

Electricity Certificates and Emissions Permits Schemes in Sweden

Strategic implications for Vattenfall AB and Sydkraft AB

Juan Carlos Caycedo G.

Supervisors

Dr Lars Hansson

Dr. Renato J. Orsato

Thesis for the fulfilment of the
Master of Science in Environmental Management and Policy
Lund, Sweden, October 2003

© You may use the contents of the IIEE publications for informational purposes only. You may not copy, lend, hire, transmit or redistribute these materials for commercial purposes or for compensation of any kind without written permission from IIEE. When using IIEE material you must include the following copyright notice: 'Copyright © IIEE, Lund University. All rights reserved' in any copy that you make in a clearly visible position. You may not modify the materials without the permission of IIEE.

Published in 2003 by IIEE, Lund University, P.O. Box 196, S-221 00 LUND, Sweden,
Tel: +46 – 46 222 02 00, Fax: +46 – 46 222 02 10, e-mail: iiee@iiee.lu.se.
Printed by KFS AB, Lund.

ISSN 1401-9191

Acknowledgements

When the time comes to thank all people involved into the process of ending this thesis, one run on the risk of being broad and general or not to include all the people that was important to achieve this goal. Hence, initially, I would like to bring all my gratitude to every single person who directly or indirectly helped me to reach this point. This thesis is the summary of your teaching, points of view, advice and support.

However, this thesis started more a year ago in Colombia, where I would like to thank, in the very first place, to my parents for their tireless support. All this time far from home makes me feel closer to you. In a second instance, to my friends of the Andean Centre for Economics in the Environment: Thomas, Luis Fernando, Liana, Andrea, Martha Liliana, Giovanni and Olga. Your work was my inspiration for this thesis. To all my family and friends who were near all this time lightening all those difficult times, thanks a lot.

I owe a special thanks to my supervisors: Renato Orsato who guided the whole process of this thesis, without his help this thesis had never been finished; and Lars Hansson who gave me his orientation and advice in the economic field this thesis is centred. My gratefulness to Don Huisingh who was my life advisor all this time, I hope to count on you forever. Rolf Henrikson made possible to me to work in this topic; he opened all possible doors in the companies and introduced me to the Swedish reality of the energy sector. Thanks Rolf. I thank to Thomas B. Johansson for the invitation to swim into the deep waters of the tradable emissions permits world in Brussels. Finally, I thank all the IIIEE staff for their guidance and advice, but especially to: Håkan Rhode, Zinaida Fadeeva, Adriana Budeanu, Luis Mundaca, Anna Aronson and Dolores Piegretti.

I give a special recognition to the tolerance of all those people that take time for solving my endless questions. In Sydkraft: Teresa Mattison, Ulrika Bergström, Christina Stafström, Mattias Örtenvik, Gert Lyngsjö and Leif Josefsson. In Vattenfall: Staffan Gortz (double thanks), Leif Westin, Göran Svenson and Bo Nielsen. In the Swedish EPA, to Mark Storey and in the Swedish National Energy Administration, to Thord Nicklasson and Thomas Levander.

Finally, to each one of my classmates who shared with me this unforgettable year, I give all my gratitude. All of you will always be in my mind.

To Mom and Dad

Abstract

In Sweden, energy utilities face the double challenge of complying with the Kyoto protocol targets and increasing renewable energy capacity to make use of the electricity certificates system. Sydkraft AB and Vattenfall AB, two of the largest players in the Nordic electricity market, have different expectations regarding the future development of the two mechanisms and, therefore, have different approaches to the uncertainties that the two mechanisms involve. Therefore, this research looks into the strategic implications of the emissions trading system and electricity certificates system for Sydkraft and Vattenfall.

The strategic implications of the implementation of both flexible mechanisms for Sydkraft and Vattenfall are: a) both companies will make few investments to build renewable energy capacity and reduce carbon dioxide emissions, since investing in new capacity is currently a risky activity. Therefore, independent entrepreneurs are expected to be responsible for new developments in renewable energy; b) both companies will lose opportunities in green certificates trading, in the voluntary scheme of the Renewable Energy Certificates System (RECS), the Norwegian electricity certificates system or/and the European Tradable Renewable Energy Certificates System, if they become reality; c) both companies will face strategic disadvantages for not taking early moves in reducing carbon dioxide emissions and increasing renewable energy capacity, allowing other utilities to gain in experience and performance in the industry. Finally, in Sweden, electricity certificates and tradable emission permits are working in parallel and there are few possibilities to link them in order to both increase renewable energy capacity and reduce carbon dioxide emissions.

Executive Summary

The relevance of the carbon dioxide emission consequences made Europe accept the target proposed by the Kyoto protocol of 8% reductions during the period 2008 – 2012, compared with their emissions in 1990. To accomplish these reductions at the lowest economic costs for society, the Kyoto protocol created three flexible mechanisms: Clean Development Mechanism (CDM), Joint Implementation (JI), and Tradable Emission Permits (TEP). TEP was designed to be applied within developed nations. Furthermore, the European Union nations agreed to increase the existing renewable energy capacity with the purpose of reducing their dependence upon non-renewable sources of energy and to reduce their carbon dioxide emissions. Different instruments are being used for this purpose being the green certificates scheme, the one designed to provide economic advantages similar to the tradable emission permits.

Sweden has started a green certificates approach, “electricity certificates system” and, simultaneously, the country is preparing their market conditions for the European market on emissions trading to begin in 2005. In Sweden, the main stakeholders affected by the operation of the two instruments are the main energy producers, which include Sydkraft and Vattenfall that together, produce 70% of the country’s electricity.

The research question formulated for use within this thesis was: What are the strategic implications of the implementation of the tradable emission permits and electricity certificates for Sydkraft and Vattenfall?

The author used a systematic analysis framework to gain insight into the strategies of the firms under the uncertainties that the tradable emissions permits and the electricity certificates. Also, the author analysed two additional factors closely interrelated with Swedish political issues currently under active debate: decommissioning of nuclear power and fossil fuels use within energy utilities.

The author utilised in-depth interviews with key company representatives to obtain insights into the strategies of the companies with regard to all of these factors. Additionally these energy representatives were asked about the strategy of the company if future conditions on the factors follow the trend of two different scenarios after 2010. The first scenario proposed a future with ratification of the Kyoto protocol and continuation of the electricity certificates system, which implies tougher targets in carbon dioxide emission reductions and increase in renewable energy capacity. The second scenario posed relaxed targets in both carbon dioxide emissions and renewables capacity.

This approach permitted the thesis author to develop conclusions about the strategic postures and moves that the energy companies currently have and about their current and anticipated strategies with regard to tradable emission permits and electricity certificates.

The analysis determined the strategic postures and moves that companies could take on each one of the factors according to the answers given by companies’ representatives.

With regard to the proposed phase-out of Barsebäck’s second reactor Sydkraft negotiated with the government that if the Barsebäck’s second reactor is decommissioned they will receive the same share of energy in other nuclear reactor. On this topic, Vattenfall leadership believes that the future conditions of the market will cope with the lack of energy due to the possible closure of that nuclear plant. However, the possibility of the second reactor phase out is remote because new investments in power plants will be based in natural gas electricity production and those projects will increase the country’s carbon dioxide emissions. Thus, if

Sweden is to comply with the Kyoto protocol target neither Barsebäck second reactor nor other nuclear plants should be phased out in the future.

With regard to electricity certificates, both firms have made investments on renewable energy and, at present, are investing in research and development on new technologies in this field. However, their position in looking to the future is that they will not make new investments in increasing capacity unless it is profitable to do so. Thus, if the conditions for building additional electrical power generation capacity are not appropriate for them, they will rely on the electricity certificates market, purchasing certificates and not producing them.

With regard to tradable emission permits, both companies' leaders believe that additional reductions in carbon dioxide emissions, below the actual level of emissions, are difficult and costly since they have made a significant effort in past years. Therefore, both Swedish energy companies intend to fulfil their permit requirements by purchasing emission reduction credits from other countries where it is cheaper to reduce emissions.

With regard to the use of fossil fuels, the energy companies will not adjust their usage based upon changes in prices since both companies have a reduced use of fossil fuels and increases in fossil fuel prices due to environmental regulation on carbon dioxide emission reductions will better off the profits of both companies.

The main conclusions that the thesis author made with respect to the research question were:

- a) Both, Sydkraft and Vattenfall, will make few investments in build renewable energy capacity and reduce carbon dioxide emissions, since investing in new capacity is currently a risky activity. Therefore, independent entrepreneurs are expected to make the new developments in renewable energy.
- b) Both companies will lose opportunities on the green certificates trading, in the voluntary scheme of the Renewable Energy Certificates System (RECS), the Norwegian electricity certificates system or/and the European Tradable Renewable Energy Certificates System, if they become reality.
- c) Both companies will face strategic disadvantages for not taking early moves in reducing carbon dioxide emissions and increasing renewable energy capacity, allowing other utilities to gain in experience and performance in the industry.

Finally, in Sweden electricity certificates and tradable emission permits are working in parallel and there are few possibilities to link them in order to improve the performance of achieving both renewable energy and reduction in carbon dioxide emissions targets.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION	1
1.1 BACKGROUND OF THE RESEARCH.....	1
1.2 RESEARCH PROBLEM	1
1.3 JUSTIFICATION FOR THE RESEARCH	2
1.4 METHODOLOGY.....	3
1.5 LIMITATIONS AND KEY ASSUMPTIONS	4
1.6 OUTLINE OF THE THESIS	5
2. LITERATURE REVIEW	6
2.1 LAW AND ENVIRONMENTAL ECONOMICS	6
2.1.1 <i>The economic instruments theory</i>	7
2.1.2 <i>The liberalised market of energy in Europe</i>	9
2.1.3 <i>Legislation concerning environmental issues</i>	10
2.1.4 <i>Distribution and costs of renewable energy in Europe</i>	12
2.2 THE ELECTRICITY MARKET IN SWEDEN	13
2.2.1 <i>The role of the different stakeholders in the electricity business in Sweden</i>	13
2.2.2 <i>The electricity market</i>	14
2.2.3 <i>Perspectives on the renewable energy potential</i>	17
2.2.4 <i>Sydkraft and Vattenfall</i>	19
2.3 CORPORATE STRATEGY.....	20
2.3.1 <i>The schools of strategy</i>	21
2.3.2 <i>Corporate environmental strategy</i>	23
2.3.3 <i>Strategy under high levels of uncertainty</i>	24
2.3.4 <i>Scenario Planning</i>	26
2.4 CONCLUSIONS	27
3. FRAMEWORK TO ANALYSE UNCERTAINTIES RELATED TO TRADABLE EMISSION PERMITS AND ELECTRICITY CERTIFICATES	28
3.1 AVAILABLE OPTIONS OF STRATEGIC DECISIONS FOR ENERGY UTILITIES.....	28
3.1.1 <i>Nuclear power</i>	28
3.1.2 <i>Electricity certificates</i>	31
3.1.3 <i>Tradable emission permits for carbon dioxide emissions</i>	33
3.1.4 <i>Use of fossil fuel</i>	34
3.2 SCENARIOS.....	38
3.2.1 <i>Scenario 1: stringent environmental conditions and more opportunities in the market</i>	38
3.2.2 <i>Scenario 2: opportunities in the market and environmental regulation similar as today's conditions</i>	40
4. METHODOLOGY	42
4.1 JUSTIFICATION OF THE PARADIGM AND METHODOLOGY	42
4.2 RESEARCH PROCEDURES	44
4.3 LIMITATION OF THE METHODOLOGY.....	46
5. ANALYSIS.....	48
5.1 THE CURRENT ACTIONS	49
5.1.1 <i>The companies' postures</i>	49
5.1.2 <i>Summary of the current companies' postures</i>	51
5.2 MOVES THAT COMPANIES WILL TAKE ACCORDING TO THE PROPOSED SCENARIOS	52
5.2.1 <i>Summary on the companies' reactions to different scenarios</i>	52
5.3 CONCLUSION: IMPLICATIONS OF THE POSTURES AND MOVES	53

6. CONCLUSIONS AND RECOMMENDATIONS	55
6.1 CONCLUSIONS ABOUT THE RESEARCH QUESTION	56
6.2 IMPLICATIONS FOR THEORY	58
6.3 IMPLICATIONS FOR POLICY	59
6.4 LIMITATIONS.....	62
6.5 IMPLICATIONS FOR FURTHER RESEARCH	62
BIBLIOGRAPHY.....	64
ABBREVIATIONS.....	66
APPENDICES.....	67

List of Figures

Figure 1-1: Research phases	5
Figure 2-1: Field of research.....	6
Figure 2-2: Power generation in Renewable sources.....	12
Figure 2-3: Cost of renewable power generation in Europe. Source:(Faber et al., 2001)	13
Figure 2-4: Energy supply and use in Sweden 2001, TWh	16
Figure 4-1: Methodology	42
Figure A-0-1: Command and control	67
Figure A-0-2: Green taxes	68
Figure A-0-3: Tradable permits.....	69
Figure A-0-4: Demand and Supply at green electricity market	70

List of Tables

Table 2-1: Potential for renewable energy capacity increase in Sweden.....	18
Table 2-2: Largest Nordic electricity generators and the electricity they generated in 2001 19	
Table 2-3: Actual electricity and heat generation in Sydkraft and Vattenfall in Sweden in 2002	20
Table 2-4: Postures and moves that a company can take under uncertainty.....	25
Table 3-1: Postures and moves that energy utilities can take in the long run under a decommission of the Barsebäck second reactor.....	30
Table 3-2: Postures and moves for energy utilities dealing with electricity certificates	33
Table 3-3: Postures and moves that companies dealing with tradable emission permits can adopt	35
Table 3-4: Postures and moves an energy utility can take under decision of the use of fossil fuels.....	37
Table 5-1: Postures and moves adopted by Sydkraft and Vattenfall's current strategy.....	51
Table 5-2: Sydkraft and Vattenfall's future actions on the four factors	53

1. Introduction

1.1 Background of the research

In 1997, the Kyoto Protocol was settled with the aim of preventing the climate change consequences produced by the accumulation of green house gases in the atmosphere (GHG). The target proposed by the protocol to European countries was to reduce GHG to 8% of the 1990 levels. To reach this goal each country was assigned with a specific target to attain.

In order to facilitate the countries an easier transition to cleaner technologies and to support economic efficiency among polluters to reduce their environmental burdens, various flexibility mechanisms were created. The most important mechanism for developed nations is the Tradable Emission Permits (TEP). They allow trading of permits among developed polluter nations with high marginal abatement costs and those with low marginal abatement costs, which can reduce emissions beyond compliance, increasing the possibilities for all firms to comply while reducing total economic costs for achieving these reductions.

TEP have not yet been implemented in Europe but they are expected to enter into the market in 2005. However, to gain experience on how the market of Tradable Permits may function, some European countries have developed their own schemes and implemented Tradable Permits locally. TEP will force high levels of efficiency in electricity production and reduce the dependence upon non-renewable energy power sources. This mechanism is expected to force coal and oil based power plants to substantially modify their electricity production processes or to buy large amount of permits to comply with the carbon dioxide reduction targets, thereby losing competitiveness in the market.

On the other hand, Electricity Certificates were created to promote an increase in renewable energy production. Additionally, they were designed to help achieve the Kyoto protocol targets and, at the same time, to reduce the dependence upon nuclear power and fossil fuels. Some initiatives like the European Renewable Electricity Certificates Trading Project (RECerT) were designed to create a model for a unified Tradable Green Certificates (TGC) scheme for Europe.

Sweden has implemented a system called Electricity Certificates System (ECS) that promotes the use of renewable energy among electricity users. These certificates are going to be allocated to the energy producers according to the amount of the renewable energy they produce. They can sell or store (bank) the certificates in order to obtain better certificates prices in the market. On the demand side, electricity distributors or end users are required to demonstrate their use of renewable energy by presenting a certain amount of certificates, or quota, depending on their use of energy. In 2010, users need to demonstrate that 16.9% of their electricity consumption comes from renewable energy. In 2003, users are obliged to have 7.5% of renewable energy share, and this requirement will increase 1.3% yearly until reaching 16.9% in 2010.

1.2 Research problem

In light of the above scenario, the main concern of this thesis is how will energy utilities act in response to the challenge of increasing the production of renewable energy while reducing their actual CO₂ emissions. Additional questions arising from the last concern are: What are

the most relevant variables affected by the implementation of the two systems? And, What are the strategies that the firms will follow in addressing this problem?

At present, Sweden has implemented a quota-based certificates system to promote renewable energy production. Additionally, with the directives of the EU Parliament about the entry into force of the Emissions Trading System, some experiments have been made in Sweden to look into its implications for the country. However, it is still uncertain what the outputs of the two systems could be when they start functioning together.

It is expected that the Tradable Emission Permits and the Electricity Certificates will bring incentives to energy utilities to reach both targets in a cost-effective manner. However, it is difficult to predict what will be the strategic decisions of energy utilities and how far they can or will increase their capacity in renewable energy. Hence, This study aims to answer the following research question:

What are the strategic implications of the implementation of the Emissions Trading System and the Electricity Certificates System for Vattenfall AB and Sydkraft AB?

Subsidiary research questions surrounding this question are:

- What is, and what will be the capacity in renewable energy and carbon dioxide emission abatement from Vattenfall and Sydkraft?
- What are the potential interactions between the Emissions Trading System and the electricity Certificates System, when they are both implemented in Sweden?

1.3 Justification for the research

The present research investigated the possible consequences of the application of these two mechanisms upon the energy utilities as they work to achieve compliance in with the carbon dioxide emission's reductions and increase in renewable energy capacity targets.

The Swedish government has proposed a 4% reduction of carbon dioxide emissions below the level of the national emissions in 1990 as the level for the compliance period 2008 – 2012. They have also proposed that energy companies must have a 16,9% renewable energy share by 2010.

Recent literature dealing with interactions between the tradable permits and electricity certificates highlights the main concern of how countries will confront the problem of taking advantage of both schemes. Morthorst¹ proposed a system where the obligations on both systems are flexible, meaning that if a country decides to expand its renewable energy production, it is essential that the carbon dioxide emission's reductions target were reduced. Mavrakis and Konidary² stressed the fact that a negative outcome could happen under poor planning of the interaction between the two systems. Therefore, an analysis from the utilities' point of view is needed to confirm the effect of the implementation of the two systems in Sweden.

Additionally, this research was designed to gain insight into the vision and strategic decisions that energy utilities face when the two systems are implemented together. The recent events

¹ (Morthorst, 2003)

² (Mavrakis & Konidari, 2003)

on liberalisation of the energy market, nuclear power decommissioning, reduction on carbon dioxide emissions and obligations for increasing the renewable energy capacity are posing completely new challenges for energy utilities. The present way to plan for investments in energy utilities is oriented by customer demands and political decisions.

The two mechanisms pose uncertainties that are difficult to forecast and pose a challenge to the traditional profit maximisation analysis that utilities currently use in making investment decisions. Hence, firms have two alternatives: the first one is to wait until uncertainties are removed and it is possible to make better forecasts and to then make decisions, or on the contrary, they can take a more proactive strategy and lead the way to obtain a better performance in the industry.

Courtney, Kirkland and Viguerie³ developed a framework that is designed to help firms better understand the uncertainties they deal with, and to provide support for decision-making. Thus, a similar framework is needed for energy utilities dealing with an electricity certificates system, which was started in June 2003, and a tradable emissions permit system that has not yet been started.

1.4 Methodology

The geographical boundaries for this research are constrained to the Swedish conditions for the Electricity Certificates System and the Tradable Emissions Permits. The study was directed to the Swedish energy utilities that deal with the problem. The research was focused in Vattenfall AB and Sydkraft AB, which produced 70% of the total energy production in 2001. As a result, the decisions to be made by these companies in electricity certificates and tradable emission permits affects, to a large extent, will be the decision on energy production in Sweden.

The strategy of the companies was obtained thru interviews with relevant representatives in both companies. The interviewees included production and sales managers involved in the formulation of the strategies in each company. Additionally, officials from the Swedish EPA an Energy agency were interviewed to know de development of the tradable permits and electricity certificates in Sweden.

The research was divided into three phases: research design, fieldwork, and analysis and interpretation. An explanation of each of the phases is presented in Figure 1-1.

The research design phase had two parts. The first part dealt with the definition of the topic, scope and methodology. Unstructured interviews were performed with representatives of the sales, production and communication areas, to determine the trends and relevant variables that affect utilities in the fields of tradable permits and electricity certificates. The result of these interviews led to the definition of the research question, the key persons to interview in the fieldwork, and the key variables to have in mind for the analysis. The second part dealt with the development of the uncertainty analysis. Again, unstructured interviews were performed with governmental representatives to obtain insight into the relevant factors to analyse within the companies.

The second phase dealt with the fieldwork. On this phase, key representatives of the companies were interviewed to obtain insights into the positions on the relevant factors found in the

³ (Courtney, Kirkland, & Viguerie, 1997)

prior phase. Structured interviews were performed with high corporate representatives who expressed the possible decisions of each company around the two flexible mechanisms. To obtain the data for this phase, a questionnaire was developed and utilised. It was divided into three steps: the first step asked for relevant figures not found in the companies' literature; the second step asked for the current strategy of the company for reducing carbon dioxide emissions and increasing renewable energy capacity; and the final step of the questionnaire asked what the company would do if, after 2010, any of the two scenarios presented occur. The outcome of this phase was a view of the companies' anticipated actions on tradable emission permits and electricity certificates under two widely different conditions.

The third phase dealt with the analysis and interpretation of the results. This phase was also divided in two parts. The first one analysed the answers of the companies and drew conclusions on the future implications of the strategies assumed by the companies. The second part shows the implications for theory of the strategies that the companies followed.

1.5 Limitations and key assumptions

The research is limited to Sweden given its unique conditions for a research on the implications of the two systems, ECS and TEP, for energy utilities since Sweden has implemented the electricity certificates system, which started delivering certificates in June 2003. On the other hand, Sweden has ratified the Kyoto protocol, has a target on emissions reductions, it has participated actively in the discussion about the Emissions Trading System (ETS) and it has performed and finished experiments about the possible effects of the ETS for the country. Therefore, the Nordic or European energy sectors are not analysed in the context of this research.

The research was limited to Sydkraft and Vattenfall since they produce 70% of the electricity in Sweden. An assumption made was that under the requirement of increasing renewable energy capacity, those utilities with the biggest production and fixed assets have the capital for a quick move to invest in renewable energy. This assumption resulted in the emphasis upon the regional utilities and disregarding the local energy producers.

The research was limited to the implications on Tradable Emission Permits and Electricity Certificates. Other measures like the Clean Development Mechanism (CDM) or Joint Implementation (JI) measures were not considered.

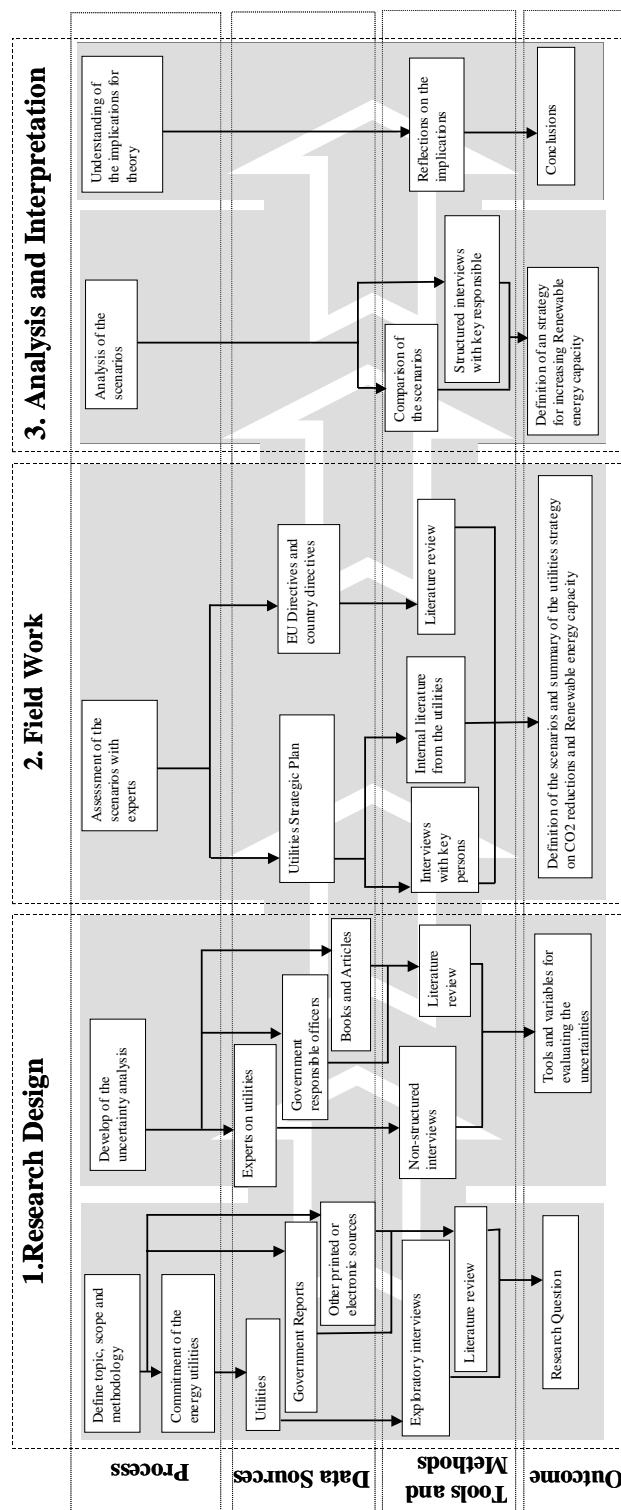
The research was limited to the strategic corporate decisions that Sydkraft and Vattenfall are pursuing to achieve the emission reduction targets and the challenge to increase renewable energy capacity. Since each energy facility has a different composition of shareholders the analysis on energy facilities may bring a different solution in the use of tradable permits and electricity certificates while at the corporate level the strategies they design are the stand to negotiate with other shareholders and stakeholders.

The environmental impacts considered are the reduction of carbon dioxide emissions due to the implementation of the Tradable Emission Permits and the reduction of fossil fuels use due to the electricity certificates. Other environmental impacts of energy generation are not included in the research.

1.6 Outline of the thesis

This thesis is divided into five chapters. *The first chapter* explains the research question and its boundaries. *The second chapter* introduces the field of research, which is comprised into three parts: the environmental law and economics field, the energy sector in Sweden and the strategic environmental management field. *The third chapter* presents the framework to analyse utilities' behaviour with regard to both mechanisms. In this chapter the company's postures are explained and the moves that the utilities may have under the uncertainties presented by the electricity certificates and tradable permits are presented. *The fourth chapter* introduces the methodology used to analyse the companies' answers about their strategies in tradable emissions permits and electricity certificates. *The fifth chapter* analyses the answers of Sydkraft and Vattenfall representatives about the strategies of each company. Finally, the sixth chapter presents the conclusions of the research.

