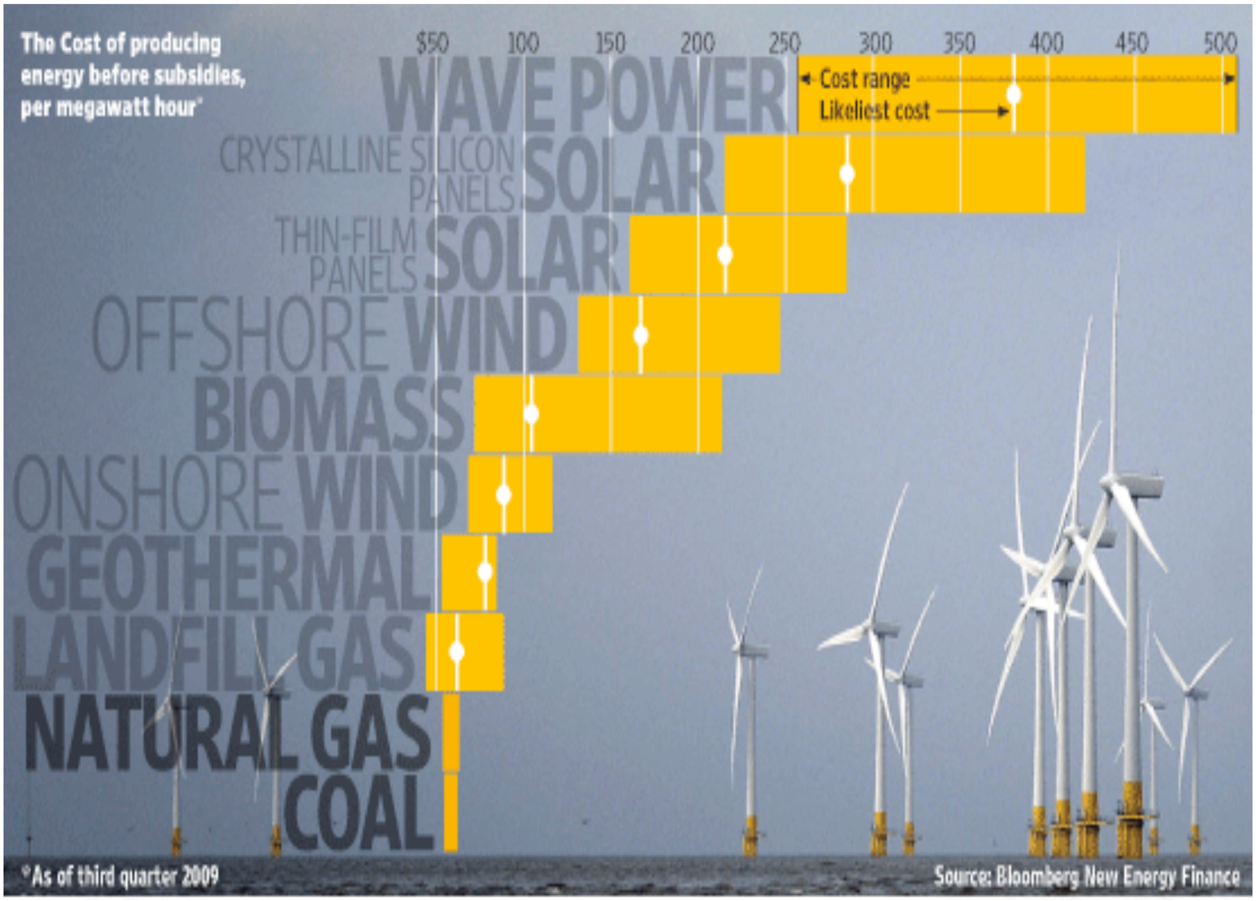

Figure 8-1. Source, Bllomberg New Energy Finance 2009