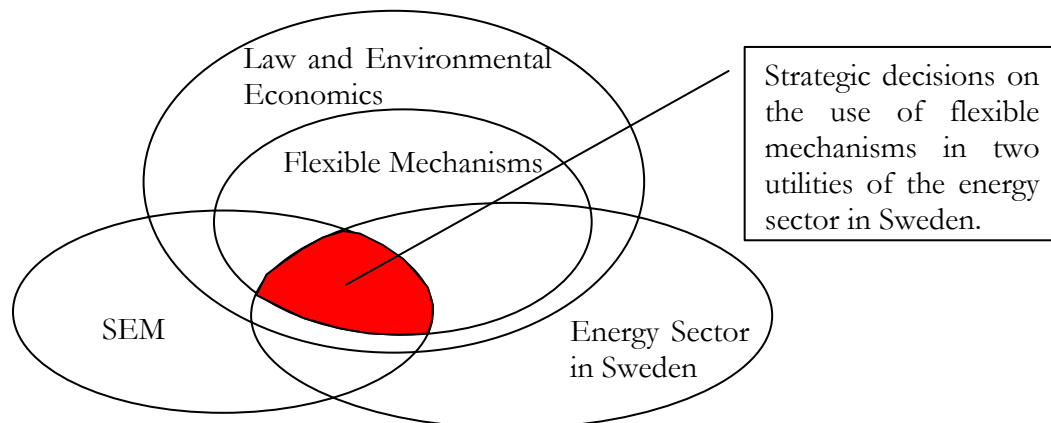
Figure 1-1: Research phases



2. Literature Review

The research topic and question are included into the field of environmental law and economics where the motivations to create a more sustainable production are involved. On this area was reviewed the directives of the European commission in the energy sector. Additionally, decisions of the energy agency and the Swedish EPA, regarding the direction of the energy sector was included in the literature review, as well. A sub-bundle of the environmental law and economics area considers flexible mechanisms as a tool to reach environmental goals. The mechanisms include the Tradable Emissions trading and the Electricity Certificates System in Sweden. To understand how the energy sector works in Sweden, a description of the sector was included. Finally the Strategic Environmental Management considers the decisions of the firms and reveals their objectives and goals. In the literature review was included the way firms develop their strategies and how to deal with uncertainties. A Schematic approach to the literature review to consider is shown in Figure 2-1.

Figure 2-1: Field of research



The main purpose of this chapter is to introduce the challenges that energy utilities are confronted with, when they deal with tradable emissions permits and electricity certificates. Chapter's order is in relation with the topics presented:

- The law and environmental economics area includes the legislative acts and economic instruments environment, that utilities are forced to follow according to the government decisions.
- The energy sector in Sweden area describes the competitive environment that energy utilities are involved in.
- Finally the strategic environmental management area describes the possibilities and competitive advantages that firms are able to reach when they decide upon the strategic actions to follow.

2.1 Law and environmental economics

Since 1990, a high volume of reforms took place in Europe affecting energy utilities. Initially, a decision of the EU council decided to liberalise the energy market. Then, in 1997, the

Kyoto Protocol imposed an additional burden on energy production. Finally, a green paper on renewable energy capacity was proposed to the EU council. Sweden has followed these directives that guide the work of the energy sector within the country.

Sweden liberalised energy market started in 1996 followed by Norway, Finland and finally Denmark. To consolidate this liberalised market Svenska Kräftnat and Statskraft (from Norway) formed the Nordpool, a stocks market where physical energy is negotiated. Subsequently, customers were given with the possibility of choosing their energy provider. At the same time, energy utilities started expanding their actions to neighbouring countries to gain negotiation power.

In the present section, the legislative and economic environment that energy utilities are involved in is presented. This section starts with a review of the economic instruments principles. Then the liberalisation of the energy market is introduced, followed by an introduction of the implications of the Kyoto Protocol (KP) and EU directives for energy utilities, and the directives on green energy.

2.1.1 The economic instruments theory

Two different approaches for reducing the pollution levels can be found in the literature: the strictly regulatory system often called Command and Control, and the economic instruments involving the Green Taxes and Tradable Permits. In the Command and Control system all firms are forced to reduce their pollution in a certain amount according with a socially desirable standard under the penalty of being sued and/or charged in case of non-compliance. The authority in charge becomes a prosecutor responsible for verifying that the emission standards won't be exceeded. The decision of the limit is based on standards supported on environmental impact assessments, health standards or other studies that tend to improve the environmental quality. On the other hand, the standard represents a balance among the desire of a community to reduce the nuisances caused by pollution, the costs to be paid by the companies subject to meet those standards, and the risk (on the environment, or on public health, or on political issues) that a certain level of standard can produce on the two sectors: population and industry.⁴ Appendix A presents a numerical example of the economic efficiency advantages of the three systems.

Basically, almost all economies have introduced Command and Control measures to restrict polluting activities. The command and control approach is used when risk to health damages on population is high or the environmental impact of the pollution generated by industries can hardly be restored.

Green Taxes would have an advantage when industries in a region have different pollution abatement cost. Then, there is a possibility of reaching the same goal, like a command and control approach, but at a lower cost for industry as a whole. The principle relies on charging industries per unit of emission released. Given that industries know their abatement costs, they decide whether to invest in abatement technology or to pay the charge. The level of the charge to be imposed by the authority is subject to negotiation between the two parties. If the authority made a good evaluation of the required abatement and the abatement costs, the agreed level of charge will give an incentive to reach a desired level of abatement.

⁴ (Field, 1994)

The main challenges to the pollution charges system are the level of the charge, the use of the revenues from the tax, and the question on whether wealthy polluters are able to emit as much as they want no matter the impacts of the pollution they emitted. The level of the tax is a difficult issue since firms have complete information of the cost and the economic impacts of every level of charge. While authorities have only vague ideas of the costs for companies, relying only on the desired level of abatement to be reached. On the other hand, firms argue that the remaining payment of the tax should be invested in the same area where it was paid, e.g. if the tax was paid to solve the situation in the water sector, the tax should be invested in solutions to the water sector. Revenue neutral green taxes are designed in this way, however not in all situations does it make sense that the money collected from taxes designed to correct environmental situations, should be resituated in the same field to bring additional help to the sector that paid the tax. Finally, the question about wealthy companies, the green tax approach expects that all firms behave in a rational way making firms to reduce pollution if the green tax increases due to their own emissions.

In the Tradable Permits System each unit of pollution released by industry requires a Permit. Industries in a region are permitted to emit a certain amount of units. The role of the authority is to demand from each company the number of permits equivalent to the number of pollution's units released. Companies, whose costs of reducing emissions beyond the target are below the market price of the permit, are able to sell Permits to other companies with higher marginal abatement costs. If a firm is unable to demonstrate permits enough that cover its level of emissions, the uncovered emissions are penalised with a higher non-compliance fee than the market price of the permit.⁵

The Tradable Permits System creates a new market for "Permits" which size depends on the number of units required by the authority. One problem of the tradable permits systems is that the demand of certificates created by the authority, by means of imposing a target to a specific population or industry, is highly dependent on political situations. Additionally, companies required to comply with emissions abatement by this means, become more dependent on political decisions and less on their own performance in the industry. Finally, companies are discouraged from participating in the permits' market and they move their facilities to less demanding countries⁶. However, the bigger the market is the higher is the willingness of the companies to participate in it.

Finally, the Green Certificates are a special kind of tradable permits, where instead of pollution units, the unit to be measured is kWh or MWh of green electricity produced by certified producers of this kind of energy. Again the authorities define a target to reach by users of energy and then make a requisition for a number of certificates users must show to comply with the target. For instance, the authority starts a market of certificates, each certificate representing the production of 1 MWh of green electricity and the authority requires a share in the electricity consumption of 10% in renewable energy. A company consuming 1000 MWh per year should present to the authority, at the end of the year a quantity of 100 certificates to fulfil its requirement. Appendix A describes, *in extenso*, how the market of green certificates functions.

The EU Commission draft directive⁷ includes as RES-E the energy generated from wind, solar, geothermal, waves, tidal, small hydro (less than 10 MW) and biomass (including

⁵ (Tietenberg, 1992)

⁶ (Allen, 2002)

⁷ (EU Commission, 1997)

untreated wood waste and cork waste). Technologies at a higher stage of development have more opportunities to continue improving their performance due to the support from green certificates. Wood use and Wind power generation have the bigger advantages, solar power generation is still too costly. Meyer⁸ propose that one possible solution is to reserve the green market for the most matured renewable technologies and to promote other desired technologies through a quota tender model.

2.1.2 The liberalised market of energy in Europe

In 1996, the European Parliament decided to liberalise the market of electricity based on the principle of “comprise an area without internal frontiers in which the free movement of goods, persons, services and capital are ensured”⁹. The objective was to increase efficiency in the production, transmission and distribution of electricity, while reinforcing security of supply, competitiveness of the European economy, and respecting environmental protection. It is expected that this process will increase the competitiveness and, therefore, lead to lower prices for electricity for all customers. In the future, generation, grid transmission and distribution will have to be administratively independent from each other.

The EU countries can be divided in three groups of countries inside the electricity market. Those countries that have already liberalised their electricity market, those that are reluctant to liberalise it or are in a very early stage of liberalisation, and those who have taken some steps in this sense being somewhere in the middle of the process. In the first group we find Germany, the UK, the Netherlands, Sweden, Finland, Italy and Denmark. The second group includes: Greece, France, Luxembourg, and Portugal. Finally in the third group are Australia Ireland, Belgium and Spain.

In Germany the electricity and gas markets were 100 per cent liberalized in one step. In the model provided, grid access rules and transmission tariffs were left to the industry itself¹⁰. Electricity prices for all groups of customers have fallen dramatically. The UK electricity market was liberalized in phases; large customers (over 100 kWh) were enabled to choose their supplier. In the Netherlands, customers consuming over 2 MW annually and representing 33 per cent of electricity demand in 1995 can choose their supplier, while household consumers and small business will only be freed to choose their supplier in 2004. The main participation of the electricity system is still remaining under the government control. In Finland, all consumers were freed to select their electricity supplier in January 1997. Since the revision of the Finnish Electricity Act in 1995, any producer could sell electricity to any end-user or retailer throughout the country. In Italy the electricity market has already been divided in generation, transmission, dispatching and distribution.

Observing the countries considered as the reluctant, the Greek government is reconsidering the regulation for the electricity sector. In France, efforts to liberalize have been progressing very slowly, becoming one of the latecomers in the deregulation front. Market opening was oriented to the minimum stipulations of the directive. In Luxembourg, third party access to the electricity market is restricted. In Portugal’s restructuring of the electricity supply industry came in 1994. The system is under the control of the regulatory authority, which started its activities in 1997. The market opening has reached 26 per cent. The eligible customers are those with consumption above 15 GWh/year.

⁸ (Meyer, 2003)

⁹ Treaty establishing the European Community, and in particular Article 57 (2), Article 66 and Article 100a.

¹⁰ (Boots *et al.*, 2000)

A third group includes those countries that have made some advances in the implementation of the liberalization of the electricity market. In Ireland, for example, 28 per cent of all electricity is supplied within a liberalized market. Large customers (above 4 GWh/year) and renewable electricity customers can choose their supplier. Belgium's market opening reached 35 per cent by the end of 2000 and is planned for 100% in 2007. The basic regulation that led to the liberalization of the Spanish electricity system was approved in 1997.

The state of the art in the liberalization process suggests that the tendency is to continue in time and expanding through all Europe. The main problem with the liberalization is that the most efficient technologies have an advantage when introduced as new electricity generators. In the case of renewables, the generation of electricity is more expensive than other options like coal or large hydropower generation facilities. Therefore, liberalization and promotion of renewable energy technologies presents a big difficulty in the sense that cheaper technologies compete with expensive ones.

2.1.3 Legislation concerning environmental issues

This section combines the international and domestic conditions that Swedish energy utilities are immersed in, and it aims to present the challenges that energy utilities have been experiencing during last years, especially in the environmental field.

As it was said before, the liberalization of the market was one of the first pressures on the energy field. The de-regulation in Sweden took several years and finally came out in 1996 with the subdivision of the energy business in different stages (production, transmission and distribution), finalizing in 1999 with the opportunity for all customers of choosing the provider they want. Section 2.2 explains how the energy market in Sweden works.

In 1992, at the Rio Earth Summit, the Framework Convention on Climate Change was created with the main target of creating a strategy to reduce the Green House Gases (GHG) released to the atmosphere¹¹ and to mitigate the consequences of global climate change. As a part of this challenge, under the Kyoto Protocol in 1997, the targets to accomplish in the period 2008 – 2012 and the mechanisms to reach this goal¹² were proposed.

At the EU level, countries decided to distribute the 8% responsibility among the 15 countries, resulting for Sweden in the possibility of increasing 4% over the 1990 emissions, given its low emissions level and their past actions in the abatement of carbon dioxide emissions. The framework convention recognised the energy sector as one of the biggest actors for emissions reductions, accounting 85% of all GHG emissions in the developed world.¹³ The possibilities for reducing these emissions rely, on the one hand, on the capability of the countries to cut down the production of energy from fossil fuels and, on the other hand, on the availability of the different certificates issued from flexible mechanisms proposed by the Kyoto Protocol. The protocol is legally binding, hence, those countries that fail to achieve the target will receive for the next period of compliance, in addition to the burden of reducing the remaining emissions from the first period, an additional 30% of those “remaining emissions” as a punishment.

¹¹ The six main GHG considered are: carbon dioxide, nitrogen oxide, hydrofluorocarbons (HFCs), sulphur hexafluoride and perfluorocarbons.

¹² The global target will be to reduce 5,2% of the emissions released in 1990 being European countries responsible to reduce 8% of their 1990 emissions, United States 7%, and Japan 6%.

¹³ (Priddle, 2000)

Sweden has been participating in the framework convention since it was created and its actions towards carbon dioxide abatement are in line with the convention principles. Sweden's GHG are lower than other European countries, being 2,5% of the total European emissions, and its increase is relatively low. As an example, Swedish carbon dioxide emissions during 1999 were 70,7 million tonnes, while the emissions in 1990 were 70,5 million tonnes.¹⁴

In 1991, Sweden introduced the first carbon dioxide tax with the purpose of stabilising carbon dioxide emissions at 1990 levels. Later, in 1997, with the Swedish subscription to the Kyoto Protocol, guidelines were proposed for a Climate Strategy in the Energy Sector that limited, as far as possible, GHG emissions in the sector "without losing the competitive strength, employment and welfare of the industry"¹⁵. Because of this, the carbon dioxide tax was not levied on electricity generation. Energy production, especially, heat production accounts for almost half of the total emissions, followed by transportation (30%), agriculture (10%) and process industries (8%)¹⁶. In 2001, a new bill proposed a 4% reduction of carbon dioxide emission from the 1990 level. According to the government proposal, these reductions should be reached without uptakes in carbon sinks or participation within flexible mechanisms.

The aim of the energy sector is to secure supplies of power in competitive terms in relation to other countries with a low impact on the environment, health and climate. The policy includes the closure of the first reactor of Barsebäck nuclear power station, the increase in the capacity of renewable energy and the investment in Research and Development in new energy techniques, emphasising the international cooperation, especially, among Baltic Sea Countries.

Another issue concerning with the burden imposed on energy utilities is the necessity of increasing the capacity in renewable energy in order to secure the energy supply for the coming years and to reduce carbon dioxide emissions. In 2000, the green paper proposed by the European Commission¹⁷ presented the danger of the dependence upon fossil fuel based energy for European countries, considering the impact of the oil prices increases from March 1999 and its relationship with the prices of energy in Europe. The green paper proposal re-directed the energy policy towards consumers to change their consumption behaviour, and, in the supply side, to increase the consumption of new renewable energy technologies.

In 2002 the Swedish government tabled a new bill named "A secure, efficient and environmentally-friendly energy supply". The aim of that bill was to promote, in the medium and long term, an efficient use of energy and a cost-effective energy supply, taking care of reducing the impacts on climate change. Acting on the supply side, the new bill proposed to increase the generation of renewable energy from the actual level to 10 TWh in 2010. Until now, the government supported the generation of renewable energy by:

- A grant of 15% of the investment to those hydroelectric projects generating less than 1,5MW with a 0,09 SEK/kWh price support for the energy generated,
- A grant of 25% of the investment for Biomass projects,

¹⁴ (Swedish Energy Agency, 2002b)

¹⁵ (Swedish Ministry of the Environment, 2001)

¹⁶ Ibidem

¹⁷ (European Commission, 2000)

- A grant of 10% – 15% of the investment for Wind power generation and 0,27 SEK/kWh for the electricity generated on the top of lowest market price (0,15 SEK/kWh).

The new bill cuts down the subsidies brought to renewable energy producers and left the prices to the de-regulated market. The energy sources considered, as part of this mechanism, are Wind and Solar power, Biofuels, Geothermal and Wave energy, and small hydropower or increases in capacity of large hydropower.

2.1.4 Distribution and costs of renewable energy in Europe

According to the EU commission, Europe should increase the use of renewable energy from 13.9% in 1997 to 22.1% in 2010, including the output from hydropower plants individually exceeding 10MW. Since actual large hydropower plants are competitive with other types of energy generation, they cannot qualify for additional subsidies. After subtracting the large-scale hydropower, only 3.2% is produced by renewables with a target of 12.5% by 2010¹⁸. Figure 2-2 shows the targets with and without the inclusion of large hydropower.

Figure 2-2: Power generation in Renewable sources.

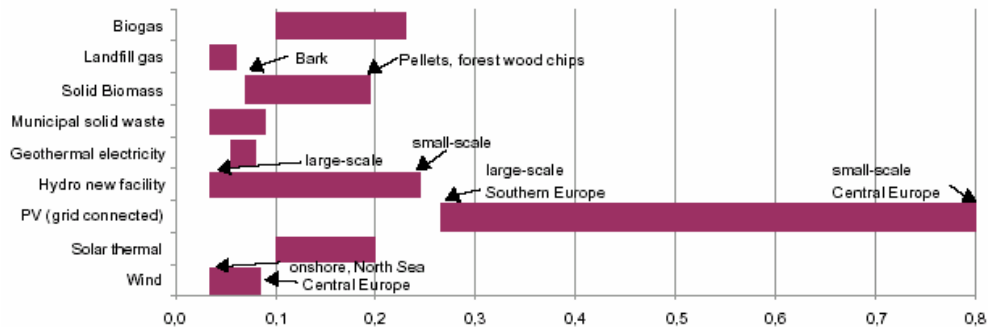
RES-E %	Including large hydro		Without large hydro	
	1997	2010	1997	2010
Austria	72.7	78.1	10.7	21.1
Belgium	1.1	6.0	0.9	5.8
Denmark	8.7	29.0	8.7	29.0
Finland	24.7	35.0	10.4	21.7
France	15.0	21.0	2.2	8.9
Germany	4.5	12.5	2.4	10.3
Greece	8.6	20.1	0.4	14.5
Ireland	3.6	13.2	1.1	11.7
Italy	16.0	25.0	4.5	14.9
Luxembourg	2.1	5.7	2.1	5.7
Netherlands	3.5	12.0	3.5	12.0
Portugal	38.5	45.6	4.8	21.5
Spain	19.9	29.4	3.6	17.5
Sweden	49.1	60.0	5.1	15.7
United Kingdom	1.7	10.0	0.9	9.3
European Union	13.9%	22.1%	3.2%	12.5%

Source: (EU Commission, 2000)

Looking at the cost side, the generation of renewable energy has been reduced, however, they are still high compared to the cost of generation from other sources. In 2000, the most costly energy production were photovoltaic energy, municipal waste incineration and production of biogas, while the cheaper ones were hydropower, landfill gas and onshore wind power. Figure 2-3 shows the range of costs of generation of renewable energy in Europe.

¹⁸ (Jensen & Skytte, 2002)

Figure 2-3: Cost of renewable power generation in Europe. Source: (Faber et al., 2001)



The renewable energy production costs make most of them not viable for the competition on a free market. However, the targets imposed on CO₂ emissions for Europe make them a good alternative to reach these goals. Other alternatives to reduce emissions, like reductions on transportation emissions, could be more costly and could not be reached in the short time. That's why alternatives for supporting the renewable energies take an increased importance in the frame of CO₂ emissions reduction.

2.2 The electricity market in Sweden

On January 1st 1996, competition was introduced in trade and generation of electric power. Since then electricity users have the choice of select the electricity provider. Supervision of prices was discontinued. According to the Swedish energy agency¹⁹, the market price for electricity, among other factors, depends on fuel prices, availability of water and power and energy balance. During the period 1997 –2001, electricity prices dropped, charges on network remained the same and taxes increased. So, total cost for households (subject to taxes) increased while for industry (exempt from taxes) the cost decreased. Sweden no longer has a surplus on generation capacity due to decommissioning of the condensing power stations and the closure of Barsebäck's first reactor. However, peak consumption increased. In conclusion, the margin to supply the energy during peak demand times was lowered. Svenska Kräftnat purchased a power reserve to adjust the balance problems, however, the energy agency, believes, that it is only a transitional solution.²⁰

2.2.1 The role of the different stakeholders in the electricity business in Sweden

In Sweden, three parts can be differentiated in the net of institutions that deal with energy: the government or regulators; the generating and delivering system; and the final users. There are the four main players in the *generating and delivering* system. (1) The *Network Owners*, who use the electricity lines under a network concession to build and operate the net and transport energy from the generating plants to the users. (2) The *Electricity Generators*, who own the generating plants and sell electricity to the trading companies or directly to the end consumers. (3) The *Electricity Trading Companies*, who sell electricity from the generator or from their own plants to the customer, and can operate as a balance provider with the additional responsibility of maintaining a balance between generation and consumption.

¹⁹ (Swedish Energy Agency, 2002a)

²⁰ (Swedish Energy Agency, 2002a)

Those who sell electricity to the market, either electricity generators or electricity trading companies are called Electricity Suppliers. (4) The *Nordpool* serves as the electricity marketplace for Nordic countries (Norway, Finland, Sweden and Denmark) where buyers and sellers agree to a price for electricity. The interaction among these four entities assures the energy required by customers. The total cost of electricity for final users depends on price of electricity, network charges and taxes. The taxes depend on what type of customer is receiving the electricity; industries receive a lower tax while households have a higher charge.

The responsibilities of the *government/regulator* side, is to assure a continuous flow of electricity and to regulate prices of the network. *The Ministry of Industry, Employment and Communications* is responsible for bringing the concessions to the network owners and giving advice to the Swedish Energy Agency in prices of transmission. The *Swedish Energy Agency* brings the guidelines for grid transmission and distribution prices, and controls the monopolistic situation of the electricity suppliers in the market. The *Swedish Competition Authority* regulates the competition on the market of power by preventing abuses in the dominant position in the market and inhibiting discrimination. *Svenska Kräftnat* is the balance provider, its function is to balance production and consumption on the grid. To do this job, the balance provider makes special agreements with those Electricity Trading Companies able to generate electricity in any specific moment to balance the excess of consumption. The *Swedish National Electrical Safety Board* brings the guidelines for security in the network operations.

2.2.2 The electricity market

This section summarizes the facts around the energy market in Sweden. Initially, the supply sources and the uses of energy are discussed, subsequently the behavior of the electricity, biofuels, district heating and cooling, oil, coal and gases markets is explained. Finally, is addressed an explanation of the use of energy by different sectors.

The Swedish per capita energy consumption is one of the highest in the world after Norway, Iceland and Canada. The total energy supply in Sweden during 2001 was 616 TWh. The electricity supply grew 35% in the period 1970-2001 changing from oil based to nuclear and Hydropower electricity generation. The fossil fuels use for electricity generation was reduced from 77% share in 1970 to 31% in 2001 while biofuels and peat use increased from 9% to 16%. The energy consumption by industry and households has been constant in the 1970 – 2001 period, while there's an increase of 64% in the transportation sector (excluding international shipping). The total final use of energy is 398 TWh.

The final use of energy is comprised of: electricity; district heating; biofuels and peat; coal and coke; Natural gas; and oil energy producers, each one having its own market. Figure 2-4 presents the distribution of the energy produced in Sweden.

In 2001 the electricity production sources were Nuclear power (69,2 TWh); Hydropower (78,5 TWh); combustion-based production²¹ (9,7 TWh); and wind power (0,45TWh). The situation in 1970 has changed from a combustion-base production to hydro and nuclear power based production, tending to change even more in the near future because of the closure of Barsebäck's first reactor, in 1999, and the decision to phase out the second reactor. This loss of energy will be "compensated by the introduction of new production capacity and a reduced use of energy"²². The sectors using the bigger part of the electricity produced are

²¹ Using as fuel: 35% coal; 35% biofuels; and 26% oil

²² Report of the Standing committee on economic affairs, 2001/02:NNU17

the residential and services sectors, and the industrial sector. In the residential and services sectors there was a yearly increase of 6,7% from 1970 to 1998, and stabilized since 1998 to 1% annual increase. The last period of increase was mainly due to the use of domestic electricity and electricity for building services systems. Industry increases were 0,6% per annum in the period 1998 – 2001. The use of electricity by other sectors has remained at a stable level.²³

The electricity trade in the Nordic countries through Nordpool has resulted in a more efficient pricing of electricity. As stated before, the electricity prices depend on the hydropower availability especially in Sweden and Norway. However, energy from Germany, Poland²⁴, Denmark and Finland are also traded in the Nordic market. The competition for energy has resulted that utilities find it cheaper to buy electricity in the Nordpool or in the energy market, than to produce it themselves²⁵.

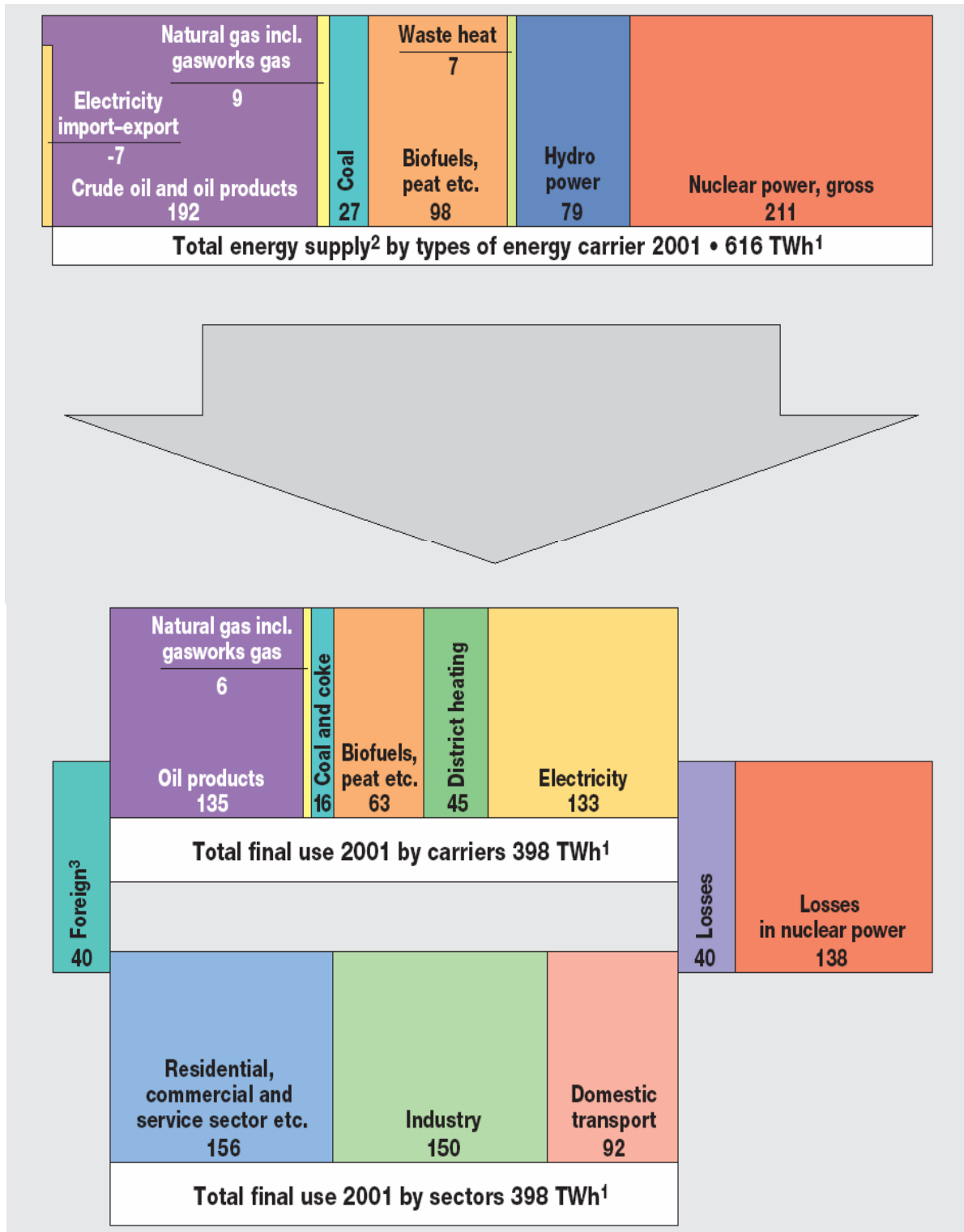
The market for biofuels includes: wood fuels; black liquor in pulp mills; peat, refuse; straw and energy grasses; accounting a total energy production of 97 TWh in 2001. In Sweden, the potential use of biofuels for 2010 is expected to be 160 TWh. In the forest products industry, only black liquor produced 34,5 TWh of the energy (excluding electricity production), and 16,8 TWh in the form of wood fuels, which fulfilled the electricity needs and energy requirements in the pulp industry, sawmills and other industries of the sector. In the district-heating sector, wood fuels had an increase by factor five since 1990, accounting for 30 TWh in 2001. Incineration of refuse will increase in the next years due to the ban of disposing combustible material in landfills. Biofuels used for electricity produced 4,4 TWh, coming basically from the use of black liquor and wood fuels.

²³ Other sectors are represented by the transport sector used almost entirely by the rail borne transport and electricity for heating assisted by the availability of grants for conversion from electric heating.

²⁴ Germany and Poland are not allowed to trade electricity throughout the Nordpool.

²⁵ (Swedish Energy Agency, 2002b)

Figure 2-4: Energy supply and use in Sweden 2001, TWh



Source: Electricity in Sweden 2002 (Swedish Energy Agency, 2002b)

District heating used 52,1 TWh in 2001, out of which 29,9 TWh were produced by biofuels. During the last 20 years the production of heat changed from oil to a mix of fuels due to the pressure made by the carbon dioxide tax and the availability of electricity to operate the heat pumps. On the other hand, since 1990 district cooling capacity was increased, reaching a 0,4

TWh of cooling in 2002. An increase in the capacity of heating and cooling districts can be expected in future years because of the legislation on buildings, and the interest of users' associations and companies like Vattenfall and Sydkraft on purchasing energy utilities, including district-heating businesses.

The total amount of oil used by Sweden in 2001 was 103,3 million barrels, 66% of which was used in the transportation sector. The oil price instability maintains the energy policy of reducing the country's oil consumption, maintaining in 2001 an oil consumption reduction by half of the consumption in 1970.

During the 1950s and later on, coal was used extensively for energy purposes. However, the low prices and easy handling of oil replaced the coal use. After the energy crisis in 1973, coal was used again for energy purposes, limiting by this way the dependence upon oil. In 1990, the use of coal was reduced due to the carbon dioxide tax and other environmental legislation. In 2002, 3,28 million tones of hard coal²⁶ were used in Sweden, accounting 10,3 TWh. The metallurgical process used 1,92 million tones of energy from hard coal together with 0,87 million tones of energy coal. Coal use was abandoned in plants that only produce heat. CHP plants used 0,48 million tones of coal during 2001, from which 0,33 were used for electricity production. CHP plants still use some coal due to the exemption in carbon dioxide tax for electricity production. Adding the coking oven and blast furnace gases a total of 2,1 TWh of electricity was produced.

Finally, natural gas, LPG, Biogas, and Town gas comprise the energy gases market. In future years, the use of energy gases will increase due to the support from the EU natural gas directive and the proposal of the Baltic Gas Interconnector (BGI), which links Germany, Denmark and Sweden. Natural Gas was introduced in Sweden in 1985 and increased capacity until 1992. Industry, CHP plants and district heating plants consumption are equivalent to 8,12 TWh, and domestic consumers use 1,5 TWh. On the national scale, the use of natural gas represents nearly 1% of the total energy consumption. The environmental advantage of natural gas is that it produces 25% less carbon dioxide emission than oil and 40% less than coal per kWh of energy produced. LPG is used mainly in industry as well as in restaurants and agriculture. During 2001, 4,1 TWh were used in industry and 0,3 TWh in district heating. For the environment, LPG represents the same advantages than natural gas, however, its use could be subject of energy taxation and it is dependent on the fuel prices. Biogas is used for electricity and heat production, which accounted for 0,57 and 0,31 TWh of energy respectively in 2001. Additionally, today a little part of the biogas is used as a fuel in transportation and can also be cleaned and introduced in the natural gas line as a "green natural gas". Today, Sweden has 100 Biogas plants in operation. The Town gas is used for heating in detached houses, large properties and industries, its use in 2001 was 0,5 TWh

2.2.3 Perspectives on the renewable energy potential

The SOU 2001:77 report presented data about the renewable energy potential in Sweden. Table 2-1 summarizes the potential for several technologies and their costs. The technologies studied are heat power for electricity purposes, small-scale hydropower, backpressure generated in the pulp and paper industry and wind power. The Energy Agency is studying other sources of electricity but, at present, the technologies, presented in Table 2-1, are those with the best feasibility to be implemented in the next seven years due to their low costs of

²⁶ Hard coal is a kind of coal used on energy demanding processes due to its high calorific power. Traditionally it is divided into two categories: Coking or metallurgical and steam coal also known as energy coal.

investment and operation. Photovoltaic cells and hydrogen cells are being studied but their costs are too high to be considered as an alternative to increase the renewable energy capacity at this time. Nevertheless, Sydkraft and Vattenfall have started a joint research project on the feasibility of solar panels in Sweden.

It's important to have in mind that with the electricity certificates, the costs of increasing the capacity are reduced by the price of the certificates themselves and the price of the energy to sell. According to the current evolution of the certificate prices and the spot prices for electricity, small hydropower has higher costs than the support that certificates and electricity selling could bring. Similar happens with wind power, which is on the limit of feasibility because of the availability of places for building this projects and the still high cost of investments, requiring much higher support than the actual price of certificates can bring to this kind of projects. If projects in hydropower and wind power are not built, the possibility to reach the target of 10 TWh of renewable energy capacity in 2010 is remote.

Table 2-1: Potential for renewable energy capacity increase in Sweden.

Source	Current capacity	Potential (TWh)	Cost of increasing capacity
Heat power for electricity based in biofuels	Without increases in capacity only increase the load operation hours from 2500 to 3500 hours per year	0,5	14 – 16 öre/kWh (140 – 160 SEK/MWh)
Heat power for electricity changing from fossil fuel use to biofuels	1,9 TWh of fossil fuel	1,5	6 – 8 öre/kWh (60 – 80 SEK/MWh)
Total		2	
Small Hydropower (<1MWH)	<1MWh=900 units ²⁷ <1,5MWh=1100 units Most of them have been decommissioned	1	From 0,53 to 4,1 SEK/kWh (530 – 4100 SEK/MWh)
Increase in efficiency		2,5	
New improvements in Hydropower	Currently excluding reserved areas = 65 TWh. By increasing the capacity in the existing hydropower	5	
Total		8,5	
Backpressure in Pulp and paper industry		3,2 (6-7 according to other studies)	40 – >240 SEK/MWh
Wind Power	0,44 TWh (in 2000)	0,5	35 – 43 öre/kWh (350-430 SEK/MWh)

Source: Trading with electricity certificates, SOU 2001:77. (Näringsdepartementet, 2001)

²⁷ According to the applications for support. (Näringsdepartementet, 2001)

On the other hand, the energy agency²⁸ considers that the way of reducing emissions can be achieved by conversion of existing facilities or replacing production technologies by new technologies that are at least carbon dioxide-neutral. The present taxation system brings no incentives to energy suppliers since the production of electricity is exempt from the tax. On the other hand, fossil fuels used for district heating are about 20% and “only a small portion of district heating can be converted at a reasonable cost.”²⁹ The agency estimates that reducing emissions from district heating will have a boomerang effect since the residential and commercial sector can increase the use of small individual boilers.

2.2.4 Sydkraft and Vattenfall

In the Swedish energy market, Vattenfall and Sydkraft are the largest electricity producers generating almost 70% of the total electricity in Sweden, and 28% of the total electricity production in the Nordic countries. Table 2-2 presents the importance of energy generation of Sydkraft and Vattenfall in the Nordic energy context.

Table 2-2: Largest Nordic electricity generators and the electricity they generated in 2001

Generators	Electricity Generated in 2001, TWh	Proportion in Nordic countries (%)
Vattenfall	76,6	20
Sydkraft	32,7	8
Total Sweden	157,8	41
Statskraft	33,3	9
Norsk Hydro	9,8	3
Total Norway	121,9	31
Fortum*	40,4	10
Pohjolan Voima Oy	15,9	4
Total Finland	71,6	18
Elsam	16,1	4
Energy E2	11,8	3
Total Denmark	36	9
Total for largest Nordic electricity generators	236,6	61
Total for the Nordic countries	387,3	100

*Byrka energy AB was recently owned by Fortum. Birka represented nearly 14% of the energy produced in Sweden. Aprox. 22 TWh

Source: The electricity market 2002. ET 10:2002. Swedish Energy Agency

There are big differences between the companies' energy generation. Sydkraft produces one third of the Vattenfall's energy generation. However, oil-based production within Sydkraft is ten times higher than Vattenfall's one. The production of renewable energy (other than large hydropower) in both companies is low and most of the biofuels are used for heat production (65% in Sydkraft and 77% in Vattenfall). Finally, the combined hydropower generation in both companies accounts for 38% of the total generation in Sydkraft and Vattenfall. Table 2-3 illustrates the energy capacity of the two companies. As can be seen in Table 2-3, renewable energy sources for electricity are still in an early stage in both companies.

²⁸ (Swedish National Energy Administration, 2001)

²⁹ (Swedish National Energy Administration, 2001)

Table 2-3: Actual electricity and heat generation in Sydkraft and Vattenfall in Sweden in 2002

Year, 2002	Sydkraft		Vattenfall	
	Electricity	Heat	Electricity	Heat
Hydro (TWh)	9,9		34	
Wind (TWh)	0,025		0,046	
Nuclear (TWh)	17,4		52	
Gas (TWh)		1,1	0,02	0,4
Oil (TWh)	0,5	0,4	0,04	0,5
Coal (TWh)	0,2	0,06	0,3	0,06
Biofuels (TWh)			0,18	4,5
Peat (TWh)	0,1	3		
Refuse (TWh)				
Other (TWh)			0,03	0,3
Total (TWh)	28,5	4,6	86,6	5,8
CO2 emissions (kilo tonnes)	506	553	150	512

Sources: Energy Market 2002. Vattenfall AB. 365 days of opportunities. Annual Report 2002. Sydkraft AB; Örtenvik, Mattias. Sydkraft AB.

These figures express the importance of the two companies in the electricity market, and as a consequence, their market positions make them leaders whose behavior will affect the development of the Nordic electricity industry.

2.3 Corporate strategy

To look into the corporate strategy it is necessary to make a review of the strategies the firms can follow to obtain a competitive advantage over other firms. There is no single definition of what a strategy is. However, a general statement about strategy is “a pattern or plan that integrates organization’s major goals, policies and action sequences into a cohesive whole”³⁰. From this definition it can be said that a strategic decision is the one that determines the overall direction of the firm. The strategy should be directed to the goals to be achieved, the policies guide and limit the strategy and the activities to reach the goals. The essence of the strategy is to define a posture that is so strong that companies can achieve their goals in spite of the uncertainties of the future. The criteria arguments for evaluating a strategy are³¹:

- *Clear, decisive objectives*: the flexible decisions during the competition should be guided by the main goals.
- *Maintain the initiative*: in order to lead the actions in spite of the time to reach the goals.
- *Concentration*: to put the necessary resources in the place and time where they are required.
- *Flexibility*: To adapt the strategy to the changing situations in the future
- *Coordinated and committed leadership*: the objectives of the leaders must be in line with the firm’s strategy objectives.

³⁰ (Mintzberg, Quinn, & Ghoshal, 1999)

³¹ Christensen in (Mintzberg et al., 1999)

- *Surprise*: To propose unexpected alternatives
- *Security*: To be confident over all the possible situations

To follow each one of these items, the company must evaluate the external factors influencing the decisions and the internal resources that support those decisions. Additionally, they must consider the uncertainties involved in each factor to focus on those that bring the better opportunities without disregarding the factors that, due to its unpredictability, could bring a surprising move, leading the company to a better position within the industry. Subsequent sections of this thesis present how companies can evaluate the factors under the high level of uncertainties imposed by the tradable emissions permits and electricity certificates.

2.3.1 The schools of strategy

Different schools of thought propose different points of view of how to reach the mentioned criteria in the formulation of the company's strategy. To reach a position in the market, energy utilities need to pay close attention to external and internal factors.

Examples of external factors are: the composition of the energy market, the players within the industry, the investments other companies in the industry are making, and the reason for these investments. The composition of the energy supplied determines the prices of energy in the following way: the extended use of waterpower-based electricity means lower electricity prices, but for Sweden it means higher incomes due to its large hydropower facilities. On the contrary, a dry year means a fossil fuels based supply which means more energy coming from Finland or Denmark. Additionally, new investments from the other companies in the Nordic energy sector reveal threats or opportunities. One example is the Finnish Fortum energy utility acquiring a larger stock share in Birka power, a Swedish energy company.

On the other hand, firms need to take care of their internal resources as well as of their customers. Internally, utilities need to strengthen their resources based on the market requirements. For instance, the de-regulation of the energy market in the Nordic countries allows users to choose the energy utility they like the most for providing their electricity. This implies a better customer service, which should be based on better conditions for the employees and their disposition for remaining in the company. Sydkraft and Vattenfall, for instance, include in their annual reports a section as "attractive employer". Additionally, the adoption of new standards concerning environmental behavior of firms, encourage companies to preserve their knowledge on environmental technologies and procedures (like ISO14000s ones).

The "Positioning School" looks at the firms in the context of the whole industry and analyses their position as a result of a series of actions that the firm takes to compete in an organizational environment. The actions can be classified according to Michael Porter's Five Forces³².

The first one is called *the threat of new entrants*, which intends to avoid the entrance of other firms into the industry by putting up "barriers". These barriers could be: economies of scale, basic capital requirements, or loyalty of the customers to one brand. These conditions

³² (Mintzberg, Ahlstrand, & Lampel, 1998)

actually happen in the energy industry since companies sharing the market have high investments in energy generation, they have improved technologies that made them achieve high levels of economies of scale, and users remain loyal to the energy utility since they have only received the energy service by one firm in their lifetime.

The bargaining power of firms' suppliers and customers constitutes the second and third forces. The actions to take should be difficult to imitate, discouraging new firms from investing in that specific industry. Firm's suppliers want higher prices for their products and customers want lower prices or higher quality. The Nordic energy market provides these incentives. On the one hand, firms rely on their own capacity for electricity generation hence little suppliers bargain is allowed, on the other hand, the Nordic Power Exchange market place (Nordpool) guarantees the lower prices of energy to firms according to the supply available in the Nordic countries.

The fourth force is *the threat of substitute products*, which in the energy context can be translated as the availability of new sources of energy. In the Swedish context, customer can choose what kind of energy they want to use and they are compelled to have a renewable energy share based on their monthly consumption of electricity. Hence, the customer has the opportunity to choose the energy source he wants and firms are obliged to fulfill customer's demands.

The final force is *the intensity of rivalry among competing firms*. In the Nordic energy market alliances and attack moves are present. An example of alliances is the R&D investment in solar energy made by Vattenfall and Sydkraft. An attack move is, for instance, new generation facilities in Finland and Norway.

According to Porter exist "three generic strategies to achieve an above-average performance in the industry: cost leadership, differentiation and focus."³³

Low cost aims the lowest cost of production in an industry. For energy utilities in Sweden lower costs are already achieved throughout technology performance and experience in the field. Additionally, large hydropower brings the lowest production costs of all energy producing technologies in the market. A more complex panorama includes international competence on the electricity market through the Nordpool that aims to bring the lowest available prices of energy in the Nordic countries.

Differentiation strategies aim to produce a product whose characteristics are unique in the market. Energy utilities produce two kinds of products: electricity and/or heat. Customers cannot differentiate in the quality of the product and hardly differentiate the quality of the services, since services that energy utilities bring to customers are mostly the same in all utilities. In consequence is difficult to attain a differentiation strategy. However, one of the ways energy utilities differentiate the product is by reducing the carbon dioxide emissions or increasing the renewable energy share. In reduction of carbon dioxide emissions, Swedish utilities have lower emissions than most of the European utilities giving them already an advantage on the European energy industry. The new challenge comes from increasing renewable energy capacity. A higher share in renewable energy was a successful strategy for utilities in the Netherlands. For accomplishing this challenge in a cost effective way, the Swedish government have imposed a target on renewable energy consumption to users, which will bring additional incentives to raise renewable energy capacity to energy utilities. ,

³³ from (Mintzberg et al., 1998). page 103.

Finally, firms use *focus* strategies to narrow market segments by groups, product lines or geographic markets. Focus strategies are not feasible to large energy utilities. In the case of Swedish energy utilities, firms deal with a market beyond the country's limits, e.g. Finland, Norway, Denmark, Germany and other Baltic countries.

If companies base their decisions looking at the internal environment instead of the external one, the Resources Based View (RBV) brings an insight on how to analyze them. The RBV looks inside the companies and base the market position of the company in the internal strengths the firm has. By "resources" the RBV implies the "assets, capabilities, organizational processes, information, knowledge, etc., controlled by a firm"³⁴ that makes the firm to create and achieve effective strategies. There are, at least, three types of resources: physical, human, and organizational resources. These resources are linked by their shared interpretations, which maintains, renews, and shapes the resources net. Strategic resources are important to the company if they are: *Valuable*: that improves the firm's efficiency and effectiveness; *Rare*: and being rare is limited, thus, increase in value because its demand; *Inimitable*: because its historical fact, unique characteristics, or its complexity that makes costly and time demanding to replicate the resource; *Not easy to substitute*: if competitors can find a substitute is not a strategic resource of the firm. Tangible assets for inimitability are, for instance, patents and trademarks. Intangible assets are, for instance, knowledge, skills, organizational systems and culture.

2.3.2 Corporate environmental strategy

Since nature will be a limiting factor in the future, Hart³⁵ proposed a strategy based in natural resources based view which pursues three key objectives: pollution prevention, product stewardship and sustainable development. The *pollution prevention* strategy has as final outcome for the firm, saving production costs by minimizing emissions, which lead to improved efficiency of the machinery, have a good housekeeping, create a regular maintenance program and control of production. *Product stewardship* will lead to preempt competitors by a close integration with stakeholders to minimize the life cycle cost of products. Companies able to reduce their product's impacts through its whole life cycle will replace the market position of those who are not able to do it given the world's tendency to a stringent environmental legislation. *Sustainable development* proposes the challenge of thinking globally and, likewise, to reduce the global impacts of the products (produced locally) by sharing the company's vision with all stakeholders. Thus, companies will gain a competitive advantage in the future, as well as a privileged position in the market.

The three strategies are closely related. Those companies that enforce a pollution prevention strategy will save costs, and it will be easier for them to assume a product stewardship program. Those companies that enforce a product stewardship program will replace companies in the industry who have not reached that position. For them, it will be easier to be involved in political decisions around the environmental matters they have performed and they are ready to assume a future position in the market through sustainable development programs. With these arguments, a company that implements a natural resource based view is prepared to assume future positions in the market, based on the internal knowledge and skills obtained in the three strategic capabilities making them valuable, rare and inimitable.

³⁴ Barney, 1991 in (Mintzberg et al., 1998).

³⁵ (Hart, 1995)

The energy industry assumes a similar challenge. To Reduce carbon dioxide emissions and to increase renewable energy capacity, are the two main topics to gain a strategic position in the future energy market. A more sustainable energy production will guarantee independence from external sources of energy, knowledge in the use of new technologies and an environmental image to show to the world. Swedish energy utilities have a reduced carbon dioxide emissions, however, dependence of energy supply from neighboring countries during dry years increases emissions in all Nordic countries. The natural resources based view path is still at an early stage in energy utilities, even though they have invested in renewable energy and carbon dioxide emission reductions. However, following the corporate environmental strategy it is difficult to see a better performance of the energy utilities in the future beyond the activities that companies have yet implemented.

2.3.3 Strategy under high levels of uncertainty

From the point of view of the utilities involved in the emission permits' market and the certificates' market exists high levels of uncertainties depending on at least three factors: the prices of certificates, permits and fossil fuels prices, the costs of technology, and the development of the energy markets.

The trends of the mentioned variables depend on multiple events that make it difficult to predict the future, using analytical tools. The variables are only predictable to some extent and the uncertainty, for decisions of leading companies, is still high. According to Courtney, *et al.*,³⁶ uncertainties can be classified in four levels. At *level one* there is a clear enough future so the residual uncertainty is irrelevant. A forecast is enough to define the strategy. At *level two*, there are alternative futures that can be described on a few discrete scenarios. The difference with the first level of uncertainty is that some elements of the strategy could be changed if the results became predictable. Also it can happen that the outcome of the scenarios depend on strategies of competitors. At *level three* of uncertainty, a limited number of variables can define the potential futures. There are no natural discrete scenarios. At *level four* of uncertainty, it is almost impossible to predict potential scenarios within a range, and it might not even possible to identify relevant variables.

Courtney *et al.*³⁷, define the moves and postures that a company can take under an uncertain future. The *postures* define the purpose or objective of the strategy to follow considering the future state of the industry in which the company is participating. The moves define the actions that the company has among a portfolio of actions. The postures that a company can adopt are:

- *Shapers*, those companies that try to control the direction of the market thereby reducing the level of uncertainty.
- *Adapters*, those companies that react to the opportunities the market brings.
- *Reserving right to play*, which is a special case of the adapter's posture, depicts those companies that make incremental investments in the present to have a privileged position in the future, expecting for the time that conditions turn less uncertain.

³⁶ (Courtney et al., 1997)

³⁷ (Courtney et al., 1997)

The moves that the company can take within each posture are:

- *Big bets move*, it involves large commitments including capital investments and acquisitions. Shaping strategies usually involves big bets;
- *Options* moves, companies takes the best “options” of scenarios that bring the higher profits to compensate those scenarios with negative payoffs. Examples of Options moves include, for instance, the use of pilot experiments before trying full-scale projects.
- *No-regret moves*, these are those investments that will bring profits irrespective of what happens in the future.

With the purpose of illustrating the above mentioned, Table 2-4 presents how the postures and moves relate. Chapter 3 explains the characteristic of each posture and move from a point of view of energy utilities in Sweden, however, not all cells in the table are possible to fill. For instance, it is difficult to define an adapter’s posture with a big bet move or a shaper posture making no-regret moves. These cells are colored in black. Other strategies are possible. They stand from a “cold” position (dark grey) adapters making no-regret moves and waiting to reduce uncertainty, to a “hot” position (light grey) which are shapers making big bets on a shaper’s posture.

Table 2-4: Postures and moves that a company can take under uncertainty

Moves \ Postures	Shapers	Reserving the right to play	Adapters
Big bets			
Options			
No-regret moves			

Given that the nature of the variables is not discrete, and whichever is the strategy of the bigger utilities in Sweden involved in this study, they will move the market in a given direction. Once the direction is established, they can only identify a range of possible outcomes after making the decision. Under these factors, the most appropriate definition of the uncertainty of the firms is a level three of uncertainty. The analysis of level three of uncertainty should follow the following steps³⁸:

1. Identify the nature and extent of residual uncertainties;
2. Choose a strategic posture;
3. Build a portfolio of actions, and
4. Actively manage the strategy.

The above mentioned steps to analyze uncertainties lead the company to take a stand on how to confront the future according to the company’s performance within the industry and its

³⁸ (Courtney et al., 1997)

own resources, and finally consider the possible alternatives that can occur under a range of changes to the current conditions. The outcome for the companies is a bundle of alternatives that the company can take if any of these changes happen, making them anticipate moves from other companies in the industry

Tradable emission permits and electricity certificates produce a level 3 of uncertainty since the emissions market will start in 2005 and the electricity certificates market just started in June 2003. Therefore, energy utilities can not forecast the outcome of possible actions in the market nor can they develop discrete scenarios since the residual uncertainty is vast. To explore the companies' strategies under a level 3 of uncertainty it is necessary for them to define their postures according to their performance on the industry and their internal resources. Afterwards, companies need to define a move that brings them the better portfolio of actions on each posture by identifying a set of scenarios that describe extreme points in the range of possible future outcomes.

2.3.4 Scenario Planning

Scenarios are used when there is not a clear pathway to the future, however, companies must be prepared to adapt their strategies under alternative futures. Properly constructed, scenarios go beyond forecast, clarifying complex issues and reducing them to basic components.

Scenarios have been used widely as a way of answering 'what – if' questions. Opposite to the common belief, scenario analysis does not pretend to be a crystal ball that predicts the future. A combination of scenario definitions explain the role of the scenarios on this thesis: "Scenarios are archetypal descriptions of alternative images of the future... that reflect different perspectives on ... future developments"³⁹ "for the purpose of focussing attention on causal processes and decision points"⁴⁰.

One can distinguish several types of scenarios. A *first type* of scenario corresponds to forecasting or backcasting scenarios. A forecasting scenario describes possible futures starting from a current situation, including or not, expected policy efforts. A backcasting scenario describes a desirable future and proposes several strategies to reach it. A *second type* of scenario is the descriptive or normative scenario. A descriptive scenario depicts an order of events irrespective of their desirability. A normative scenario takes into account values and interests. A *third type* corresponds to quantitative or qualitative scenarios. Quantitative scenarios are based on models while qualitative ones are based upon narratives. Finally, a *fourth type* corresponds to trend or peripheral scenarios. Trend scenarios represent an extrapolation of the current trends while peripheral scenarios include extreme events. These extreme events are classified as Unimaginable surprises, Imaginable and improbable surprises and Imaginable and probable surprises.

The eight steps to follow in the construction of the scenarios are⁴¹

- 1) Identify the focal issue.
- 2) List key factors in the environment.
- 3) List the driving forces.

³⁹ Rothmans and van Asselt in (Ribeiro et al., 2000)

⁴⁰ Khan and Wiener in (Ribeiro et al., 2000)

⁴¹ (Robbins, 1995)

- 4) Rank the key factors and trends to pick up the most important driving forces and factors.
- 5) Select the plot lines that best fit the information.
- 6) Flesh out the scenario and create a story that communicates an easily to understand message.
- 7) Develop the implications.
- 8) Select the leading indicators.

Finally, three definitions are needed in order to develop scenarios on this research. Initially, is important to define the context of the scenarios. For this study, the context is: Sydkraft and Vattenfall two regional energy utilities under the Swedish conditions on Tradable Emission Permits and Electricity Certificates. The second definition corresponds to a time frame. The purpose for this study is to evaluate the conditions within the period of compliance for Tradable Emission Permits (2003 –2012). Within this period is included the period of compliance for Electricity Certificates (2003-2010). Finally, scenarios always involve perceptions and judgements, depending on the point of view of the researcher. To avoid lack of transparency the scenarios should show explicitly the assumptions made on their elaboration, these assumptions are presented in Chapter 3.3.

2.4 Conclusions

1. Sweden holds a unique position within the European countries. Sweden has internally implemented the EU Council of Ministers directives in tradable emission permits and electricity certificates. Additionally, the country has one of the lowest carbon dioxide emissions and has the third largest hydropower capacity.
2. The deregulated market implemented in the Nordic countries has broadened the field of the energy utilities allowing them to purchase shares in Norwegian, Finish, Danish, German, Polish and other countries' energy utilities. This behavior distorts the application of the regulation in Sweden.
3. To analyze the Swedish utilities facing the tradable emission permits and electricity certificates systems, a framework is needed that takes into account the high level of uncertainties that the systems represent.

3. Framework to Analyse Uncertainties Related to Tradable Emission Permits and Electricity Certificates

In the literature review the theoretical framework was presented to develop firms' strategies when they are exposed to high levels of uncertainties. Additionally, it was clarified that Sydkraft and Vattenfall are involved in a level three of uncertainty, where a limited number of variables define the potential futures and there are no discrete scenarios, when it comes to decisions on tradable emission permits and electricity certificates. The steps proposed for analysing this level of uncertainty are: *to identify the nature and extent of residual uncertainties*. Section 3.1 proposes the possible options available for energy utilities dealing with the two flexible mechanisms and two closely related factors: decommissioning of nuclear power plants and fossil fuel use. In this part there is a discussion on the possible choices that companies can take on the four factors defined. This section brings an idea on the relevant variables and theoretical considerations companies might adopt on their strategies in the four factors.

The definition of the postures is developed through the standing that companies assume on the portfolio of actions presented in Section 3.1. On the other hand, the moves are defined according to the perception and beliefs on the trends of factors evaluated. For instance, if one company defined that they should strength its performance in the industry by increasing energy production (shapers posture), its belief in a bigger electricity market due to the addition of eastern European countries to the European Union make the company take a big bets move. In Section 3.2, as suggested by Courtney, *et al*, two scenarios presenting the probable range of future outcomes were developed.

3.1 Available options of strategic decisions for energy utilities

Time is the main consideration that companies need to have in mind for taking decisions. As usual, companies deal with short, medium and long-term considerations of their decisions. The short run, in the context of this research, refers to the actions taken until no other alternatives can be developed. For instance, whether the construction of a wind farm takes two years, the short run means the time the companies will take to build and operate the wind power plant. The medium and long run is, therefore, the period starting when the new power plant is operating and 2010, which is the year defined in this research to evaluate the strategies since afterwards new conditions are brought to energy utilities. Since the time frame defined is narrow, for defining the periods it could be said that the short run decisions are those taken from 2003 to 2005. The medium term decisions are those taken from 2005 to 2008 and the long run are those decisions made from 2008 to 2010 and beyond.

3.1.1 Nuclear power

Swedish energy utilities will face a reduction of the electricity supply because of the decommissioning of Barsebäck's second reactor. The total loss in energy production is 4.5 TWh/year. In the short run, the companies' alternative to recover the electricity lost is to import electricity. In the medium and long run companies may follow several alternatives. The four postures that companies might take are: 1) to continue importing the required energy from other countries through the Nordpool or other suppliers like German or Polish electricity suppliers, which correspond to an *adapter* posture. 2) To have a mix between imports and their own generation, which corresponds to a *reserving the right to play* posture with

options and no regret moves. 3) To produce the needed energy themselves, which corresponds to a *shaper* posture and options move. 4) To produce more energy than the older supply in order to take advantage of new opportunities in the market. Table 3.1 presents the postures and moves that companies could take. To develop the postures and moves, it was assumed that companies have capacity enough to cover the growth in electricity demand from 2003 to 2012, and the lack of energy is only due to the planned closure of Barsebäck's second reactor.

Table 3-1: Postures and moves that energy utilities can take in the long run under a decommission of the Barsebäck second reactor

Postures Moves	Shaper	Reserving the Right to play	Adapter
Big Bets	The firm decides to generate all the energy capacity lost from the Barsebäck nuclear plant decommissioning and produce even more capacity for future needs. The decision is taken because they believe that new decommissions of nuclear power will occur in the future, and, additionally, there are possibilities to expand its energy market with energy production generated by themselves.		
Options	The firm decides to invest until reaching the old capacity. The firm will be proactive in the development of new technologies. The decision is taken for strengthening their generating position in the future, reducing the dependence from external sources.	The firm decides to invest to some level between the capacities before and after decommission of the Barsebäck nuclear plant because the firm believes in the benefits of a higher production in Sweden. However, the firm makes the investment at a slow	
No-regret moves		pace trying to adapt the decision to the market conditions at the moment of building the new capacity.	The firm decides to import the lost capacity from other countries where it is possible to buy cheaper energy.

3.1.2 Electricity certificates

Electricity certificates are restricted to non-conventional renewable energy that produces electricity delivered by the electricity grid. These non-conventional sources include wind energy, wave energy, solar energy, geothermal energy, biofuels and hydropower energy plants. The requirements for hydropower to receive support from electricity certificates are that: hydropower plants must not exceed 1.5MW generation capacity; or should be decommissioned before July 2001 and recommissioned after the end of 2002; or commissioned for the first time after the end of 2002; or increase their production of electricity; or plants that are unable to maintain a profitable production in the future.

Electricity certificates allow renewable energy producers to generate electricity that can be sold in the electricity market, and additionally, to receive electricity certificates (one per each megawatt hour of electricity delivered to the grid) that can be sold to users who require certificates to show compliance with the renewable energy target.

The future uncertainty sources for investing in renewable energy comes from the price of certificates and the costs of technologies, hence, a strategic decision should consider all possible options that the company has at each level of prices and costs. These decisions are different in the short and long run. A definition of short and long run assumed in this research is, assuming that it takes two years to build a renewable energy power plant or changing the current fuel to a renewable option, in the short run the feasible alternatives of the firm during this two years, while the long run will be the options that the firm takes during the period 2006-2010.

In the short run, users or electricity distributors with the obligation of showing users compliance will buy certificates or will pay the penalty price. In the long run, utilities need to evaluate the costs of building and operating new renewable energy capacity and, additionally, evaluate the prices of electricity at the Nordpool.

The postures that companies can take include: (1) *adapters*; (2) *reserving the right to play*; and (3) *shapers*. With the purpose of understanding the shaper's posture let's imagine an energy utility facing the challenge of increasing the capacity in Renewable Energy Sources for Electricity (RES-E).

A company acting as a *shaper*, will invest in renewable energy much faster than its competitors, given its expectancies in a higher price of certificates as well as the spot price of electricity in the future. If these two events occur in the period 2004–2010, the company will have a shorter payback on their investments. Furthermore, customers will remain loyal since the company can bring the service of guaranteeing the required certificates the users need to show compliance with the renewable energy target. Additionally, the firm will make savings for not having to buy certificates in the market and will obtain benefits from selling the electricity produced in the renewable energy power plants. Intangible benefits, out of the ones mentioned before, come from the consumer's recognition of the company as interested in environmental aspects. This recognition could bring to the company more users interested in receiving green energy, similar to what has happened in the Netherlands. Other intangible benefits are: the knowledge obtained in the production of electricity from renewable energy, which will give them an advantage in case tougher targets are imposed after 2010; the reduction of cost because of the knowledge acquired; and the possibility of having a better position for negotiating new renewable energy targets in the future within Sweden and the European Union. A difficulty that firms have for taking a shapers posture are the

expectations of a reduction in the cost of the renewable energy production technologies.⁴² However, a firm taking a shapers posture will evaluate the benefits obtained with an early investment against the opportunities lost if the company waits for the reduction of technology costs. In a shapers posture making big bets firms decide to go beyond compliance because they see that, additional to the above-mentioned benefits, after 2010 a European market for renewable electricity will be a reality and the company will have a better performance in the industry if its effort towards increasing renewable energy capacity is recognized within European countries, and this recognition will bring more business opportunities. The advantages after 2010 for shapers making big bets are: in case an international market will be created in the future, they can sell certificates in a broader market than Sweden; in the case the Renewable Energy Certificates System (RECS) fails in Europe, firms have reduced their cost in renewable energy capacity and there is more electricity to sell. In the *shapers* posture with option moves the firm decides to reach the target by its own means because of its belief in the above mentioned advantages of expanding renewable energy capacity in the future, but the firm will only produce the required certificates to show its own users compliance. Additionally, the firm decides to invest in pilot projects on renewable energy to learn how to reduce costs of new technologies in the future. This posture and move implies that the firm had chosen to invest in research and development of renewable energy technologies beforehand.

In a *reserving the right to play*, posture, the company will follow the same rationale. They will not produce all the certificates required by its users expecting better prices of certificates in the market in order to find equilibrium between the investments to be made and the benefits obtained. Firms assuming this posture wait for clearer signals from the costs of technology, certificates prices and spot prices of electricity. Firms considering a *reserving the right to play* posture will evaluate the cost of building renewable energy capacity (sunk costs), the operation costs of different technologies in time, the possible revenues from selling the electricity produced and the possible revenues of selling the electricity certificates. By calculating these variables, they will invest in those technologies that have the shorter payback (reserving the right to play posture with non-regret moves). Or, firms will invest in technologies with the shorter payback and, additionally, invest in research and development to reduce their costs of learning how to adapt and manage the new technology (reserving the right to play with options moves). The lack of renewable energy to reach the target will be obtained by purchasing certificates.

An *adapters* posture will reach today's efficient point by making no additional investments. Their expectations on future development of the variables are low, and then, is safer to make investments only when a clear path can be seen. The *adapter* posture can be found when firms decide to make a bigger use of the certificate's market. Table 3.2 presents the postures and moves that energy utilities can adopt when they are deciding about how to deal with electricity certificates.

⁴² The experience curves for renewable energy express the cost reductions due to the scale of the production technologies, marginal technological improvements and field experience of renewable energy producers. According to the World Energy Assessment (UNDP, 2000) each cumulative doubling in the capacity of solar photovoltaics, wind generators and gas turbines results in a 20% cost reductions. Klaassen and Söderholm (2002) defined three drivers for increasing Wind energy capacity in western European countries: invention, innovation and diffusion. They conclude that diffusion of wind power generation is the most important driving force but it is dependent of political will. Wind power become cheaper by: a) gradual diffusion and learning activities in existing plants; and b) Public R&D support to test new production processes.

Table 3-2: Postures and moves for energy utilities dealing with electricity certificates

Moves \ Postures	Shaper	Reserving the Right to play	Adapter
Big Bets	The firm decision is to comply with the target of electricity certificates and go beyond compliance.		
Options	The firm decides to go to the limit of compliance by its own means. The firm decides to raise a pilot project to learn from other alternatives of RES-E and at the same time generate electricity and obtain certificate from this projects.	The firm decides to invest in technologies whose cost/MWh of building and operating compared with the revenue for selling electricity and certificates are at least the same. Other certificates are bought in the market of electricity certificates. Additionally, the firm decides to invest in Program of Research and Development of RES-E technologies.	
No-regret moves		The firm decides to invest in technologies whose cost/MWh of building and operating compared with the revenue for selling electricity are at least the same. Other certificates are bought in the market of electricity certificates	The firm decides to buy certificates because they are cheaper than to produce energy by RES-E means.

3.1.3 Tradable emission permits for carbon dioxide emissions

In order to introduce the Swedish conditions on tradable emission permits, three assumptions was made before explaining the postures and moves that a firm could take on the tradable emissions permits area. The initial assumption is that energy utilities need to reduce 4% of their emissions in the period 2008 – 2012; however, at present there is no consensus on the target that will be imposed on different industries. But the concept applied for this assumption is similar to a command and control approach where all industries are required the same level of emission reductions. A second assumption is that all the emission reductions will be generated in Sweden, as proposed by the government, therefore, firms will not use other flexible mechanisms like CDM or Joint Implementation. A third assumption is that energy utilities still have work to do in emission reductions to reach the target proposed

for the 2008-2010 period, although, they had a good performance in emission reductions on last years.

Under the assumptions explained above, in the short run firms will react in an adapter posture buying permits from the market until they are able to make their own emission reductions. In the long run, firms need, on the one hand, to take decisions about the kind of technologies they will use in order to reduce emissions, and on the other hand, being able to forecast the tradable emission permits prices, the marginal abatement costs of reducing carbon dioxide emissions and the target to be imposed after 2012 by the authorities.

The *shapers* posture making big bets implies that the firms are aware of the consequences of carbon dioxide emissions for the environment. Additionally, this posture implies that the firm will go beyond compliance because the firm believes that in the period 2012 – 2020 harsh conditions than today's ones will be imposed, and under the uncertain conditions of abatement technology cost the faster the company reduces its emissions the higher will be the savings in the future. Consequently, the company can offer "green electricity"⁴³ faster than other companies and obtain a better position in the market. A *shapers* posture with options moves implies that the firm reach the target by its own means and invest in pilot projects that lead them to reduce the uncertainty of the technologies and reduce its costs for the next period of compliance.

A firm assuming a *reserving the right to play* posture will not produce all needed permits by itself but will make investments that put the firm in a safe position, keeping track of the permit prices and technology cost trends, for making the necessary investments in the right moment when the prices reveal a clear and defined tendency.

An *adapter* posture will consider only today's market signals and try to take advantage of them. The adapter posture implies that the firms will adopt a "wait and see" strategy. Firms will wait for the development of the emission permits prices. A firm acting as an adapter will invest until its cost of reducing one additional tonne of carbon dioxide equals the permits price, and they will obtain the needed emission reductions by purchasing the required permits. Table 3-3 illustrates the implications of the options and no-regret moves at *reserving the right to play* posture.

3.1.4 Use of fossil fuel

In the short run, increases in the cost of using fossil fuels lead to decisions of changing the fuel used to generate electricity and heat, or to pay the cost of using fossil fuels. A decision on changing the fuel used to generate energy depends on the ability of the plant to switch from one source to another, e.g. oil to natural gas. At present, coal presents the lowest prices but there are high pressures on the use of coal as a source of energy. A suitable alternative is the use of natural gas. As mentioned in the literature review, the BGI project (Baltic Gas Interconnector) will bring gas from Germany to Sweden. Prices of natural gas are lower than petroleum prices.

⁴³ In the sense of electricity produced with a minimum carbon dioxide emissions that will bring the firm a product stewardship for the generation of this electricity or heat.

Table 3-3: Postures and moves that companies dealing with tradable emission permits can adopt

Moves \ Postures	Shaper	Reserving the Right to play	Adapter
Big Bets	The firm decides to go beyond compliance on its emission reductions, motivated by the believing that regulation on climate change issues will be stronger in the future and a possibility to access the market of green energy the first.		
Options	The firm decides to fulfill the target requirements and invest in pilot project to reduce even more and learn from the experience to be prepared for possible stringent measures in the future.	The firm decides to reduce the higher amount of emissions by its own means and invest in research and development to reduce costs of compliance in the future.	
No-regret moves		The firm decides to invest in emission reductions to the higher extent possible, trying to reduce emissions itself and to rely temporarily, on other kinds of certificates like CDM and JI. The firm takes this decision due to the government declarations and the low credibility that other kinds of permits have in the market.	The firm will reduce emission until the level of the certificates price and the lacking emissions will be obtained by purchasing permits. The firm will always take the lower cost option by means of TEP, CDM or Joint Implementation

However, in the long run, additional to the prices of fuels other factors are involved in the decision of using or not using fossil fuels. The first one comes from the national commitment of reducing carbon dioxide emissions, achieved in Sweden by means of the carbon dioxide tax. At present there is a project to reduce the tax in 2005 for the sector once the tradable emission permits transactions start. The second factor comes from the

international decisions on carbon dioxide reductions and the implementation of the tradable emission permits. As was stated before, at the international level and according to the burden sharing decision from the of the EU commission, Sweden has the possibility to increase its carbon dioxide emissions 4% from the 1990 level. Nevertheless, Sweden decided to reduce its emissions 4% from the 1990 level. In consequence, since the energy sector is one of the important stakeholders in achieving this target⁴⁴, an allocation of emissions among different sectors in Sweden could result in the same 4% target of emission reductions for energy utilities.

On the other hand, the de-regulation/liberalisation of the energy market in Europe and the limitation in building large hydropower plants and nuclear power facilities due to its landscape and natural ecosystem's impacts are stressing a higher use of fossil fuels. The de-regulation of the energy markets has created competition among energy utilities to bring the cheaper price per kWh to customers. This competition has guided companies to reduce costs to be competitive on an international market. The restriction on building new large hydropower and nuclear capacity makes it harder to reduce costs since they are the cheaper sources for producing energy. Finally, as an alternative, fossil fuel remains as the cheapest option.

The extreme strategic decisions come from shapers and adapters. An adapting decision could be adopted in two cases.

- The first one implies that under the conditions of: 1) increases in fossil fuel prices; 2) expectations on stringent measures on carbon dioxide emission reductions for the second period of compliance of the Kyoto protocol; and 3) the increasing pressure from the de-regulated market to reduce energy prices; companies decide to invest in changing the technology of production to natural gas systems, thereby, they get an advantage on reducing carbon dioxide emissions and reducing the cost of production to a lower cost. The changes will be made to the point that they still remain profitable for the companies and place them in a compliance position.
- To develop the second adapting case, let's hold the second and third conditions fixed because they seem to be constant conditions in time, and only change the first condition: increases in fossil fuels prices. Hence, companies expect that prices will not change drastically, remaining in a range that companies can afford to continue producing in the same way they have been producing until now. Therefore, the second adapting case involves a slow change in technologies in a way that companies keep the same level of profitability of the modified plants.

Table 3-4 explains the positions and moves that an energy utility can take on the use of fossil fuels.

The shapers posture with big bets moves will imply that: 1) Companies see that in the future, disregarding the fossil fuel prices, the earlier a firm reduces its emissions the faster they can bring clean energy to the market and have an advantage on the energy market. Additionally, companies will learn faster how to manage the technologies for reducing its costs. 2) Energy utilities recognise that the pressure on lowering the price on energy imposed by the liberalisation of the European energy market can be reduced by the willing of consumer to reduce carbon dioxide emissions. An example of this decision comes from the Green

⁴⁴ (Swedish National Energy Administration, 2001)

certificates scheme implemented in the Netherlands where from 1996 to 2001 the sales of green electricity increased in approximately 500 times and in 2001 there were more than seven hundred thousand (700 000) customers for this kind of energy.⁴⁵

Table 3-4: Postures and moves an energy utility can take under decision of the use of fossil fuels

Postures Moves	Shaper	Reserving the Right to play	Adapting
Big Bets	The firm decides to reduce their fossil fuels consumption beyond the target imposed. The firm pay reduced attention to fossil fuel prices expecting to receive revenues from tradable emission permits, electricity certificates and by selling green electricity		
Options	The firm decides to reduce its fossil fuel consumption until a 4% reduction in carbon dioxide emissions. Additionally, the firm invests in pilot projects to reduce, even more, the fossil fuel consumption.	The Firm decides to reduce their consumption of fossil fuels, despite the fossil fuel prices, to reach additional carbon dioxide emissions reduction.	
No-regret moves		The firm decides to slowly switch from fossil fuel based energy production to natural gas and biofuels. The firm expects those non-accomplished carbon dioxide emissions reductions could be fulfilled by means of the tradable emission permits and a reduction on the carbon dioxide tax.	Under the increase in prices of fossil fuels, utilities will be forced to reduce their consumption and replace it with the use of other technologies (i.e. Natural gas) Under the reduction in prices and the current pressure on CO2 emissions reduction companies slowly will make a change in technology to natural gas

⁴⁵ (Kwant, 2003)

3.2 Scenarios

To evaluate the postures and moves that companies will take to reduce the uncertain condition in the future, two scenarios were developed that incorporate the four factors explained before. The condition proposed to the firms deal with: how will be prepared the company if in 2010 the conditions correspond to the ones mentioned on each scenario? The scenarios were prepared based on the government officials' opinions on the future of the electricity certificates after 2010 and the future of the tradable emission permits for the second period of compliance.

The Swedish EPA officials' appraisal takes into account two suitable conditions to occur in the future on the tradable emission permits market. The first one considers no ratification of the Kyoto protocol. This case proposes a challenge to European countries due to the work done until 2012, which will make countries consider continuing with the emissions trading system but the target for the second period of compliance will be reduced. The reduction in the target for the second period of compliance are difficult to forecast since they depend on many political situations in the future, one of them is how hard the countries find it to reach the current targets in emission reductions. The second one considers full ratification of the Kyoto protocol and stringent conditions of emission reductions for the second period of compliance.

In the field of the electricity certificates is even more difficult to forecast since it is still a recent issue. Officials from the Swedish National Energy Administration are optimistic on the future of the electricity certificates. Several countries in Europe have adopted different systems to promote the use of renewable energy and the decisions from the European Council of Ministers bring support to these schemes. Additionally, the RECS system is dealing with an international experience for the support of renewable energy projects. However, problems with the harmonisation of the systems and the additional cost that the electricity certificates will impose to the customers could be factors to reduce the targets after 2010, on the one hand, or finishing the system completely, on the other hand.

3.2.1 Scenario 1: stringent environmental conditions and more opportunities in the market

This scenario considers a continuation in time of the conditions for electricity certificates and tradable emission permits after 2010. The present section explains the drivers that companies could consider within their strategies.

1. On nuclear power plants decommissioning

Different visions about nuclear power plants decommissioning regard to a stringent policy after 2010. Sydkraft⁴⁶, based on the estimation of Elforsk AB, forecasts for 2050 decommissioning of all nuclear power plants. This decommissioning will be gradually made in all existent nuclear plants, finding their longer useful life. The phase out of nuclear plants will happen through the period 2010 – 2050. On the other hand, decommissioning of Barsebäck second reactor was programmed for December 2003 with the restriction of closing it down only if the market conditions are met. Under the increasing public pressure for decommissioning nuclear plants and closure of other nuclear plants made in other European countries, it is feasible to think that more decommissionings of nuclear power,

⁴⁶ (Sydkraft AB, 1999)

additional to the Barsebäck one, will come after 2010. The assumptions on this scenario rely on the expectations of Barsebäck's second reactor being decommissioned during the period 2003 - 2010, and the closure of other nuclear plants after 2010 in Sweden.

2. On electricity certificates

The assumptions for the electricity certificates deal with internal and external drivers. The internal drivers deal with a continuation of the electricity certificates system and tougher targets for the next period of compliance. The continuation of the electricity certificates market depends on the fulfilment of the current targets by industries and customers, support from the European commission for a harmonised green certificates system, and political consensus on the continuation of the system based on the costs that, for that time, industries have borne. Other internal drivers depend on cost of renewable energy. In the future, costs of renewable energy technologies are expected to decrease. Companies need to invest in research and development to learn the technologies and reduce cost of implementing new renewable energy technology.

The external drivers come from the expectations of a European market to trade green electricity, which could be based in a harmonised system for all Europe or a voluntary system like the RECS one. The Green-X⁴⁷ project looks for the harmonisation of the conditions to increase the renewable energy capacity throughout the European Union, searching for conditions in this countries to implement market based mechanisms that leads to a European trading system of green energy. The RECS project is dealing with a voluntary system of electricity certificates where companies and countries, through a certification process promote the use of green energy. A second external driver deals with the possibility of exporting green energy to neighbouring countries like Finland, Denmark and other Baltic countries entering into the European Union. For 2010, companies that decided to go beyond compliance on the renewable energy target can find customers outside Sweden. Other countries that are able to participate in the Nordic energy system and are still not included into the European Union will need to get the same targets as other European countries. Hence, for 2010 there will be an enhanced market for renewable energy.

Summarising, on electricity certificates this scenario implies: for 2010, that there will be a second period of use of the electricity certificates system. Sweden will impose more stringent targets on the share of renewable energy. The cost of renewable energy technologies will decrease making them more competitive compared with hydropower or other energy solutions, and there is a possibility for an enhanced market of green electricity.

3. On tradable emission permits

On 2005, the European Union will start the emissions trading, despite the fact that ratification of the Kyoto protocol is still uncertain depending on the decisions of countries like Russia, Australia, and Japan. At the European Commission, some countries have started to negotiate the targets for the second period of compliance starting in 2012. In Sweden the government have imposed a target of 4% reduction from the 1990 emissions. The allocation system to be implemented will be grandfathering based in historical emissions in the period 1998 – 2001 according to information from the Swedish⁴⁸ National Energy Administration.

⁴⁷ (Green-X project, 2002)

⁴⁸ Interview to Thomas Levander, official of the Swedish National Energy Administration. A summary of this interview can be found in the Appendix B.

Under these facts it is expected that after 2012, stringent targets will be imposed to European union countries, and hence, to energy utilities who need to look upon additional emission reductions. Finally, companies with potential to reduce carbon dioxide emissions beyond the target will be able to trade emissions. Energy utilities have the potential to reduce emission by changing from heavy oil to biofuels-powered plants according to the estimations made by the government.⁴⁹ The conclusion for the conditions that companies will face on 2010 are stringent targets on carbon dioxide emissions and the possibility to trade with the additional permits generated.

4. On Fossil Fuels use

On fossil fuels use, the tendency in Sweden shows a gradual changes from the use of oil and coal for heating and electricity to a higher use in gas and biomass to cut the dependence upon oil based power generation. The motivations for this change were, basically, the uncertain prices on oil and the tougher requirements on emissions reductions. In the last two years the prices of crude oil and residential heating oil have increased from the average price in the period 1987 – 2000.⁵⁰ Since 2001, prices have decreased but they are still higher than the average price in the mentioned period. The proposed future for this scenario in 2010 is an increase in the total cost of using fossil fuels.

3.2.2 Scenario 2: opportunities in the market and environmental regulation similar as today's conditions

This scenario considers no continuation of the electricity certificates after 2010 and no ratification of the Kyoto Protocol after 2012, which will lead to make softer the current conditions on both markets.

1. On decommissioning of nuclear power plants

The Barsebäck second reactor decommissioning decision has been postponed several times and a decision on closing it down in the near future will affect the compliance with the targets of carbon dioxide emission reductions. The energy produced by the nuclear plant should be replaced by new electricity generation based on natural gas. Additionally, this decommissioning decision will result in a less competitive energy industry in Sweden with regard of the Nordic energy market. Hence, a Barsebäck second reactor decommissioning decision will be delayed and the discussion on the closure of other nuclear power plants will be postponed until after 2010.

2. On electricity certificates

By 2010, the electricity certificates system will end due to one of the following conditions:

1. Renewable energy technologies operational costs have been reduced and are competitive in the market, hence, they need no further support for operating and higher targets on renewable energy capacity can be imposed without damaging the economic stability of the energy sector;

⁴⁹ (Näringsdepartamentet, 2002)

⁵⁰ (Energy Information Administration, 2003)

2. There is no international market on electricity certificates and, if the system continues to work, it will impose more stringent targets to Swedish energy utilities than to other countries.

3. On tradable emission permits

There is a possibility that the Kyoto protocol will not be ratified, however, as stated earlier, Europe will continue with the trend of an emission trading system imposing new targets, maybe not as stringent as it would have done if the protocol were ratified.

4. On Fossil Fuels use

The total cost of using fossil fuels will decrease on the today's level, bringing incentives for its use. This scenario is possible since the OPEC is claiming that on the stringent measures that Europe is imposing on emissions reductions, the petroleum producing countries should be compensated since it means a loss in the incomes for those countries.⁵¹

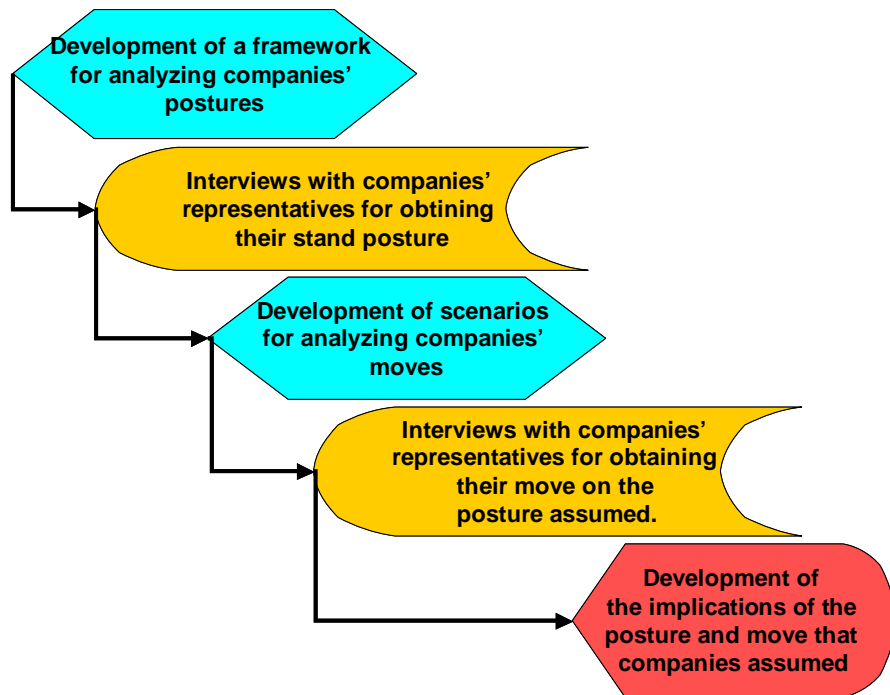
⁵¹ (Environmental media services, 2003)

4. Methodology

In previous sections the author reviewed how the tradable emission permits and electricity certificates function and the regulations implemented in Sweden for implementing them. Additionally, it was seen how the energy system functions and its composition and the strategic decisions of energy utilities could take under an uncertain development in both flexible mechanisms. To deal with the uncertainties in Chapter 3 a framework for analyse the utilities behaviour concluding with the feasible scenarios that companies can face in the future was developed.

Chapter 4 presents the methodology used to capture the postures and moves that Sydkraft and Vattenfall are thinking to take on the use of the tradable emission permits and electricity certificates. The steps to obtain these answers are presented in Figure 4-1.

Figure 4-1: Methodology



4.1 Justification of the paradigm and methodology

To understand the scope of the research question and justify the methodology to use, it is necessary to take a look back to the research topic and research question. The research topic of this thesis deals with how to bring and additional support to renewable energy in Sweden. Among various possibilities to solve the research topic, two flexible mechanisms, Tradable Emission Permits and Electricity Certificates, are proposed in Sweden. A large number of companies are involved into these mechanisms, but for narrow down the scope of this research, it has been chosen two of the biggest companies in the market of electricity in Sweden: Vattenfall AB and Sydkraft AB. The research question involves the two mechanisms, the two companies and the possible decisions these companies can take to deal with these mechanisms. Finally, the research question proposed was:

What are the strategic implications of the implementation of the Emissions Trading System and the Electricity Certificates System for Vattenfall AB and Sydkraft AB?

The *strategic implications* relate on the decisions of the firms. For this research, the postures and moves presented in the literature review explain the strategic decisions that utilities have. These strategies are subject to an intrinsic level of uncertainty of the chosen factors. Companies deal with the uncertainties according to the expectations they have on the development of electricity certificates and tradable permits. Additional to these two factors exist two more factors closely related with the decisions on the two flexible mechanisms according to the scenarios for carbon dioxide emissions presented by the energy agency⁵². These factors are the phase out of nuclear power and the fossil fuel use. Decommission of nuclear power will affect the carbon dioxide emissions since a lack of energy will lead to the increase in capacity in cheap technologies for compensating the loss. The alternatives on hand are fossil fuels and natural gas. Both of these technologies will increase carbon dioxide emissions and, therefore, companies will need more tradable permits to show compliance. As a consequence, the decisions on fossil fuel use take relevance and utilities will need to decide what technologies suit them the best to achieve emissions and renewable energy targets.

The selection of the companies corresponds to their relevance in the Swedish context. The companies were selected according to their electricity production. It is important to emphasise that the deregulated market allows customers to choose the electricity provider they consider bring them the better price or services conditions. Therefore, for evaluating the relevance of the companies they should be seen from the Nordic market perspective. As presented in Chapter 2.2 Sydkraft and Vattenfall produce 70% of the total electricity production in Sweden and 28% of the electricity production in the Nordic countries. Therefore, centring the study in this two utilities bring a panorama of how the energy market in Sweden and the Nordic countries will behave.

Energy utilities have developed a vision on each mechanism, however, the implementation of the two mechanisms at the same time, in Sweden, propose a new challenge for the companies. Companies have several options on each mechanism. 1) Purchase certificates or permits only, not to produce them. 2) In the case of Tradable Emission Permits, utilities will only use the permits to fulfill their requirements. Or 3) reduce emissions that allow them to sell permits and, therefore, have an additional income. 4) In the case of Electricity Certificates, utilities can produce renewable energy, sell the electricity and sell the certificates. The strategic decisions that companies can take on each mechanism were developed in Chapter 3. To understand the decisions that companies will take on the four factors were made interviews with companies' representatives that deal with the development of the strategy for each company. The importance of the interviews was to capture the postures and moves of the decisions on each factor. Finally, the representatives' answers were analyzed to develop the implications of these decisions.

⁵² (Swedish National Energy Administration, 2001)

4.2 Research Procedures

Following Courtney, *et al*⁵³, the steps proposed to manage a level 3 of uncertainty are: first, to establish a stand posture and finally to define the move companies choose to act on that posture.

Development of a framework for analysing companies' postures

The criteria for the classification on the postures and moves that a company can adopt was:

- 1) *A Shapers posture making big bets.* The decisions of the firm are not primarily based on how the prices of the factors change but on the future position that the company want to reach after 2012. Under this strategy the firm acts going beyond compliance. The decision under this strategy leads the company to make investments that place the company on a strategic advantage in front of the competitors. According to Mintzberg⁵⁴ this posture and move represents a deliberate proactive strategy.
- 2) *A Shapers posture taking options moves.* The decisions of the firm are based in a belief of tougher conditions in the future for which the company should be prepared acting as a leader. Under this strategy, firms will be on the compliance limit making additional investments to reduce uncertainty in the future (e.g. investment in Pilot plants)
- 3) *A Reserving the right to play taking options moves.* The firm goes beyond the limit of the lower cost options in order to be prepared to unexpected changes in the factors. Basically, the firms act as risk averse but take some risks until they don't represent big monetary loses. Again, according to Mintzberg this posture and move is an emergent active strategy.
- 4) *A Reserving the right to play making no-regrets moves.* Firms remain on the limit of the lower cost options preparing themselves to unexpected changes in the factors. According to Mintzberg this posture and move is an intended but unrealised strategy.
- 5) *An Adapter posture.* Adapters will act taking always the lower cost moves. They only invest when other options are more expensive otherwise take the cheaper options. Mintzberg named this strategy a deliberate reactive strategy.

The above definitions serve to state the position on each factor that the company can adopt. A detailed definition of this postures and moves was presented in Chapter 3.

Interviews to companies' representatives to capture companies' stand posture.

To identify *companies' posture* were interviewed the production managers in both companies. The purpose of this interview was to determine what is the current strategy that companies are following. This stand will bring the decisions that companies have made on the four main factors. Their answers were classified according to the criteria explained above.

To capture the answers was created a questionnaire proposed to production and sales managers in both companies. The questionnaire had open-ended questions with the purpose

⁵³ (Courtney et al., 1997)

⁵⁴ (Mintzberg, 1978)

of capturing why the companies planned to take the strategies they have chosen. A copy of the questionnaire is at Appendix B. After the interviews, the answers on the strategies on each factor were explained and summarised.

Development of scenarios to analyse companies' moves

According to Robbins⁵⁵, the first step proposed is to *identify the focal issue*. Considering that the research topic is bringing an additional support to increase the capacity of renewable energy in Sweden, the focal issue is what decisions in Sydkraft and Vattenfall will make that RES-E capacity increase within each company. The consequences of this question will have implications on purchasing Electricity Certificates and Tradable Emission Permits.

Several scenarios have determined different *factors* to be considered. The Swedish National Energy Administration⁵⁶ has defined, eight factors that rule the carbon dioxide emissions in Sweden. The factors are Nuclear power decommission, Gross domestic product (GDP), Industrial growth, Private and Public consumption growth, Exports and imports, prices of fossil fuels, prices of biofuels and prices for electricity. Under the "SAME project"⁵⁷ the Swedish EPA, Swedish National Energy Administration, the Swedish Power Association and the Swedish District Heating Association defined scenarios for renewable energy on the basis of a total disclosure of nuclear power on 2050. The forecast objective was to determine the energy level based on estimations of the residential, commercial and national production growth increasing at the same rate than GDP. The outcome shows GDP growing in two directions, a high and a low level, for finally forecast the two basic scenarios of energy production.

As explained in Chapter 4.1, the chosen factors of interest and their *driving forces* for this research are:

- The *near term phase out of the Barsebäck's second reactor and decommission of other nuclear plants after 2010*, which implies a reduction in the energy generation that companies will need to fulfil with other types of energy generation, as it was mentioned in the literature review. The exact moment when the nuclear plant will be closed is still uncertain. The government position is that the plant will be disclosed when the conditions on the market of electricity are met. However, the main effect of the plant disclosure is that Vattenfall and Sydkraft sell the energy produced by the plant. Thus, in the short term both companies will face a lack of energy to supply that should be obtained by means of purchasing energy from the Nordpool or by building new energy capacity.
- The *fossil fuels use*. The use of fossil fuels is closely related to the level of the carbon dioxide tax and the prices of permits. The companies will continue using the same amount of fossil fuels or increase their use whether lack of energy from nuclear power decommission is feasible or no other cheaper alternatives are found to increase energy capacity.

⁵⁵ (Robbins, 1995)

⁵⁶ (Swedish National Energy Administration, 2001)

⁵⁷ (Swedish Environmental Protection Agency, 2002)

- The *Electricity Certificates prices* will support the increase in the capacity of renewable energy. This factor constitutes one of the bigger uncertainties since the market of certificates has just started in June 2003.
- The *Tradable Emission Permits prices* will determine the extent of the carbon dioxide emission reductions, but at the same time, imposes the challenge to utilities of finding new clean technologies. As stated before, the emissions permits' market will be opened on 2005, which constitutes an additional source of uncertainty.

A *rank* in the factors was made according to the research topic, which deals with the increase in renewable energy capacity, the role of the Electricity Certificates is stressed. The other factors should help to analyse if companies will raise their RES-E capacity or not.

The current strategies of the companies consider future situations after 2010. Revealing the uncertainties make companies to take actions in advance to obtain a better position in the market (above average performance in the industry). Finally, the *story line* of the scenarios was developed in Chapter 3.2.

Interviews to companies' representatives to capture their move on the posture assumed.

Two scenarios were created to reveal the uncertainties. The scenarios were presented to managers and strategy team leaders to capture how companies will change their strategies if the conditions of the factors after 2010 follow the trend presented in the scenarios. The answers were explained and classified according to the same criteria explained above.

Development of the implications of the posture and move that companies assumed

The interviews was transcribed and analyzed according to the framework presented in Chapter 3. The companies' representatives' answers were tabulated in Chapters 5.1 and 5.2. The consequences of the postures and moves are presented in Chapter 5.3.

4.3 Limitation of the methodology

The four factors analysed on this research are not the only factors to be considered for the companies to create their strategy. The energy industry is a broad study field. Other external factors to the proposed in this research are: the weather, the competence in a European de-regulated market, the growth of the whole industry and the GDP per capita in the Nordic countries and in Europe, the entrance of new countries to the European Union, etc. The time restriction for this research made not possible to involve more external factors for this research.

Additionally, internal factors on the companies can influence the strategies, for instance, the de-regulation implemented in the Nordic countries made utilities to be sectioned in different areas (energy production itself, transmission, sales) where each area look for different targets, reducing the communication between the areas, and making each area to work as a company itself. In the interviews could be seen that production and sells areas have different opinions on the same topics due their distance into the company. Another big limitation for this research of the company's desegregation, is that for the production area electricity certificates is optional to invest in renewable energy, while for the sales area is compulsory to reach the renewable energy share target. However, the decisions of the production area will determine the possibilities for new renewable energy capacity. Although both areas are important to

define the actions of the utilities in the electricity certificates field, the research topic of this thesis dealt with an increase in the renewable energy capacity, therefore, its focus is centred on the production area.

Sydkraft and Vattenfall are two companies involved in the same industry, and as such, competitors in the Swedish and Nordic market of electricity. The questions, answers and conclusions obtained on this research are based on positions that companies' representatives discussed in the interviews. Therefore, most of the answers seem to be general since a detailed inventory of activities is part of the internal strategies of companies, which are still under construction, as it was perceived in the interviews. Finally, most of the information to evaluate the scenarios is confidential and belongs to strategic information of the companies. Therefore, the analysis of the factors presented is evaluated in a qualitative way.

5. Analysis

Four factors were chosen to analyse the companies' behaviour. As was explained before, the new role of the electricity certificates and the tradable emission permits (to be implemented in 2005) impose new challenges to energy utilities, and the positions that companies have on these issues are the core objective on this research. Additionally, but not less relevant, there are the issues on decommission of nuclear plants and fossil fuel use for energy generation. Decommission of nuclear plants has become an important aspect on energy generation since the decision on decommission of Barsebäck second reactor was decided to take place in December 2003. This decision has been postponed several times and it seems that the decision of the phase out for December will also be postponed. On the other hand, the fossil fuel use reduction has a long history since the carbon dioxide tax was implemented in Sweden.

Uncertainty plays an important role in the research. Regarding fossil fuels use, it is still possible to forecast what the future prices of oil or coal could be. However, considering the past failures on forecasting political factors affecting oil prices (e.g. 1973 oil prices increase), prices can only be forecasted in a short term. Thus, a medium and long-term strategy based on oil prices is difficult to achieve. Electricity certificates are a new component of energy utilities legislative burden. The bill on electricity certificates was passed in December 2002; the conditions for the transactions were delivered in May 2003 and the electricity certificates market started in June 2003. Thus, forecasts on prices of certificates, costs of technologies and investment in new projects is still uncertain. On tradable emission permits, multiple conditions are to be met to determine the prices of permits. For instance, how the CDM and JI projects will affect the emissions trading in Europe, or how the ratification of Russia and other countries will affect the price of permits. These are not solved questions for a market that will start in 2005. The forecasts of the permits price are in a range between 5 and 50 dollars per tonne of carbon dioxide emission reduction. Finally, decommission of nuclear power plants in Sweden is becoming more and more complicated because the Barsebäck decommission is still a political debate and a decision of phasing out the plant has been postponed several times.

This chapter is divided into three parts. The first section reviews the current strategies that the companies are following to deal with the factors defining the companies stand on the posture to deal within the four factors. The second section describes the answers that companies gave to the proposed scenarios defining the moves companies will make on each posture. Finally, the third section concludes with the implications for the energy sector of the actions that the two largest players of the Swedish energy market will take.

5.1 The current actions

Representatives from Sydkraft and Vattenfall were asked about their current strategies for dealing with the factors presented in Chapter 3.1. Their answers reveal the stand that companies have chosen on each factor.

5.1.1 The companies' postures

Sydkraft

1. On nuclear power: The company does not believe that further decommissions of nuclear power facilities will take place in Sweden. This belief is based on the fact that if Sweden is to comply the Kyoto protocol targets, further decommissions of nuclear power are not possible. Decommissions of nuclear power will take place according to technical procedures based in the lifetime of the plants. Hence, older nuclear plants will be decommissioned first. However, decommissions will start after 2030. Barsebäck decommission will depend on political will, but decisions will be delayed until the energy sector finds alternatives that let them compete on the Nordic Market. If Barsebäck nuclear plant is decommissioned in December, Sydkraft will suffer no lack of energy, due to the negotiations with the government, which gave the company the same share of energy in other nuclear plants.⁵⁸
2. On renewable energy capacity: At present the company is developing activities related with increasing the renewable energy capacity. Since 1970, the company have invested in renewable energy, on the one hand, to learn about the use and costs of technology, and on the other hand, to reduce political pressures on the use of nuclear power. According to the points of view from some interviewees⁵⁹ Sydkraft invested in wind to reduce the political pressure on the use of Nuclear power. On early 1970s, Sydkraft had a big share on nuclear power and a little share on hydropower. The strategy to reduce the political pressure was to build some demonstrative projects in wind power. Afterwards the firms invested in demonstrative projects in biofuels based energy production, which consisted in changing production from fossil fuels to wood products. This last project was successful and the payback period was reduced to three years, hence, energy production based in biofuels was increased because of its profitability. Today's production of electricity from renewable sources is 0,1 TWh. Future investments will be in the participation of the wind power project in Denmark and the construction of a CHP plant in Malmö. The wind farm project in Denmark will not affect the renewable energy generation in Sweden, hence, is not possible to demonstrate compliance from the electricity certificates point of view. According to these facts, the company is taking some measures on increasing renewable energy capacity. Nevertheless, the company will make no additional investments on renewable energy if there is no extra support to build new capacity. At present, electricity certificates do not bring incentive enough for new investments. The production vice-president⁶⁰ bases this behavior in the fact that even though technologies could be profitable in the future the investments on these technologies are made at today's prices. Hence, decision-makers will consider present return on investment before than looking at future conditions.

⁵⁸ Interview with Mr. Leif Josefsson. A transcription of this interview is at appendix C.

⁵⁹ Interview to professor Rolf Henrickson and Mr. Leif Josefsson. A summary of this interview is at Appendix C.

⁶⁰ Interview with Mr. Gert Lyngsjö. Transcription of this interview at Appendix C.

3. On carbon dioxide emission reductions: Sydkraft has very low carbon dioxide emissions at present. Total carbon dioxide emissions in Sweden account for 55Mtonnes. Emissions from electricity and district heating systems account for 9Mtonnes from which Sydkraft represents 10% of the emissions (1Mtonnes). Improvements on technology have been made, especially in heat production, passing from oil and coal generation to biofuels energy production. Hence, new improvements will be done in the medium-term when economic conditions make feasible to invest in those changes. The company considers that the government will impose no additional targets to energy utilities with the tradable emissions permits system implementation in 2005. To reduce the impacts of tougher targets in the future, Sydkraft is in the process of licensing a Combined Cycle Gas Turbine (CCGT) plant, which will produce 300MW electricity and 400MW heat. If the government imposes tougher targets in carbon dioxide emissions reduction, like reducing a 4% the emissions based in the ones produced in 1998 – 2001 period, the company will need to increase the pace of building the Malmö facility. And, if more permits are needed to show compliance, these permits will be produced in facilities abroad where is easier to reduce emissions. A final alternative to cut down emissions in Sweden is to import energy from Denmark or Germany through the submarine cable that the company owns. At present, the capacity of the cable is used almost completely but the company is discussing an expansion by connecting an additional cable, joining Sweden with Germany.
4. Use of fossil fuels: Sydkraft has little fossil fuels based energy production. If prices of fossil fuels increase, that increase will affect all the energy industry increasing all prices of fossil fuels based electricity. This increase in prices will affect positively Sydkraft that base its production in hydro and nuclear power. Hence, Sydkraft will have more revenues for the electricity supplied. Whether the prices of fossil fuels decrease the company won't be affected.

Vattenfall

1. On Nuclear Power. The first problem with the disclosure of Barsebäck nuclear power plant will be the lack of energy and, as a side effect; there will be a problem of balance in the energy production since the most of the current electricity generation is located in the north part of the country. To solve this problem the government should invest in improving the electricity grid. The lack of energy will correspond to 5 TWh per year. This lack of energy must be supplied again to the Swedish energy market and any of the players of the Nordic electricity market can supply it. At present, Finland is planning to build a Nuclear power facility and Norway is planning to build a natural gas based power plant. Finally, the lack of energy will be fulfilled by new capacity generated in the Nordic energy market.
2. On renewable energy capacity: Vattenfall claims to be a pioneer in the field of biomass energy generation accounting for 0,18 TWh of electricity generated by this mean. Additionally the company has invested in wind power accounting 0,046 TWh. Representatives of the company think that in the mean time the actions to take are those that represent the least cost, which at present are a higher use of biofuels and conversion from oil to biofuels generation plants. However, these options are applied today to a high extent, and there is a little margin for further electricity generation from these sources. Decisions on building capacity on other technologies will be delayed until they become profitable or a further support is placed to invest in them. The company has started a project to develop alternatives for solar energy in Nordic countries, together with Sydkraft.

3. On reduction of CO2 emission: The company produces 900 thousand tones of carbon dioxide, which is a very low quantity of emissions compared with the electricity the firm produces. If additional targets are imposed to the current production the firm can bring permits from Poland or Germany where it is cheaper to produce the emission permits.
4. On Fossil fuels use: The current capacity technology allows few modifications for reducing fossil fuels use. If prices of fossil fuels increase the company will result benefited of the situation due to its little fossil fuels based production.

5.1.2 Summary of the current companies' postures

According to the postures and moves that companies can take in the four factors, explained in chapter 3.1, the companies' strategies can be defined as illustrated in Table 5-1.

Table 5-1: Postures and moves adopted by Sydkraft and Vattenfall's current strategy

	Sydkraft	Vattenfall
1. Decommission of Nuclear Power	Shaper: They have solved their reduction on energy production by negotiating with the government the same amount of energy from other nuclear power plant.	Adapter: The Nordic energy market will solve the situation.
2. Electricity certificates	Reserving the Right to Play: CHP plant Malmö additional need of certificates will be taken from the market. Additionally, the company is making investments in research and development in solar power. Further needs of certificates will be obtained in the certificates market.	Reserving the Right to Play: investments in biomass fuelled powered plants and wind power. Additional investments in R&D in solar power are taking place. Further needs of certificates will be obtained in the certificates market.
3. Tradable emission Permits (TEP)	Reserving the Right to Play: Investments in a CCGT plant and a CHP plant in Malmö. Further needs of permits will be obtained in the TEP market.	Adapter: Further needs of permits, if any, will be obtained in the TEP market.
4. Fossil Fuels Use	Adapter: Increase in fossil fuels price will put the company in a better position versus the Nordic competence. Decrease in prices will not affect the firm	Adapter: Same argument as Sydkraft.

The second stage is to define the moves companies will take on each posture. For this purpose, companies' representatives were asked about changes in the current strategy if after 2010 the situations on the proposed scenarios occur. Next section shows the result of the moves.

5.2 Moves that companies will take according to the proposed scenarios

Sydkraft

1. On nuclear power: There is no need to plan a closure. According to the negotiations taking place in this moment it is not viable to close any more reactors. If it happens, at that moment the company will start to plan further actions. Sydkraft will produce the same amount of nuclear power that has been producing until now. Additional capacity will come from the CCGT and CHP projects.
2. On Electricity Certificates: Sydkraft is not planning for a further increase in renewable energy. A stringent regulation on electricity certificates will not change the company's decision. The possibility of an international market will affect positively the investment's decision allowing investments in wind power. Investing in additional capacity renewable energy capacity is interesting only if the company can make money out of that.
3. On tradable emissions: Sydkraft has very little emissions in comparison with its competence, so it is difficult to think in tougher targets in emission reductions for the company.
4. On fossil fuel use: Sydkraft will not be affected by fluctuations in fossil fuel prices.

Vattenfall

1. On nuclear power: There is a low probability that further decommissions of other nuclear power reactors will take place. If that happens the whole Nordic market will be aware to supply that capacity. With the projects to be built in Finland and Norway it is possible that no additional capacity will be required.
2. On Electricity Certificates: It is not realistic that in the future stringent targets will be imposed, considering the current possibilities for increasing the renewable energy capacity. Additionally, an increase in capacity will depend on the consumers' willingness to pay for the renewable energy.
3. On tradable emissions: If Kyoto is or is not ratified or if tougher, or relaxed targets are imposed on the energy sector, the company will have to adapt its decisions to the market conditions.
4. On fossil fuel use: Vattenfall will not be affected by fluctuations in fossil fuel prices.

5.2.1 Summary on the companies' reactions to different scenarios

According to the postures and moves that companies can take in the four factors, explained in Chapter 3.1, and the scenarios depicted in Chapter 3.2, the future companies' strategies can be defined as illustrated in Table 5-2.

Table 5-2: Sydkraft and Vattenfall's future actions on the four factors

	Sydkraft	Vattenfall
1. Decommission of nuclear power plants	Options: Out of the question. The company is not planning for further decommissions. No additional capacity in nuclear power	No regret moves: The Nordic electricity market players will deal with the supply of energy
2. Electricity Certificates	Options: if renewable energy becomes profitable the firm will invest on it.	No regret moves: Swedish society will need to define their willingness to pay for more renewable energy
3. Tradable emission Permits	No regret moves: Emissions in both companies are lower than other companies in the Nordic market and Europe.	
4. Fossil fuels use	Non regret moves: The share in the use of fossil fuels is low in both companies, thus, variations in the price can only affect positively the firms.	

In summary, Sydkraft is planning a shaper posture with options moves on nuclear power having in the future the same amount of energy production they have today but thinking on investments in new power capacity. Vattenfall has an adapter posture with no regrets move based on the market behaviour in the future. In electricity certificates Sydkraft has a reserving the right to play with options moves planning investments of new CHP capacity and investing in research and development on photovoltaic power. Vattenfall has a reserving the right to play posture with no regrets move investing in research and development, increasing the use of biomass and waiting for future conditions in the market. In tradable emission permits, Sydkraft has a reserving the right to play posture with no regret moves based on the investment in the CHP plant. Vattenfall has an adapter posture with no regret moves. Both companies think that future permits needs will be obtained from investments abroad. Finally Sydkraft and Vattenfall have an adapter posture with no regret moves on fossil fuel use due to the little use of it, letting the companies to take advantage of an increase in prices.

5.3 Conclusion: Implications of the postures and moves

1. On nuclear power

Not planning or planning poorly the actions on decommission of nuclear power could bring a dependence on the power produced abroad. Sydkraft seems to believe that no decommission of nuclear power will take place. Vattenfall seems to believe that any lack on power will be replaced with power from other countries

Companies will not take further actions because they believe in the negotiating power they have. Further nuclear power plants decommission will depend on the Swedish society will for a cleaner energy production. Sydkraft and Vattenfall believe that Swedish society have understood that nuclear power is a clean way of power generation. If it comes further decommissions, additional to Barsebäck, the most suitable way to replace the lost power is by the use of natural gas. However, the use of natural gas will increase the CO2 emissions of the companies and will place the country in a non-compliance position of the Kyoto targets. This

double way relationship supports the beliefs of the companies on no further nuclear plants decommissions. Therefore: this position of the companies is not supporting decisions in increasing renewable energy capacity nor reductions on fossil fuels use.

2. On electricity certificates

It is difficult to estimate where the compliance with the 2010 targets for renewable energy generation will come from. Companies will invest in renewable energy capacity when the support to build it will be high enough to make profitable to invest in such technologies. There are two possibilities:

- 1) Companies will wait for increasing the capacity until prices of certificates raise enough to support the decision on investment. If this happens, all companies will invest at the same time, prices will go down and all the support will be reduced.
- 2) Sydkraft and Vattenfall (and maybe Fortum) will decide not to invest and others will install the capacity. If this happens independent entrepreneurs will raise the required capacity.
- 3) Government will decide to change the definition of renewable energy and large hydropower will be considered as a renewable energy source. In this case companies will have very little to do to reach compliance.

In conclusion: companies do not see the electricity certificates as an additional support for increasing the renewable energy capacity. They will wait until prices raise enough and make profitable to build any renewable energy solution.

3. On tradable emission permits

If government decides to impose targets on emission reductions to energy utilities, according to the Kyoto protocol flexible mechanisms, companies will find compliance of the tradable emission permits targets where that were cheaper to get, which is in other countries than Sweden. Therefore, Sydkraft and Vattenfall do not feel that tradable emission permits bring an incentive to make them reduce carbon dioxide emissions.

4. Use of fossil fuels

The fossil fuels use in Sweden is low and the emission reduction policy will be the only constrain to reduce its use. However, companies will see themselves benefited for an increase in prices and they will be indifferent to a decrease in price due to the fact that Sweden is one of the countries with the lesser use of fossil fuels. Therefore, additional measures should be taken if the objective for the country is to reduce the fossil fuel use to cut down the dependence on fossil fuels, increasing the capacity on renewables, or to reduce CO2 emissions.

6. Conclusions and Recommendations

The relevance of the carbon dioxide emission consequences made Europe to assume the target proposed by the Kyoto protocol of 8% reductions from the 1990 levels by the compliance period 2008 – 2012. To accomplish these reductions at the lowest economic cost for society, the Kyoto protocol created three flexible mechanisms (Clean Development Mechanism, Joint Implementation, and Tradable Emission Permits), being the tradable emission permits the one to be applied within developed nations. Furthermore, European Union nations agreed to increase the existing renewable energy capacity with the purpose of cutting down the dependence from non-renewable sources of energy and to reduce carbon dioxide emissions. Different instruments are being used for this purpose being the green certificates model the one that brings economic advantages similar to the tradable emission permits.

Sweden has started a green certificates model called “electricity certificates system” and, simultaneously, the country is preparing the conditions for the European market on emissions trading to begin in 2005. In Sweden, the main stakeholder affected by the operation of the two instruments is the energy sector, where Sydkraft and Vattenfall produce 70% of the country’s electricity. Therefore, the research question formulated in this thesis was: What are the strategic implications of the implementation of the tradable emission permits and electricity certificates for Sydkraft and Vattenfall?

To solve the research question, a field of analysis was used comprised of: the Environmental economics and law field and within this field a sub-bundle studying the flexible mechanisms, the energy sector in Sweden, and the strategic environmental management field. With the aim of understanding how the two mechanisms are working, the environmental economics and law looked into the EU conditions for emission reductions and promotions of renewable energy initiatives, and the way Sweden implemented this measures into the country’s regulation. The flexible mechanisms field looked into the economic theory to develop command and control measures, green taxes, tradable permits and green certificates with the purpose of defining the key elements on each instrument. The energy sector in Sweden presented the main stakeholders and the composition of the production of energy in the country with the purpose of elaborating on the possible consequences of the two mechanisms in the country. Finally, the strategic environmental management field discussed the way firms create their strategies, the schools of thought in strategy formation and the alternatives companies have to analyse the strategies under uncertain conditions, with the intention of creating a framework to analyse the strategies of companies with reference to the two instruments.

The methodology proposed brings a framework to analyse the strategies of the firms under the uncertainties that the tradable emissions permits and the electricity certificates presented to the companies. Furthermore, it was proposed to analyse two additional factors closely interrelated with the two mechanisms under analysis in the research question: decommission of nuclear power and fossil fuels use on energy utilities. The next step was to ask to key companies’ representatives for the strategies the companies are thinking to follow on each one of the factors. Finally, key representatives were asked about the strategy of the company if the future conditions on the factors follow the trend of the two possible scenarios to happen after 2010 created for this purpose. This approach permitted to develop conclusions about the strategic postures and moves that companies will take on tradable emission permits and electricity certificates.

The analysis determined the strategic postures and moves that companies could take on each one of the factors. The results are that the phase out of Barsebäck second reactor was considered for Sydkraft who negotiated with the government the restitution in other nuclear plant of the same share they currently have on Barsebäck. On this topic Vattenfall thinks that the future conditions of the market will cope with the lack of energy due to the nuclear plant decommission. In electricity certificates both firms have made investments on renewable energy and, at present, are investing in research and development of new technology in this field. However, their position looking to the future is no investments in increasing capacity unless it is profitable to do it, thus, if the conditions are not met they will rely on the electricity certificates market. On tradable emission permits, both companies think that reducing even more the current emissions is too difficult and costly since they have done a significant effort in past years, therefore, the requirements in permits will be fulfilled by bringing them from abroad where it were they are cheaper to obtain it. Hence, companies will rely in the international emission permits market not by producing emission reductions in Swedish energy plants. On fossil fuels use, it will not be altered because of changes in prices since both companies have a reduced use of fossil fuels and have an advantage in the market because of this.

6.1 Conclusions about the research question

The research question proposed was:

What are the strategic implications of the implementation of the Emissions Trading System and the Electricity Certificates System for Vattenfall AB and Sydkraft AB?

The question can be solved in two steps. The first one is a summary of the strategic decisions of the companies according to the key representatives point of view. Based on these decisions one can infer their implications.

The strategic decisions on tradable emission permits that companies will follow are: in the short run, for the fulfilment of the requirements in carbon dioxide emission reductions, emission permits will be purchased from other countries, or flexibility mechanisms, where there is a lower cost to generate those permits. The countries able to produce those emission permits are Germany and Poland, according to the answers given by the firms' representatives. In the medium term, carbon dioxide emission reductions within Sweden are achievable through natural gas and no further nuclear power decommissions.

The strategic decisions on electricity certificates that companies will follow are: in the short run Sydkraft and Vattenfall will rely in the certificates produced by the renewable energy facilities currently operating in Sweden. In the medium and long term the companies will rely on independent entrepreneurs if prices of certificates do not raise enough to reach the profit's margin these companies use to manage. Hence, the initial hypothesis that energy utilities with the bigger energy production will be the first ones that will invest on renewable, energy does not correspond to the answers given by Sydkraft and Vattenfall.⁶¹

The strategic implications of the implementation of both flexible mechanisms in Sydkraft and Vattenfall are:

⁶¹ Birka Energy AB was the third large energy producer in Sweden with 14% share in 2001. In 2003 Birka was sold to the Finish Fortum. Therefore, it could be expected that Birka will behave as Sydkraft and Vattenfall on generation of new renewable energy capacity in Sweden.

- *Few investments in both fields.* Energy utilities will act as adapters in their strategies when new investment proposals are being evaluated, especially for increases in renewable energy capacity and changes to the production technology to reduce carbon dioxide emissions. Therefore, investing in new capacity is a risky activity that companies will not take unless they see a very good business in it. It means that independent entrepreneurs, who produce nearly 16% of the total electricity in Sweden, are called to make the new developments in renewable energy.
- *A loss of Opportunities.* Initially, Norway is thinking to adopt an electricity certificates system similar to the Swedish one in 2005. Secondly, the RECS system is increasing in members and the countries involved now have a protocol to convert national electricity certificates to RECS. The European commission and the European council of ministers are discussing to bring a directive to establish a tradable green certificate system. Hence, it is possible that in the next seven years, a certificates system will be implemented in Europe. Finally, eastern European countries, entering to the union, will have to comply with the union directives. Therefore, it will be an opportunity to build, on the one hand, new capacity based on the experience obtained and, on the other hand, sell electricity certificates or RECS to these countries, so these countries can show compliance with the EU regulations.
- *A strategic disadvantage for not taking early moves.* A “wait and see” strategy can lead Sydkraft and Vattenfall to lose the opportunity of being the first mover on this market allowing other utilities to gain in experience and performance in the industry. By increasing the renewable energy capacity, both companies will become less dependent on external sources of energy (i.e. nuclear or fossil fuels), which will bring a self-sufficiency advantage to those firms investing in renewables, even if neither does Norway nor the European Union decide to create a green certificates system. It could be said that increasing the renewable energy capacity is a win-win situation. Concluding, the faster a company invests in renewable energy, the faster the company will receive revenues from it, and the faster they can explore new opportunities.

Potential savings of the two systems when implemented together

Will electricity certificates help on the quest to reduce carbon dioxide emissions in Sweden? From the perspective of Sydkraft and Vattenfall, the answer is negative. Companies will continue their production as usual and the sales part of the company will look for certificates in the market. This means that companies are not looking for reducing their current production based on fossil fuels but only to fulfil the government requirements in electricity certificates.

Will carbon dioxide emission reduction targets help to attain the renewable energy targets? In past years the carbon dioxide tax made utilities use biofuels, especially wood, to a higher extent. Most of the biofuels were used in the heating sector and some CHP plants which were modified to use biofuels as an alternative fuel. At present, energy utilities argue that their emissions are one of the lower in Europe. Thus, no further targets should be imposed on them. If targets on emissions permits are imposed or increased, the Vattenfall and Sydkraft approach would be to buy certificates from abroad. In any case, the cost of the permits will be added indirectly to the cost of the electricity and the permits to buy are few compared with the competitors in Denmark, Norway or Finland. Hence, the customer will not feel the difference in the electricity price. At the end, no further renewable energy capacity will be built to reduce carbon dioxide emissions. Concluding, the two systems in

Sweden are working in parallel and there are no possibilities to link them to improve the performance of achieving these targets in the short run, neither in the long run.

6.2 Implications for theory

The Swedish electricity system represents an exception case to the tradable emissions permits system. Energy utilities in Sweden have a privileged position on carbon dioxide emission reductions. Nowadays, energy utilities in Sweden count with one of the lower emissions in Europe. Under these circumstances at least, Sydkraft and Vattenfall does not fear negative consequences of the emission reduction targets. If, because of the Kyoto protocol, energy utilities around Europe increase the price of energy, Swedish energy utilities will welcome these measures. If additional targets on emission reductions are imposed to Swedish energy utilities, the increase in price of electricity will help to pay the target requirements. Finally, on the variables mentioned in Chapter 3.1 the target on emissions is not a threat for Swedish utilities, quite the opposite, they can fulfil emission permits requirements from their own companies in Germany and Poland. The marginal abatement costs are only relevant if utilities are planning to reduce emissions to a high extent. Power plants conversion to natural gas or wood based power is a cheap solution that they have been implementing in last years. These power plant modifications can make utilities to fulfil the requirements on site. Otherwise, bringing permits from abroad is still a solution. The permit price will influence electricity price, in this case, a solution was drawn before.

For energy utilities in Sweden, a better position in the energy market is difficult to attain following only external factors. The positioning school says that the strategies to achieve a better position in the industry are cost leadership, differentiation and focus. Energy utilities in Sweden, and in the Nordic countries, have developed these strategies to a large extent. Cost leadership has been developed through the liberalised market and the Nordpool as its most important tool. Prices of energy in the Nordic countries are the lowest in Europe. Obtain a better position based on prices is possible by a reduction of the taxes and charges imposed by the different countries in the Nordic electricity market. At present, there is an initiative to homogenise taxes and charges in the Nordic countries and around Europe. Differentiation presents better characteristics of the products. In The Netherlands companies claiming to supply green energy obtained an advantage over their competitors. However, they have a 4% share in RES-E and no large hydropower. In the Nordic countries the energy supplied is based in hydropower, to a large extent (50% in Sweden, 99% in Norway and 20% in Finland). Hence, the differences between the Netherlands case and the Nordic countries conditions make it difficult to have a similar successful result in the Nordic countries as it happened in the Netherlands. Finally, a focus strategy is not suitable for energy utilities because of a bigger market represents economies of scale for them and, additionally, the liberalised market implemented in Europe is making utilities to reduce the prices imposed to end users.

Energy utilities that strengthen their internal resources can obtain a competitive advantage in the future, but the present strategy of the firms does not let them consider this possibility. Following Hart, the Resources Based View establishes three steps to follow for companies to achieve an above average performance in the industry: pollution prevention, product stewardship and sustainable development. Swedish energy utilities had strengthened their capabilities in reducing fossil fuels use, however, there is a long way ahead to replace nuclear power. Hence, a pollution prevention strategy is still a goal to achieve. Sydkraft and Vattenfall's representatives argue that Swedish customers have understood that nuclear power is a clean energy source, however, they are aware that no new nuclear power

capacity will be allowed in Sweden. These two arguments bring a future paradox when nuclear power facilities reach their maximum lifetime, in 20 or 30 years, and a decision on phasing them out have to be made. However, by that time, energy utilities expect that the market itself will bring solutions to replace those facilities. If the scope is reduced to fossil fuels use, Swedish energy utilities are able to obtain a better performance than the European energy industry due to their reduced carbon dioxide emissions. However, the challenge of increasing capacity on renewable energy is not yet fulfilled. Thus, to obtain a better performance than the firms within the industry, energy utilities have to consider increasing renewable energy capacity. This advantage will give them an environmental product stewardship. Not investing in renewable energy will bring, as a consequence, being out of the decisions of a Pan-European model of green certificates. Finally, a sustainable development advantage will occur when, the green certificate model is extended worldwide, and in the same way it happened with the Kyoto protocol.

6.3 Implications for policy

The electricity certificates model is not bringing support to an increase in renewable energy capacity in Sydkraft and Vattenfall because of the de-regulated market the firms are involved in. As explained in Chapter 3.1 the main elements of the electricity certificates model are: 1) the price of the spot market for electricity. 2) The renewable energy target measured in percentage of the electricity delivered to users, which depicts the demand for electricity certificates at the same time; 3) The supply curve representing the cost of the different renewable energy technology alternatives; and 4) the penalty price which represents the maximum price of the certificates.

Let's start a discussion with the last topic: the penalty price. The model has determined the penalty prices as the price that must be paid by users and suppliers that do not fulfil the quota obligation by purchasing certificates. It corresponds to 150% of the average price of the certificates in the year but not greater than 175SEK/MWh in 2004 and 240SEK/MWh in 2005. These prices are taken from the SOU 2001:77 report⁶², where with a spot price for electricity of about 300SEK (475SEK of support in total). There will be incentive enough to increase the renewable energy capacity in approximately 5,7TWh, according to Table 2-1. However, even though prices of certificates have been near this level, energy utilities are not planning for further increases in renewable energy capacity. This is because the investment costs and the payback time of the investments do not bring incentives to build new capacity. Hence, as proposed by Sydkraft and Vattenfall representatives, energy utilities will prefer to pay the penalty price instead of investing in new capacity. Finally, there are two solutions to this dilemma. The first one is to increase the penalty price to levels that energy utilities find interesting (or dangerous) not to invest in renewable energy capacity. The second one is a bigger market of electricity certificates, which bring incentives to invest due to the large opportunities available. This last means a Pan-European green certificates market.

Morthorst⁶³ proposes that, initially, the renewable energy targets should be near the installed capacity and slowly increase the target. Sweden has followed this model. However, a yearly increase in the target does not imply an increase in the renewable energy capacity. To raise a renewable energy project takes approximately two years, according to the utilities representatives. Additionally, the liberalised market is reducing the possibilities of investments, as it was mentioned before.

⁶² (Näringsdepartementet, 2001)

⁶³ (Morthorst, 2000)

The Nordpool has become the place where companies find the higher prices to sell electricity and the cheaper prices to buying it. In the future is also expected that electricity certificates market will be included into the operations that the Nordpool offers. Concluding, the deregulated market, and the Nordpool as its main instrument, have skewed the long term planning of the energy utilities making them more cautious to present circumstances making them to take a “wait and see” frame minded for future conditions. Additionally, the deregulated market have increased the uncertainty in the market preventing companies to take long term commitments, moderating investments through risk management analysis.

The current de-regulating scheme makes companies to look for short payback periods on investments. In contrast, investment in renewable energy on the medium and long term, for instance, wind power, is usually calculated with 25 years payback time. Therefore, the difference in time approaches makes not interesting the investment in renewable energy technologies unless support for the investment on these technologies other than the mere electricity certificates. Otherwise, companies run the risk of “living poor and dying rich”

For the sake of exemplification, the recent prices of electricity certificates have varied from 60 to 220SEK per certificate. If they are added to the average spot price of selling electricity to the Nordpool, the total income per MWh is 520SEK. This support should be enough to make energy utilities invest in renewable energy sources, other than small hydropower, according to the calculations of the energy agency⁶⁴. However, a decision does not come up since, under the current market conditions, 25 years is a very long payback time. Therefore, to make a decision on investment in wind power, the price of the certificates and the prices of energy on the spot market should be much higher to reduce the payback period. How much higher should increase the price of certificates? It will depend on the profit margins and the interest rates on investments that energy utilities are managing.

If Sweden is to achieve its goal to reduce its carbon dioxide emissions by 4% lower than its emissions were in 1990 by the own country means, as proposed by the government, the carbon dioxide tax should not be reduced or removed because of the entrance of the tradable emissions permits system. At present, the carbon dioxide tax is not imposed to electricity generation. Hence, its scope is reduced to the heating sector. For promoting emission reductions within the heating sector, the available options are the emissions trading and the carbon dioxide tax. The current proposal on the two schemes is to reduce the carbon dioxide tax while increasing the target on tradable emissions permits. As stated before, energy utilities are planning to buy emission permits from abroad to cover emissions reductions requirements in Sweden. To avoid an increase in emissions, the government should balance the reductions on the carbon dioxide tax with an increase in the emission permits target to be fulfilled by the heating sector.

However this is a difficult task since the prices of emission permits vary in a range from US\$1/tonne of CO₂ emissions reduction (from CDM or JI projects) to US\$50/tonne of CO₂ emissions reduction. Thus, at the lowest permits price, energy utilities will find an incentive to maintain or increase the use on fossil fuels. The same effect will occur if the carbon dioxide tax is taken away or reduced from heat producers and no additional targets on emission permits are imposed. If the tax continues and no additional targets on emission permits are imposed, energy utilities will continue the trend they are doing until now. If the tax continues and targets on emission permits are imposed to energy utilities, the required

⁶⁴ (Näringsdepartementet, 2001)

permits for showing compliance will be bought from abroad. In conclusion only the carbon dioxide tax bring incentives to reduce emissions from the heating sector.

No nuclear power plants decommissions in the future. The Barsebäck second reactor decommissions is not feasible in the short run. Decommission of the nuclear plant has been delayed until the economic conditions in the energy market are met. Under the liberalised energy market, competence will hold the lowest prices to satisfy customer needs. As discussed early, new developments in energy capacity are difficult to attain and energy utilities are not planning new investments. Hence, a new capacity that replaces the lack of energy from Barsebäck decommission will not be feasible in the next seven years in Sweden. Thus, Barsebäck decommission will bring incentives to the Finish nuclear plant projects and the Norwegian natural gas power plant, leaving Swedish energy utilities in a market disadvantage. Perhaps, the most affected with the decommission is the state owned Vattenfall, since Sydkraft has negotiated with the government a substitution of the energy lost in Barsebäck with a share in other nuclear power plant. Additionally, an early decommission of Barsebäck will bring an incentive to build up capacity based in natural gas, which will increase the Swedish carbon dioxide emissions. As argued by Sydkraft and Vattenfall, if Sweden is to comply with the Kyoto protocol targets no further nuclear power decommissions can occur. Concluding, as remarked by Mr. Leif Josefsson, actual nuclear plants will not be phased out after 2010, nor in 2020, and in 2030 they will still be in operation; and for 2030 only those plants which have finished their life time will be phased out.

Fossil fuels prices increase will benefit Sydkraft and Vattenfall. An increase in prices of fossil fuels will benefit Swedish energy utilities since other utilities, more dependants on fossil fuels, will need to increase energy prices, increasing at the end the overall prices in the market.

A Pan-European model in green certificates is required. A bigger market of renewable energy technologies, additional support for research and development of these technologies at the European level and more opportunities to deal with certificates is required in order to reduce costs on technologies and finding more possibilities for new projects. According to the utility representatives and government officials' answers, if in 2010 there are no other countries involved in a certificates system, the Swedish system will finish because "Sweden can not be an island" and maintaining the system will bring over costs to users and a reduction in the competitiveness conditions for Swedish utilities.

Time pacing Vs. Event pacing. Eisenhardt and Brown⁶⁵ made a difference in how companies assume businesses. Event pacing refers to those companies that wait until there is an opportunity for a new business and take long periods to make decisions. While time pacing refers to those companies that develop their own pace to make businesses by developing alternatives for future markets, orchestrating transition periods, and delivering new products before anyone else in the competence can do it. On this context, time pacing becomes a resource of the firms that make them inimitable. Looking into the conclusions of this research, one can say that energy utilities in Sweden are involved into an event pacing way of making business. This happens because of the position that they currently hold in the European energy market. E.g. Sydkraft and Vattenfall holding 70% of the electricity share in Sweden or both companies (considering that Sydkraft makes part of the E.On group) are located among the five largest utilities in Europe, place them in a unique power position. Additionally, recent events like the de-regulated market in 1996, the decommission of

⁶⁵ (Eisenhardt & Brown, 1998)

Barsebäck first reactor in 1999, the decision on the carbon dioxide burden sharing among European countries in 2001, and the start of electricity certificates market in 2003, have led their behaviour, making them cautious to new events. The next challenges for energy utilities will be to reduce dependence of fossil fuels, maximising the efficiency of the existing plants and create new sources of energy. The company able to reach these challenges will win the race for the second period of compliance, starting in 2010 for electricity certificates and 2012 for the Kyoto protocol.

6.4 Limitations

Country limitation. The boundaries chosen limited the scope companies have on the flexible mechanisms use. The research was limited to Sweden because in the context of the Nordic countries was the only one who had implemented a green certificates model and have joined to the initiative of the European emissions permits market. However, the boundaries of the energy markets are different. On the one hand, the Nordpool comprises the markets of Finland, Norway, Sweden and Denmark. On the other hand, Vattenfall produce energy in Sweden, Finland, Germany and Poland and Sydkraft, now owned by the German E.On, produce energy in Sweden, Norway, Denmark, Germany and Poland. Therefore, was difficult to obtain from the companies answers to focus the attention on the Swedish conditions. On electricity certificates the companies were more oriented to those countries that finance or subsidise the investment in technology, which are Germany and Denmark, under this perspective the electricity certificates have removed the incentives to raise the renewable energy capacity in Sweden redirecting it to Germany and Denmark.

Company limitations. Time limitations restricted the scope to Sydkraft and Vattenfall. A broader view of the industry would include the association of the energy industry and the association of renewable energy producers. The last one is subdivided into production sectors, i.e. wind power producers association, which makes time demanding to include them all. Additionally, Sydkraft and Vattenfall compete on the same markets, so the representative's answers tend to be broad when analysing the general behaviour of the energy sector. Specific strategies are under development and the tendency is to not reveal the next step to be taken by them. Hence there was a limitation to the access of detailed information.

6.5 Implications for further research

Through the research was seen that the restriction of the research question to the Swedish conditions on electricity certificates and tradable emission permits do not qualify the whole panorama of the companies involved. An enhanced view of the Nordic energy market is needed to determine how possible are the solutions on increase of renewable energy capacity and reduction of carbon dioxide emissions. A new research question could be: what are the strategic implications of the use of the electricity certificates system and tradable emissions permits on the bigger energy utilities in Sweden, Denmark, Norway, Finland, Germany and Poland? This question will summarize the strategies of the Nordic electricity market and will show the trend and possibilities that renewable energy technologies have.

Additional emphasis should be put in developing the internal capabilities of energy utilities to deal with the two instruments. This research looks into the external factors that determine the possibilities of increasing renewable energy capacity. However, those companies that made their bets on reducing fossil fuels use to accomplish the targets have created an internal structure that make them inimitable. A research on the strength of these companies proposes

challenges to those who did not take the same strategy. To capture the values inside those companies will help to broaden the alternatives of all companies in the energy sector.

The conclusions obtained in this research were obtained through interviews to relevant representatives in Sydkraft and Vattenfall. The use of tools like *“the balanced score card,”* in these two specific fields is needed to obtain relevant figures on the companies’ performance.

Bibliography

- Allen, S. (2002). Getting out of Europe at exactly the wrong time. *Electric Perspectives*, 27(6), 58-60.
- Boots, M. G., Schaeffer, G. J., Zoeten, C. d., Mitchell, C., Anderson, T., Morthorst, P. E., et al. (2000). *INTRACERT: INCEPTION REPORT - The role of an integrated tradable green certificate system in a liberalising market* (No. ECN-C--00-085): EU Commission.
- Courtney, H. G., Kirkland, J., & Viguerie, P. (1997). Strategy under uncertainty. *Harvard Business Review*, 75(6), 67-81.
- Eisenhardt, K. M., & Brown, S. L. (1998). Time pacing: competing in markets that won't stand still. In *Harvard business review on managing uncertainty* (pp. 175 - 201): Harvard Business Review.
- Energy Information Administration. (2003, March 13). *Residential Heating Oil Prices: What Consumers Should Know*. Retrieved August 18th, 2003, from http://www.eia.doe.gov/pub/oil_gas/petroleum/analysis_publications/heating_brochure/heatbro.htm
- Environmental media services. (2003, august 19th). *Summaries of climate action network's cop-6 positio*. Retrieved August 19th, 2003, from http://www.ems.org/climate/CAN_positions.html
- EU Commission. (1997). *White paper for a community strategy and action plan - energy for the future: renewable sources of energy*. (No. COM (97) 599 final). Brussels.
- EU Commission. (2000). *Towards a European strategy for the security of energy supply* (No. EU/COM(2000) 769 final). Brussels, Belgium: EU Commission.
- European Commission. (2000). *Towards a European strategy for the security of energy supply* (No. COM (2000) 769 final). luxembourg: Directorate General for Energy and Transport.
- Faber, T., Green, J., Gual, M., Haas, R., Huber, C., Resch, G., et al. (2001). *Promotion strategies for electricity from Renewable Energy sources in EU countries*: EU Commission.
- Field, B. (1994). *Introduction to Environmental Economics*.
- Green-X project. (2002). *Green-X: Deriving optimal promotion strategies for increasing the share of RES-E in a dinamic European electricity market*. Retrieved 13 may, 2003, from <http://www.green-x.at/>
- Hart, S. L. (1995). A natural resource based view of the firm. *The Academy of Management Review*, 20(4), 986-1015.
- Jensen, S. G., & Skytte, K. (2002). Interactions between the power and green certificate markets. *Energy Policy*(30), 425-435.
- Klaassen, G., & Söderholm, P. (2002). *Wind Power in Europe: A Simultaneous Innovation-Diffusion Model*. Retrieved October 18, 2003, from https://www.gruponahise.com/eaere2003/PAPER_5/5C_3SODE.doc
- Kwant, K. W. (2003). Renewable energy in The Netherlands: policy and instruments. *Biomass and Bioenergy*(24), 265-267.
- Lemming, J. (2003). Financial risks for green electricity investors and producers in a tradable green certificate market. *Energy Policy*(31), 21-32.
- Mavrakis, D., & Konidari, P. (2003). CLASSIFICATION OF EMISSIONS TRADING SCHEME DESIGN CHARACTERISTICS. *European Environment*, 13, 48 - 66.
- Meyer, N. I. (2003). European schemes for promoting renewables in liberalised markets. *Energy Policy*(31), 665-676.
- Mintzberg, H. (1978). Patterns in strategy formation. *Management Science*, 24(9), 934-938.
- Mintzberg, H., Ahlstrand, B., & Lampel, J. (1998). *Strategy safari: a guided tour through the wilds of strategic management* (Vol. The free press). New york.

- Mintzberg, H., Quinn, J. B., & Ghoshal, S. (1999). *The strategy process* (Vol. Revised European edition). Essex, England: Prentice Hall.
- Morthorst, P. E. (2000). The development of a green certificate market. *Energy Policy*(28), 1085-1094.
- Morthorst, P. E. (2003). National environmental targets and international emission reduction instruments. *Energy Policy*(31), 73-83.
- Nielsen, L., & Jeppesen, T. (2003). Tradable Green Certificates in selected European countries - overview and assessment. *Energy Policy*(31), 3-14.
- Näringsdepartementet. (2002). *Cooperation for a secure, efficient and environmentally friendly energy supply* (No. 2001/02:143). Stockholm, Sweden: Swedish Ministry of the Environment.
- Näringsdepartementet. (2001). *Handel med elcertifikat - ett nytt sätt att främja el från förnybara energikällor* (No. Sou 2001:77). Stockholm: Näringsdepartementet.
- Priddle, R. (2000, March 15, 2000). *Climate Change and energy policy: the challenges for Sweden*. Paper presented at the Swedish Energy Administration Seminar, Eskilstuna, Sweden.
- Ribeiro, T., Greeuw, S. C. H., Asselt, M. B. A. v., Grosskurth, J., Storms, C. A. M. H., Rijkens-Klomp, N., et al. (Eds.). (2000). *Cloudy Crystal Balls*. Copenhagen: European Environmental Agency.
- Robbins, G. (1995). Scenario Planning: A strategic alternative. *Public Management*, 77(3), 4-8.
- Swedish Energy Agency. (2002a). *The electricity market* (No. ET 10:2002). Eskilstuna: Swedish Energy Agency.
- Swedish Energy Agency. (2002b). *Energy in sweden 2002* (No. ET 20:2002). Eskilstuna: Swedish Energy Agency.
- Swedish Environmental Protection Agency. (2002, 10 October 2002). *Energy systems of the future*. Retrieved July 30th, 2003, from <http://www.internat.naturvardsverket.se/>
- Swedish Ministry of the Environment. (2001). *The Swedish Climate Strategy* (No. 2001/02:55). Stockholm: Swedish Ministry of the Environment.
- Swedish National Energy Administration. (2001). *Energy and Climate in Sweden: Scenarios 2010* (No. EB 2:2001). Eskilstuna, Sweden: Swedish National Energy Administration.
- Sydkraft AB. (1999). *Power 2050: a vision of a sustainable electricity system in Sweden*. Malmö, Sweden: Sydkraft AB.
- Tietenberg, T. (1992). *Environmental and Natural Resource Economics*. New York.
- UNDP. (2000). *World Energy Assessment: Energy and the Challenge of Sustainability*. New York: UNDP.

Abbreviations

EPA	Environmental Protection Agency
Nordpool	Nordic Power exchange market place
GHG	Green House Gases
Watt	
Watt-hour	
kWh	kilo Watt hour. . a thousand watt hour
MWh	Mega Watt hour: a million watts hour
GWh	Giga Watt hour: a billion watts per hour
TWh	Tera Watt hour: a thousand billion watts hour
TWh/year	Tera Watt hour per year
GDP	Gross Domestic Product
RBV	Resources Based View
CCGT	Combined Cycle Gas Turbine Plant
CHP	Combined Heat and Power Plants
GHG	Green House Gases
TEP	Tradable emission permits
EC	Electricity certificates
TREC	Tradable renewable energy certificates
TGC	Tradable green certificates
GC	Green certificates
LPG	Liquid Petroleum Gas
EU	European Union
RES-E	Renewable Energy Sources for Electricity
RECS	Renewable energy certificates systems
CDM	Cleaner Development Mechanism
JI	Joint Implementation
BAU	Business as Usual
ETS	Emission Trading System

Appendices

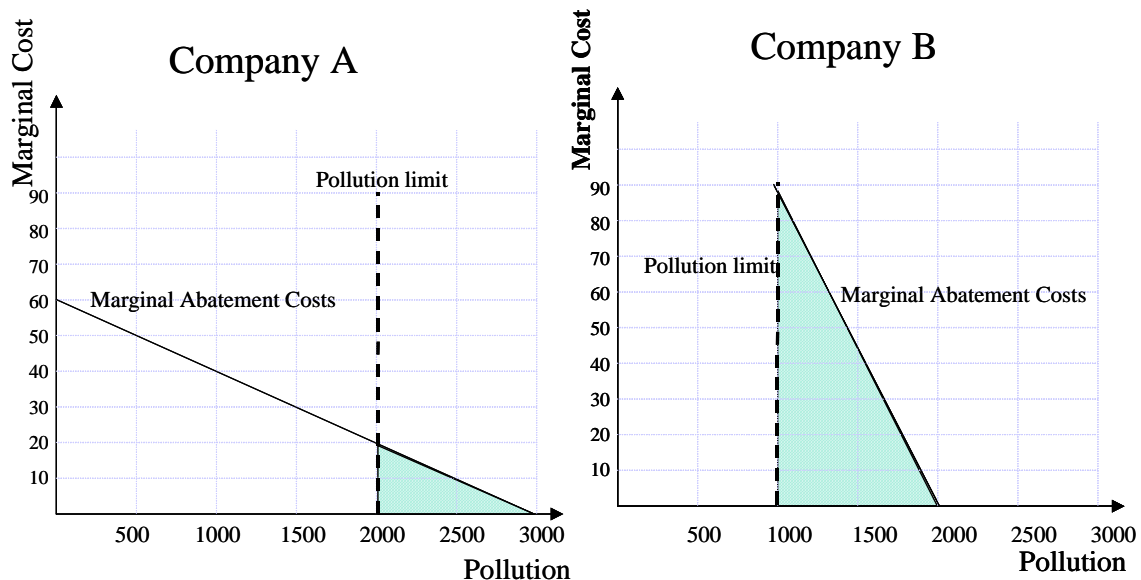
Appendix A

Command and control, green taxes, tradable permits and green certificates

For the sake of exemplification let's suppose that in a certain region exists two companies that produce a total pollution of 5000 units and their cost of reducing the pollution per unit are different. Figure A-0-1 shows that company A is emitting 3000 units of pollution, additionally; the cost for the company of reducing their whole emissions is 60SEK per unit. For company B, reducing its emission by one half have a cost of 90SEK per unit.

Assume that government decides to reduce to 3000 units the overall emissions of the companies. So, given the fact that government hardly knows the marginal abatement costs, the reduction of 2000 units will be split in two equal parts, imposing a reduction of 1000 units to each company. The effect of this decision is presented in Figure A-0-1. Company A have reduced from 3000 to 2000 units while company B reduced from 2000 to 1000. However, the cost of compliance of the two companies is different. Company A have a cost of compliance equal to 10 000SEK while company B bears a cost 45 000 SEK (Shaded areas in Figure A-0-1). In this case the policy imposes different costs to the companies and the total cost of compliance will be 55 000SEK.

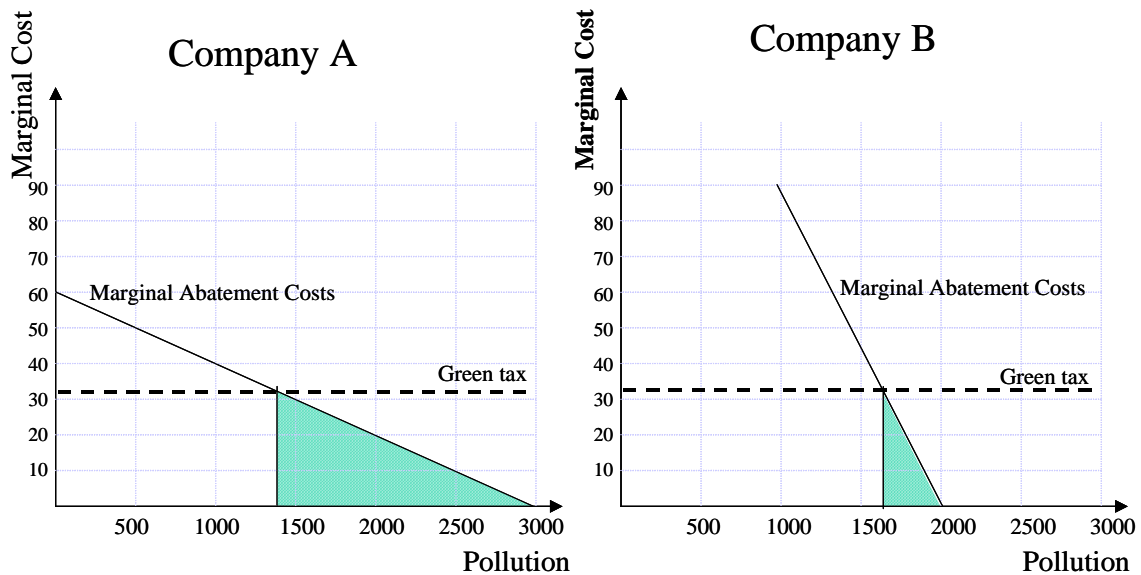
Figure A-0-1: Command and control



For reducing the cost of compliance but still reach the same target in reduction of emissions a green tax brings an additional incentive. The green tax fixes a charge per unit of pollution emitted. In the example if the polluter is imposed with a tariff of 49,1SEK per unit of pollution emitted the polluter will look into its costs and take a decision about investing in an abatement technology or implement a cleaner production alternative that leads them to reduce their emissions. The emissions will be reduced until the investment in technology is the same as the cost of compliance. Figure A-0-2 shows that on a level of 32,7SEK per unit of reduction, company A will make a reduction of 1636,6 units of pollution while company B

will only reduce 363,6 unit of pollution and the total reduction is still 2000 units. However, the costs of each plant are 26 777SEK and 5 950 respectively, so, the total cost paid for both companies is 32 727SEK and total saving is 12 272SEK.

Figure A-0-2: Green taxes



In the tradable permits each unit of pollution is now called a permit. Now all companies are required to demonstrate a certain amount of permits. In case they can't demonstrate the needed amount of permits the companies are obliged to pay for the pollution that emitted and is not correctly supported by permits. In our example let's just say that companies are required to present to the authorities 1000 permits. Company A have lower costs of reduction and can produce 636 additional permits to the 1000 required by legislation, and company B is lacking of certificates. The cost of the additional permits for company A is 16 777SEK, while the cost that company B is willing to pay for the remaining permits produced by company A is 39 049SEK (shaded areas in Figure A-0-3). Both parties can meet each other and through a process of bargaining they will set a price for the additional permits. Let's suppose that the final price in the bargain was 32,7SEK per permits, which is the price for company A of producing the 1 636 permits. So company A will receive 16 777SEK for the certificates and finally its cost of reducing the 1 636 unit of pollution will be 10 000SEK (26 777- 16 777SEK). Company B will have to pay for the additional permits so their cost of compliance will be 22 727SEK, 5 950 coming from the production of 364 permits plus 16 777SEK from the cost of the additional permits. Additionally, Company B made a saving of 18 223SEK (Area abc in Figure A-0-3) if they didn't produce the 636 permits by their own means. The final cost for company B is then 22 727SEK; however, discounting the potential savings their cost is 4049SEK. The total cost of the pollution reduction made by means of the Tradable Permits is then the costs of the two companies after savings, which is 14 504SEK, a smaller cost than the one under green taxes.

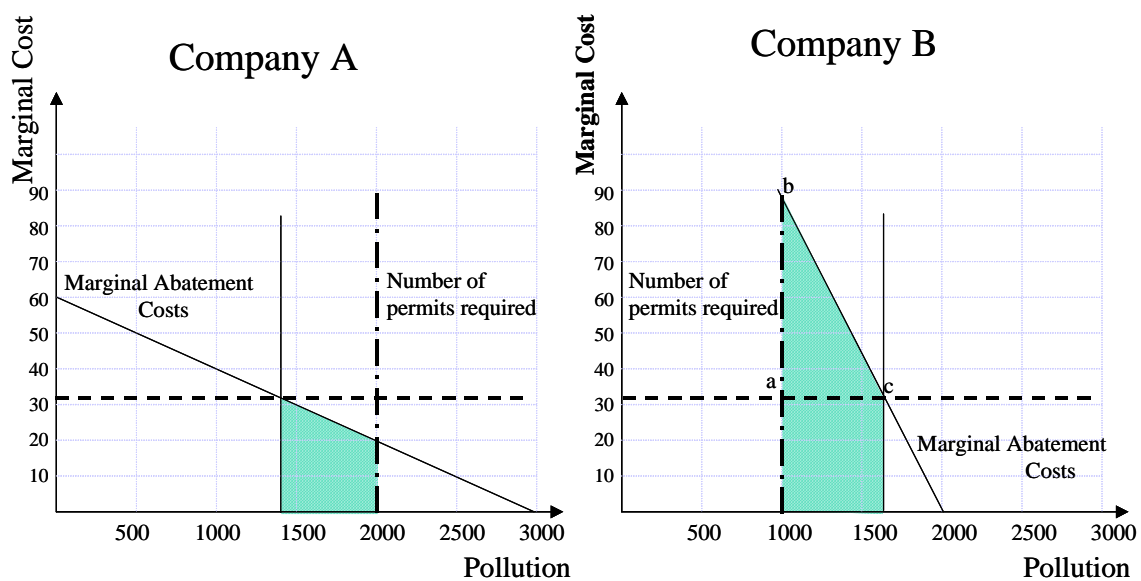
The aim of green certificate markets is to introduce conditions of market competition into the production of green electricity for technologies that are not fully competitive. A political determined target for Renewable Energy consumption drives the demand for certificates while the supply is driven by renewable energy producers that receive one certificate for each unit of energy dispatched to the grid. The certificate is then sold to consumers who need to demonstrate their share of renewable energy consumption. The supply is divided in two

curves. The first one is proposed by the previous established renewables corresponding to the marginal cost of renewable energy production. The spot market and the price of the certificates influence the renewable energy production. Thus, in the short run, producers will be willing to sell certificates if the price of the certificates plus the price of the electricity at the spot market are, at least, equal to the minimum price. If the supply follows the short run curve, the demand for certificates will increase the price until they reach the penalty payment, giving an incentive to other producers to generate new electricity. In the long run (Long Run Marginal Costs Curve (LRMCC)), new certificates will be generated until their price reaches the equilibrium price at PGC. A problem with this scheme is that under shortage of Renewable energy, the price of the certificates increases but with surplus will fall.

Depending on the conditions of the system, investor will value the risk of investing. Banking and borrowing could give a possible solution.

Figure A-0-4 shows the behaviour of the market. The demand for green certificates is expected to be inelastic since the government requires a quota for the share of renewable energy⁶⁶ (Demand for GC's, in the figure). Alternatives for making more elastic the demand have been proposed in cases of imposing a price cap and giving banking opportunities⁶⁷. In the Danish system a minimum price is settled to secure that the extra price of the production of Renewable Energy is reached. A penalty price is settled for consumers that don't fulfil their targets. If the price of the certificate is higher than the penalty price consumers will prefer to pay the penalty.

Figure A-0-3: Tradable permits



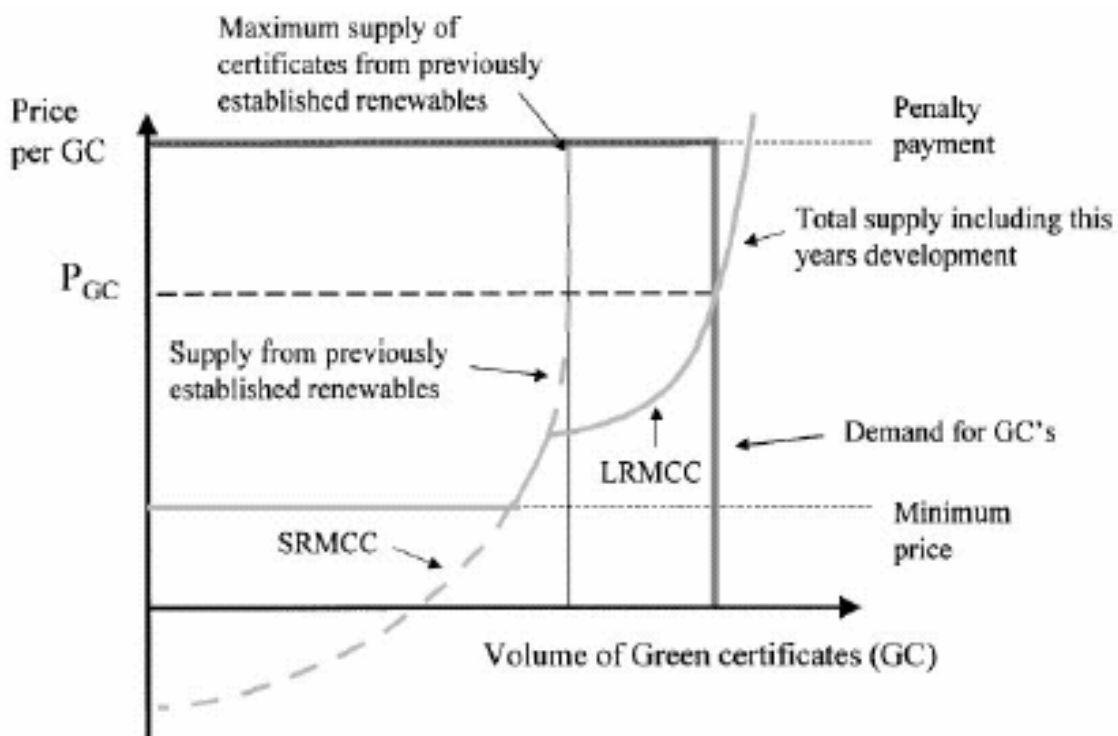
The supply is divided in two curves. The first one is proposed by the previous established renewables corresponding to the marginal cost of renewable production. The spot market and the price of the certificate influence the renewable energy production. So, in the Short Run producers will be willing to sell certificates if the price of the certificate plus the price of

⁶⁶ The figure is based in an annual market. In this period consumers are supposed to acquire no more than the actual requirement of the government. Additionally it is assumed that price determination is transparent, hence, there is no speculation.

⁶⁷ (Nielsen & Jeppesen, 2003)

the spot market for electricity are, at least, equal to their short run cost⁶⁸. In the Danish case they will sell if both prices are at least equal to the minimum price. If the supply follows the short run curve, the demand for certificates will raise the price until they reach the penalty payment giving an incentive for other producers to generate new electricity. In the long run (Long Run Marginal Cost Curve (LRMCC)) new certificates are generated until the equilibrium price at P_{GC} . A problem with this scheme is that under shortage of RE the prices of the certificates raise but with surplus will fall. Depending on the conditions of the system, investors will value the risk of investing. Banking and borrowing certificates could give a possible solution⁶⁹

Figure A-0-4: Demand and Supply at green electricity market



Source: (Morthorst, 2000)

Calculation of the costs of compliance under Command and Control

Cost of compliance of the C&C policy for Company A = $(3000-2000) \times 20/2 = 10000$

Cost of compliance of the C&C policy for Company B = $(2000-1000) \times 90/2 = 45000$

Total cost of compliance of the C&C policy = $10000+45000= 55000$

⁶⁸ (Morthorst, 2000). The Short Run Marginal Cost Curve (SRMCC) could even be negative if the price of the spot market is higher than the production costs.

⁶⁹ (Lemming, 2003)

Calculation of the price and pollution reductions of the companies under Green taxes

$$y_A = 60 - 0,02x_A$$

$$y_B = 180 - 0,09x_B$$

$$y_A = y_B$$

$$3000 - x_A + 2000 - x_B = 2000$$

$$y_A = y_B = 32,72; x_A = 1363,63; x_B = 1636,36$$

Reductions made by company A = $3000 - 1363,64 = 1636,34$

Reductions made by company B = $2000 - 1636,36 = 363,64$

Total reduction made for both companies = $2000,00$

Abatement cost for company A = $AC_A = (1636,34 \times 32,72) / 2 = 26777,07$

Abatement cost for company B = $AC_B = 5950,46$

Total abatement costs = $32727,51$

Difference with the C&C system = $22272,5$

Calculation of the advantages under Tradable permits

Cost of compliance for 1000 permits = $C_A = (3000 - 2000) \times 20 / 2 = 10000$

Total abatement cost of generating 1636,34 permits (Company A) = $26777,07$

Costs of generating the additional permits = Minimum amount of money to receive from company B for the additional permits = $AC_A - C_A = 16777,07$

Cost of compliance of generating 1000 permits (Company B) = 45000

Cost of compliance of generating 363,64 permits (Company B) = $AC_B = 5950,46$

Willingness to pay for the additional permits = $45000 - 5950,46 = 39049,54$

Total cost of compliance buying the additional permits = $5950,46 + 16777,07 = 22727,53$

Total Savings for company B = $45000 - 22727,53 = 22272,47$

Appendix B

Questionnaire

Juan Carlos Caycedo
MSc candidate
Policy and Environmental Management
International Institute for Industrial Environmental Economics – IIIIEE
Lund University

Strategic implications for Vattenfall/Sydkraft on the use of electricity certificates and tradable emission permits

Agenda

Introduction

- Thesis Objectives
- Questions to addressed

Current Strategy

- On Closure of Nuclear Power Facilities;
- On Tradable emission permits;
- On Electricity certificates;
- On Fossil fuel use.

Drivers for each one of the approaches;

Possibility for going beyond compliance on each approach;

Annexes

Set of questions

Drivers that defines position of the company in 2010

Scenario 1: continuation of the electricity certificates system and stringent targets for emission reductions

On Phase out of nuclear power

Near disclosure of Barsebäck second reactor

Stringent policy after 2010

On electricity certificates

Open market in Europe for trading green electricity

Tougher policy on increase in capacity of renewable energy

Reduction of the costs of renewable generation technology

Possibility to bring green electricity to eastern European countries

On tradable permits

Tougher restrictions on emissions reductions for 2012 – 2020

Possibility to sell emission reductions to Finland and other Baltic countries

On Fossil Fuels use

Increase in fossil fuel prices

Tougher regulation on emissions reductions

How these drivers will change the current strategy of the company?

Scenario 2: end of electricity certificates and relaxed targets in carbon dioxide emissions for the second period of compliance

On Disclosure of nuclear power

Delay on the disclosure of Barsebäck second reactor

No stringent policy after 2010

On electricity certificates

Finish of the electricity certificates system

Reduction of the costs of renewable generation technology

Possibility to bring green electricity to eastern European countries

On tradable permits

Tougher restrictions on emissions reductions for 2012 – 2020

No Possibility to sell emission reductions

On Fossil Fuels use

Decrease in fossil fuel prices

Similar conditions on regulation on emissions reductions

How these anti drivers will change the current strategy of the company?

Positioning

Do you think that going beyond compliance on the current targets for renewable energy and emissions reductions will bring to the company a better position in the market in 2010? Why?

Set of Questions

- How much have the company invested in Renewable energy? When? What was the motivation? What is the installed capacity on each project? What are the future projects? What are the current sales of energy? How the company have fulfilled the requirements in certificates?

- How much the company have invested in carbon dioxide emissions reduction? When? What was the motivation?
- Do the company have a record of their CO2 emissions?
- Do you think that the disclosure of Barsebäck second reactor will propose a challenge for Vattenfall? Is the trade of energy through the Nordpool a way for reducing the independence from the own generation of energy?
- Under which prices of electricity certificates you will decide to invest in RES-E? Which level of prices will make you to be uncertain? Which level will make you definitely not to invest?
- Under the grandfathering allocation system of tradable permits, will Vattenfall have to buy or produce permits for its own compliance?
- For your requirements in Sweden are you expecting to bring CDM or JI permits? Are you in line with the purposes of the Swedish government of reducing 4% of the CO2 emission without help of other instruments?
- How much of the energy that the company sell comes from the Barsebäck nuclear plant? How much of the energy is electricity and how much is heat? How much time does it takes to build capacity enough for recovering the losses from the disclosure of the reactor?
- How much does it costs to reduce the emissions in a 4% from the 1990 level? Can it be easily afforded by the reduction on fossil fuel? What consequences it will bring to reduce emissions to that level?
- What is the reduction in fossil fuel for 1% of reduction in CO2 emissions?
- How much have been your CO2 emission reductions since 1990?

CORPORATE STRATEGIES

On Nuclear power

What are the projects the company is investing for covering the lack of energy if the Barsebäck second reactor is closed?

On Fossil fuel use

Assuming that: 1) prices of fossil fuels (coal, natural gas, petrol) are the same as today's level; 2) the government imposes a target of 4% in CO2 emissions; 3) The level of the CO2 tax is the same as today is; and 4) the prices of energy in Europe don't change in a large extent.

- Will the company invest in changing the fossil fuel sources of energy to cleaner ones? What are the options the company is thinking? To what extent (TWh)?

According to government forecasts the prices of energy in Sweden will increase due to the shortage on water in the water dams

- What will be the consequences of this increase in electricity prices in the context of the de-regulated market in the Nordic countries?

On electricity certificates

- What are the expectancies of the company on electricity certificates after 2010?
- Is there any plan for increasing Renewable energy capacity? What technologies the company have chosen? Why?
- How much does it cost to the company reaching the 17% of energy share target for 2010 if the company were to fulfil the requirement by its own means?
- Will the company reach the target by its own means? Or the firm is relying in the market of electricity certificates

On tradable permits

- How are (Sydkraft/Vattenfall) thinking to fulfil the CO2 target in Sweden?
- What's the compliance cost if the company decides, by its own means, to reduce emissions until reaching the target?

SCENARIOS

Under the assumption that your company would like to invest in renewable energy

On Nuclear Power

- How much (in TWh) will your company increase its installed capacity of renewable energy if the Barsebäck second reactor is closed by the end of 2003, as was originally planned?
- What other sources of energy will the company invest in?
- How much of the energy will be bought in the Nordpool?

On fossil fuels use

Now lets assume that the prices in fossil fuels increase in a 10 to 50% of today's price.

- What are the actions that the company will take in the short run?
- If prices continue on that level, what are the actions in the long run? There will be an increase in capacity of renewable energy?

If prices of fossil fuels decrease in a 10 to 50% of today's price

- What are the actions that the company will take in the short run?
- If prices continue on that level, what are the actions in the long run? There will be an increase in capacity of renewable energy?

Now, let's assume that the target for the energy utilities is 2% and the prices of fossil fuels are the same as today

- To what extent the company will invest in a change of fossil fuels to other sources of power?

Now, let's assume that the CO₂ tax is reduced, the CO₂ target is 4% and the prices of fossil fuels are the same as today

- To what extent the company will invest in a change of fossil fuels to other sources of power?
- What will be the decisions if the CO₂ target is reduced to 2%?
- What will be the decision if the prices of fossil fuels decrease in 10 to 50%?

If, as a consequence of the de-regulated market of energy in the Nordic countries, the prices of energy decrease

- What will be the company's decisions about investment in renewable energy?

On electricity certificates

The relevant variables to take into account are: Prices of certificates, the cost of technologies, the penalty price, prices of energy at the stock market.

- Do the company thinks that, after 2010, the renewable energy policy will be tougher? Will it motivate the company from now on to make a higher investment in RES-E?
- What are the decisions of the company if, in the long run, prices remain very close to the penalty price? What if prices are higher? Will the decision on investing in RES depend on the evolution of the certificate prices?
- What could be the decisions of the company if the prices of certificates are lower than the penalty price? 20% lower? 30%? 40%? 50%? More?
- If in the next 3 years, the costs of renewable energy (sunk costs) decrease by 20% to 30 %, will the company be motivated to invest in renewable energy? What could be the possible investment level?
- What is the investment in Research and Development of Renewable energy (as a percentage of the net income)? How many pilot projects on renewable energy are proposed to build in the next 4 to 7 years? Does this projects correspond to the company's will of reducing cost of learning how to manage this technologies in the future?

- How will affect the decisions on investing in renewable energy a reduction in the spot price of electricity? How will affect an increase in the spot prices?
- (Optional) What will be the decisions of the company if in the long term the costs of technology and the spot market prices of electricity decrease while the certificates prices remains high?

On Tradable emission permits

The relevant variables to take into account are: The cost of technology (Marginal abatement costs), the compliance costs, the target level and the price of permits.

- What the company expects to be the future of the emissions permits after 2012?
- What will be the decisions of the company if the prices of certificates are higher than the compliance cost? Will the company wait to the development of the permits prices to take a decision on investment?
- If prices of permits are lower than the compliance cost, will the company invest until the compliance target? What will be the level of reductions the company expects to reach? Will the company expect to invest until the marginal cost equals the permits price? Will the company rely in the tradable emissions permits market for reaching compliance?
- What will be the decisions of the company if costs of abatement decrease in the next three years 10%? 20%?

Appendix C

Interviews

Summary of the Interview with Rölf Henricksson

August 11th, 2003

Objective: To know the strategic positions of Sydkraft around the issues of tradable permits and green certificates

Q: Motivations of Sydkraft for increasing capacity in renewable energy

A: Pressures

Ministry: Decommission of Nuclear power

Ministry and NGO for investing in RE

The investment was made for showing that the company was working with renewable energy. However, biomass for heating was very profitable. Investing in biomass had a payback in 3 years. The investment in Wind power was symbolic, but became profitable when Swedish NGO implemented energy as a “good environmental choice” label for energy consumption so other products was labelled. Sydkraft has a licence of 1TWh good environmental choice

Q: Incentives for going beyond compliance

A: No incentives due to the internal division of the company. Companies relying in Good Environmental Choice (GEC) electricity buy directly from Sydkraft. Lot of electricity is sold directly to the costumer through GEC

Q: Decommission of the Barsebäck second reactor

A: First import from Germany through EON through the cable from EON to Sydkraft. Replacement with natural gas. No facilities for biomass. Only one cogeneration plant. Also import from Norway (Statskraft)

Q: where the electricity certificates will come from?

A: Importing

Increase in wind

Biomass only on heat

Q: use of biofuels

A: Replacing Barsebäck by gas will increase emissions

Only option is Karlsonvagningen the largest oil condensing facility

Q: It's possible that at present Sydkraft has reduced enough to achieve compliance by means of the CO2 tax?

A: If Sydkraft in Sweden needs permits to show compliance is possible that the permits will come from the EON installations at Poland.

Q: Do companies will go beyond compliance on emission reductions and renewable energy capacity?

A: They will go to compliance and no more. Otherwise there should be a very good carrot

Carrots: enhanced market, additional electricity for reducing dependence of fossil fuel, nuclear power decommissions. Disincentives: Prices of certificates will go down, Nuclear power might be disclosed for 2030.

Summary of the interview with Thord Nicklasson

Swedish National Energy Administration

Tuesday 12th, 2003

Objective: Evolution of the electricity certificates market in Sweden

Q: Behaviour of the electricity certificates

Prices have changed from 93 and 220SEK/MWh

Obligations for 2003 (penalty price) are 175SEK/MWh. On the top of that companies need to add taxes ($175/0.72=243.05$) which is the final cost of certificates

Q: Is there enough projects for covering the target?

A: Is impossible to forecast in this moment. Is expected that utilities raise projects in biofuels and wind power. Is expected that there will be money for building wind farms but it is not known when these projects will be built or how they will be financed. Biofuels, CHP, Sydkraft plan to build a power plant, probably change from heavy oil to biofuels. In the period 2004 – 2010, since is a very short time to built new capacity, maybe what it will happen is a conversion of plants with the support of the electricity certificates.

New hydropower will be built.

With regard to CHP plants, some of them were supported by the government and still there's more potential for more reductions.

Q: What will happen with the obligation for energy utilities of presenting the certificates of their costumer after the next year?

Industries and users that want to deal with their renewable energy obligations will need to make a registration of their company/user to be able to deal with electricity certificates. In this way possibly energy utilities will reduce the certificates they need to present to the authorities. In this moment is impossible to know how many users will deal with the obligations by themselves.

Q: How the government considers that the electricity certificates system is supporting the targets on carbon dioxide emissions?

Each new kWh from renewable replaces 1kWh of energy production of fossil fuels

Q: What will happen electricity certificates after 2010

Depends on the market development. The system should be completed to more possibilities of a bigger market. Maybe in October 2004 will be completed a treaty with Norway. There are two control points one on 2004 and the second one on 2008. After the evaluation, the government will decide what will happen with the certificates. If the evaluation is bring positive results the government will increase the target to 15TWh/year of renewable energy share.

Summary of the interview with Thomas Levander

Swedish National Energy Administration

Wednesday 13th, 2003

Objective: Point of view of the government around tradable permits and electricity certificates

Q: Prices of certificates in the future

In the long term it will be necessary to have a price of 1.5 öre/kWh. 2004 will not be representative because the dry year on 2003. The higher the electricity price, the lower the certificate price. For a normal season the electricity price will be 25 öre/kWh implying that the price of certificates will be 1.5 öre/kWh (15SEK/MWh???) in order to fulfil the users obligations. The TEP market will be opened in 2005, that will affect the prices of certificates. Q: How affects the regulation of electricity market?

High prices of electricity low cost of certificates

Q: Where will compliance come from on electricity certificates?

Some utilities are investing in RES. No other certificates like RECS will intervene with the Swedish target. However, there's a project between Norway and Sweden that could be possible.

The EA is evaluating if the target in 2010 will be fulfilled. The most recent projection shows that it is possible to increase from 10 to 15TWh.

Q: Incentives for going beyond compliance?

Faster growing electricity price

Q: Disclosure of NP and reducing dependence on fossil fuels

Depends on the target for CO₂ emission. If the target is high it will be an incentive.

Q: Allowance for energy utilities on CO₂

The advice from the FlexMecs2 delegation is a carbon dioxide reduction of 24 Million tons per year. They will allocate emission considering the period 1998-2001 based on historic emission. The allocation method is Grandfathering.

Q: Future of electricity certificates

Will exist after 2010. The signal to the market is that it is worthwhile to invest in new technologies.

With the closure of Barsebäck's second reactor Emissions will go up by a million tons of CO₂ not necessarily in Sweden but in the northern part of Europe.

Q: Do Sweden rely more in the market than on its own generation?

Yes. But considering the dry years, Sweden should generate much more of its own electricity.

Q: How will the CO₂ tax affect energy utilities?

The CO₂ tax has not affected electricity production but heat production.

Summary of the interview to Mark Storey
Swedish environmental protection agency
Section for evaluation and environmental economics
Wednesday 13th, 2003
Objective: Ask for the evolution of the emissions reductions in Sweden

Q: What will be the role of the CO₂ tax after 2005?

A: There is still no decision on what will happen with the CO₂ tax after the Emissions Permits market will be implemented. Some sectors are proposing to remove completely the tax while other positions propose a reduction of the tax level.

Q: Why the government choose a reduction of 4% of the CO₂ emissions?

A: It is possible that the government wants to bank the emissions for relaxing the targets in the second period of compliance.

Q: What will be the target for energy utilities?

A: By the moment there is no decision about the distributions of the emissions target among the different sectors of the industry. In March 2004 the Swedish government should present to the European commission the burden for the different sectors. At present the Flex Mecs commission in Sweden is studying what could be the possible target for different sectors.

Q: What will happen with the emission trading system after 2012?

The more realistic scenario can be the continuation of the European emissions trading with similar target for the next period of compliance. In the mean time, companies will move slowly to the target waiting for the development of the market.

Q: what are the incentives of the companies to go beyond compliance? Companies will base their behaviour in the market?

A: Market signals will be decisive for the behaviour of firms. Going beyond compliance has two meanings. Going beyond compliance on the Kyoto targets is what companies are doing motivated by the regulation. Going beyond compliance on the Swedish targets it's unlikely for Swedish companies.

Summary of the Interview with Leif Westin
Sales representative, Vattenfall AB
June the 27th, 2003
Objective: To understand how the sales strategies of Vattenfall will be affected by the implementation of the two systems of certificates.

The interview started with a presentation of the objectives of the project. To the question about the investments of Vattenfall in renewable energy answering that the company has in the moment few investments in Renewable Energy and most of the energy is acquired from units of production in Sweden through the Nordpool. A new question was raised about how the Electricity certificates will affect the production of renewable energy answering is expected to grow however, in a first instance, Vattenfall will not invest on building RE capacity since the company is expecting to be more a buyer than a producer of certificates. Mr. Westin considers that the reason for this decision is that building a new Renewable Energy facility will take to Vattenfall from three to four years and then is difficult to calculate what could be the prices of the certificates and the payback of the investment. Anyhow, all

certificates will be acquired through the pool and will be the pool the responsible to fix the prices. Mr. Westin said that he is not in the production side of the company for taking decisions about raising the capacity of energy supply and the area in charge is the Supply and Trade Organization within the company and Mr. Klas Hedenström is the head of that group.

In the sales group the concern is to bring certificates to those companies that requires them. From this companies are excluded Pulp and paper, Mining and the Chemical industry. At present the certificates prices are 220SEK/MWh, which is above the calculated penalty price for the government. The reason for this high level price of the certificates is that whether energy utilities do not fulfil the quota of certificates they would pay the penalty price, but this cost should be deducted from the net profits after taxes, so, the penalty price plus taxes equals 242SEK. Whether the costs of the paying the penalty could be included into the total costs, the company would not pay taxes over this payment. Whether the certificates are bought before having to pay the penalty the cost of the certificates could be deducted from taxes.

The production group is dealing with the emissions permits. A recent study from the company shows that if prices of emissions permits are in the range of 5 to 10 €/Tonne the prices of electricity to consumers will rise from 2 to 7 €/MWh and the demand for energy will not be affected for this increase. Whether permits price rise to 20€/tonne the price for electricity will rise from 10 to 14 €/MWh and there is a possibility that the demand will be reduced in roughly 10%. According to the company calculations the price of certificates will be in the range of 5 to 10€/tonne. [This argument differs of the one given by Mr. Göran Svensson who thinks that the average price of certificates will be 20€/tonne].

A final problem when the two certificates be in place is that even assuming the cheaper addition to the price of electricity (2€/MWh) because of the cost of the lower price of emission permits (5€/tonne) and adding the actual price of certificates (220SEK/MWh \approx 22€/MWh) the resulting addition in price to electricity will be 24€/MWh that is still higher than the addition of 14€/MWh that will reduce the electricity demand 10%. Mr. Westin thinks that even increasing the prices in the calculated 24€/MWh consumers will pay for it. Only big companies with the ability to relocate their plant won't pay the additional cost.

Interview with Ulrika Bergström (sales) and Teresa Mattisson (production)

Sydkraft

June the 25th, 2003

Objective: Presentation of the project and involvement of the company in the project and understanding the structure of the company and the decisions made on the two kinds of certificates

The project objectives were presented to the two representatives of the company who agreed in present information that could be useful to the project under prior requirement. Additionally they agreed in helping in the construction of the scenarios. In case of absence of one of them, they will try to bring one person that could replace the one who goes.

Initially, the two representatives presented the company showing that Sydkraft has, in Sweden, production of energy in the fields of Nuclear, Oil, Heat powered by NG and Biomass and Combined Heat and power plants powered by peat. All the production is directed to the Nordic pool. In the oil fuelled plants Sydkraft has only a participation sharing the facility with the Swedish government. In Poland the company produces heat in plants powered by coal. In Denmark the company produces heat in plants powered by biomass.

The company will be a buyer of emissions permits and green certificates. The areas (Production and Sales) have different perspectives of the needs of each kind of certificates. The production area are looking reducing CO₂ emissions or buying emission permits at the lower cost, on the other hand, the sales area requires green certificates for providing it to their customers. There's not a coordinated strategy for the two certificates since all the trade takes place at the Nordpool. Although Sydkraft is looking for the maximization of the profits there is examples on a higher cost of production the company sold energy at lower prices since the price at the stock market was cheaper than the production cost. One of the remaining questions for the two areas is how to combine the objectives on certificates for gaining a competitive advantage in the market.

Questionnaire sent to Teresa Mattisson (production)

Sydkraft

June the 25th, 2003

Objective: Clarifying the drivers of the company for developing a strategy around the two types of flexible mechanisms

From the production point of view I would like to know about the pressures that are being put on Sydkraft.

1. We have talked last time about the closure of the Barsebäck nuclear power plant and it was defined that market should solve the situation. However, this is a solution for the sales part. I would like to know How will be affected the production of energy in Sydkraft with the closure of the nuclear plant? That decision will affect the overall sales to the Nordpool? Have Sydkraft thought in increasing the production capacity for compensating the closure of the nuclear plant?
2. Is there any pressure, from the political point of view, for increasing the capacity in renewable energy? Are there internal pressures inside the company for increasing the renewable energy capacity (due to the company strategy and R&D)?
3. According to the LCA brochure the production of energy from fossil fuels is roughly 2,5% (oil condensing, Gas turbines, Natural gas and biofuel/oil/coal), being the nuclear power the activity with higher CO₂eq emissions, followed by natural gas and cogeneration of biofuel/oil/coal. Last time we talked about the CO₂ permits was defined that Sydkraft will be a buyer of CO₂ permits: What will be the consequences in the energy production because of the need for buying CO₂ permits? What will be the consequences for the Swedish production (if it is possible to consider it apart)? Why is Sydkraft considering the investment in gas pipelines and gas based energy technology given the fact that they add a significant proportion of the CO₂ emissions?
4. How does the crisis in oil prices (and gas, LPG or other petroleum products) will affect the investment on energy production technologies by Sydkraft?
5. In the Netherlands, renewable energy was supported mostly by consumer's decisions for buying green electricity. Do you think that Sydkraft customers will require a higher production on renewable energy?
6. What are the expectancies in the prices of CO₂ permits that Sydkraft is considering? Under what level permits prices Sydkraft will take a decision of investing in other less pollutant technologies?

Answers

1. The production within Sydkraft was not affected due to the agreement with the Swedish state. In the agreement of Basebäck 1 the state gave Sydkraft corresponding power or owner shares in the other nuclear reactors so that the actual power output from Sydkraft was not changed. (They could do this by giving Sydkraft shares from state owned Vattenfall)

The effect on the market as a whole was not much either due to government subsidies during a number of years to increase RES power. This means that mainly a lot of CHP (biomass) ha

been built the latest years. The state also invested in the transmission system so that the capacity could increase and losses avoided.

The market will be affected if Barsebäck 2 is shut down, but in the agreement it is decided that before the closure of reactor 2 all the energy has to be replaced with new plants.

Sydkraft is seeking permission to build a CCGT plant in Malmö (400 MWe and 300 MWheat) and a biomass CHP also in Malmö.

2. Yes there is a political pressure. But the pressure is actually on the market/customers and not on the producers, through the certificate system. But when the market demand increases the prices on RES electricity rises and the incentive for the producers is high due to high prices to invest in RES.

On the heat side the incentive for the producer to invest in biomass based district heating is that you don't have to pay any CO2 tax.

I can not say that we have an internal pressure to invest in RES, but there is a strategic process going on to adapt Sydkraft to a sustainable company in the future and in a sustainable future RES are important.

3. The consequences in energy production due to CO2 -trade are really hard to say. My best guess at the moment is that it will not lead to any changes in production because the fossil base is so little. Since the LCA study our fossil dependent has decreased even further due to the incentive to not have to pay CO2-tax. But we do of course think in terms of mixing biogas in the natural gas to lower our CO2 emissions and so on. The most important effect of CO2-trade on the electricity sector is the fact that the overall electricity price will increase and for Swedish producers with high levels of hydropower and nuclear this will mean more than the fact that we might have to buy permits for CO2.

Sydkraft view on natural gas expansion is based on that natural gas is the only viable economical option in the future to replace nuclear. We believe that the energy system in the future shall contain a mix of RES and other technologies, neither is sufficient to support all the society with energy. For heat production, biomass is very good but it is a waste of resources when it comes to electricity production. Wind- and hydropower cannot provide enough electricity and as we see it, gas is, after that, the only option with the technology knowledge of today. Hopefully, in the future, there will be other technologies that can provide the needs of the society.

Even though we invest in natural gas the emissions in Sweden are very low.

4. The increase in price on fossil fuel is of course something we have to consider before future investment decisions are taken. But, again the use of fossil fuels is very low and it only comes in to the system in peak demand times and the price on electricity will just increase even more.

5. Sydkraft customers as well as almost all Swedish customers believe that the Swedish energy system already consists of mainly renewable sources (hydro) and most customers have a positive attitude towards nuclear. This means that very few are interested in buying Bra Miljöval or other labels of renewable energy.

6. We expect a price on CO2 between 5-10 euros/ton. This is not enough to invest in RES. Since every investment has to handle its own costs RES, needs an extra support or alternatively the CO2 prices have to increase enough so that the electricity price will rise to levels around the certificate price of today+ today's electricity price. I don't think this will happen for a very long time.

Summary of the interview with Gert Lyngsjö

Senior Vice President, Business Sector Production. Sydkraft AB.

Thursday 14th, 2003

Objective: Evaluation of the strategy on electricity certificates and emission permits on Sydkraft

Preamble from Mr. Lyngsho

Growing electricity

No new plants

There's a need for new capacity

Might be gas plant new CHP plant in Malmö (In license)

New Gas power plant in Norway

If disclosure of NP will be needed new capacity

No planning for new capacity... If Sweden is to comply with KP no plants could be disclosed

Planning for renewable energy... planning for wind and biomass (Malmö CHP with biomass) because with help of certificates make economic to build new capacity

e.g. Wind farm in Denmark don't generate certificates, but Denmark guaranteed the prices.

Q: How is Sydkraft planning to fulfil the target of RE?

A: It is planning to use more wind and biomass and solar

Q: What will be your position after 2010?

Drivers was shown

A: Sydkraft is working in analysis of the harmonization of the electricity market conditions in Europe

Nuclear power is not an issue. So Sydkraft is not planning for that.

Sydkraft is planning to trade emissions with Baltic countries and other countries in

Q: Drivers will be an incentive to increase capacity in renewable energy?

A: Yes. Sydkraft will have to react to the conditions. Depend on the politicians will.

Is an environmental question if Sydkraft wants to increase RES capacity?

It's hard to see the cost of the RES in the future. Without subsidies the RES capacity will not increase

Q: Position of Sydkraft after 2010

A: Part of the European system of energy

In Nordic countries 4th in Europe with EON one of the first

Q: What will happen under the less optimistic scenario?

A. On nuclear power, Sydkraft is negotiating with the government on the agenda for closure of Nuclear plants. So in this moment Sydkraft is not planning for the case of closure of Nuclear power plants.

If RES become competitive in the future, Sydkraft will invest in RES. The main presumption is that they will build capacity if the new plants can compete in the market.

There's a hard condition within the market due to the de regulation of the market.

Q: Sydkraft will only take present signals from the market

A: NO. The company need to forecast. Plants to be built will have 20 – 25 years of operation and the company so needs to forecast for the whole period. The company has a belief that better conditions will happen in the market.

The company needs to consider the cost of building today.

Sydkraft have 8% of the Nordic market of generation.

Q: Will the company plan to take a leading position in the field of green energy?

A: Only interesting if the company can make money out of that.

Q: Where will compliance come from?

A: If the company find a good business in RES, it will build more capacity. There are two positions: being net producers or net consumer of certificates. The company is not wanting to be a in any of the two sides. However everything the company will produce will sell it on the Nordpool.

Internally it exists also a market and the conditions are similar to the external market. There's no internal subsidizing. Maybe those who need the certificates can internally find a cheaper price but not too cheap

Q: What will do Sydkraft in case of a lack of certificates?

A: Sydkraft considers that there's not such a lack of certificates since in the backpressure from the pulp industry there is potential to get certificates. Sydkraft believes that there's a balance. But in the future, MAYBE there will be a lack and maybe then it could be good business to build capacity.

Otherwise the company will pay the penalty price.

If the expectation on the market price makes it profitable to build capacity, the company will increase it.

Q: Will Sydkraft take a leading position in renewable energy?

A: There is no leading position strategy but an active position if the conditions are met. Today, the company will wait and see for what the conditions will be
RECS

Sydkraft have sell biomass and hydro...

International exchange on certificates will have a positive support for RE

Summary of the interview with Mr. Göran Svensson and Mr. Bo Nelson

Göran Svensson Manager R&D and Environment

Bo Nelson

Vattenfall AB

August 20th, 2003

Objective: Current and future strategy of Vattenfall with respect to the two flexible mechanisms

Preamble: Situation of the energy sector in Sweden

Energy cannot be considered as a commodity like any other. Different to other commodities energy has too many stakeholders and the lack of energy represents a big nuisance for the society.

The deregulation of the energy market is taking place, at the moment, in Europe and especially in the Nordic countries, has no comparison with other experiences made in the world. Hence, it could be said that deregulation in Europe is a full-scale test to the European market. It is possible to say that in this moment, when the demand for energy is not growing at an accelerated pace and there is, in some countries, an excess of supply, the deregulation of the market is easier to implement. The aim of the deregulation is then to use the resources in an efficient way.

When the deregulated market was implemented in Sweden, the prices fell down and since then have risen slowly. The energy market crosses through different periods. The peak period represents high supply of energy and low energy prices while bottom periods imply the opposite for the energy market. Dry years imply bottom periods, however, in this moment the energy sector in the Nordic countries is crossing a peak period.

Q: How the company is preparing itself in case of a near decommission of Barsebäck and/or other nuclear plants?

A: Decommission of nuclear power is improbable since the government should be certain on not losing market opportunities, and energy intensive industries like the forestry chain will be affected to a high extent if other nuclear plants are decommissioned. On the other hand, if decommission of nuclear power occur, it could possibly bring support to other types of energy generation. However, the new generation should be subsidized to make competitive these new investments in technology. This is a very sensible issue since the European union is following very closely the advance in the deregulation process through all European countries, and to bring subsidies to build new capacity is seen as a step back in the deregulation of the energy market.

Nevertheless, companies are making investments, e.g. CHP plant in Malmö and a Natural gas in Göteborg. It is important to remember that nowadays a new enhanced market exists in the Nordic countries, and in case of a lack of energy in Sweden someone will build new capacity. Some examples are the construction of a new nuclear plant in Finland and a new project based upon natural gas in Norway. Therefore, the supply of energy is not a national problem any more. Now it is the society who needs to assume the problem. On this perspective, technology does not represent a problem.

In the case of an early decommissioning of Barsebäck, the electricity will be obtained, for instance, from Denmark. It is a matter of looking in the market opportunities.

One of the problems of the nuclear plants decommissioning, could be the bottlenecks in the electricity transmission. To solve the bottlenecks Sweden will need to make further investments in transmission of electricity. The market trend, having in mind the deregulation of the electricity market, is to use to the higher extent the existing capacity.

Q: How the Vattenfall is preparing itself for trading with electricity certificates?

A: Vattenfall has a long tradition on use of renewable energy. The company has been pioneer in the use of biomass and have invested in wind power. Depending on the market conditions is needed to evaluate if generating certificates is more competitive than buy it. The company is not prepared to invest in renewable energy at the today's price levels. Electricity is one of the most capital-intensive businesses, so, a decision on investment should be evaluated according to the risk it represents to obtain profits in the future. The payback periods could be so long that firms run on the risk of "living poor and dying rich." The potential for renewable energy is getting its limit. The most attractive project for increasing the renewable energy capacity is industrial CHP projects and the investments have been already done, but they are not in the market yet. The second attractive investment is wind power and the government is studying the places where this capacity could take place. In case of a harmonization of green certificates at an international level, the investments will be made indistinct of the location of the projects. Vattenfall have invested in Research and Development in the areas of Biomass use, Waste and have analysed almost all thermal potential based in biofuels, has a good knowledge in wind power, however, there are not too many opportunities to increase capacity. The increase of photovoltaic capacity depends on the industrialization of the technology. In thermal power, the company have not found a business in this kind of energy. In solar thermal, not too much money has invested in the technology. In Hydrogen, there is an investment in Germany for using fuel cells in public transportation.

Q: How the company is prepared for trading emission?

A: Vattenfall has been an active "actor" and think that in the future the will go beyond compliance. Vattenfall sees a business opportunity in the reduction of emissions and will invest to the extent that is profitable to invest on it.

Q: Looking to the year 2010 and beyond, if the pressure on the decommissioning of nuclear power increases and Barsebäck's second reactor is closed down in the near future, what will be the strategic actions of Vattenfall?

A: It is possible that part of the loss of energy generation will be supplied by renewable energy. There will be an increase in the use of natural gas and coal with a development of technologies for storing carbon dioxide. The decision will depend on the trend of the coal and gas markets in the world. Otherwise it is possible that the energy market will rely in the new capacity generated by Norway and Finland.

Q: What will be the strategic decision of Vattenfall after 2010, if the electricity certificates system imposes tougher targets to Energy Utilities?

A: Investing in RES for reaching high volume of electricity is time consuming and demands of high cost of integration. However, the company vision is to be the leading European energy company in the future, hence, in the future, the company will adapt its strategy to the conditions following the same profits rationale.