REDUCING SWEDISH CARBON DIOXIDE EMISSIONS
FROM THE BASIC INDUSTRY AND ENERGY UTILITIES

AN ACTOR AND POLICY ANALYSIS

Peter Stigson

2007

Department of Public Technology
Mälardalen University
Preface

The thesis was written during 2003-2006 as part of my PhD studies at Mälardalen University. The work process has been a long and interesting journey during which the issue of climate change has entered into the public debate and common knowledge. Due to this, changes in the policy framework during this period have been frequent. I am however now putting my foot down and make a closure, which makes sense as the thesis then provides a document of the former Government’s achievements and mistakes during their long period in office.

A number of persons have had an impact on my work and my main tutor Prof. Hans Lundberg is responsible for guiding my work to the area of climate and energy policies. It turned out to be quite in the spotlight, didn’t it Hans? Prof. Jinyue Yan, thank you for your comments and always being at hand as well as the fantastic opportunities to continue my policy studies with Chinese perspectives. Prof. Erik Dotzauer and Tobias Persson at the Swedish Energy Agency, I am looking forward to the discussions at the licentiate seminar and would like to thank you both for being involved. Dad, thank you ever so much for all the support, discussions and read-throughs! The thesis would not have been realized without the interviewees – Leif Brinck, Göran Carlsson, Peter Chudi, Mikael Hannus, Raine Harju, Gunnar Käck, Thomas Levander, Anders Lyberg, Birgitta Resvik, Ylva Rylander, Maria Sunér Fleming and Johan Tollin – who have offered their time and invaluable experience of the policy framework. Prof. Thomas B Johansson and Prof. Leif Gustavsson have provided invaluable comments on my work for which I am very grateful. I would also like to thank all others that have responded to my questions, helping me to a better understanding of the various policy perspectives. My mom, sisters, in-laws, and nephews and nieces, thank you all for being who you are. My family – Elli and Tilda – you are the reason why life makes so much sense!

Enjoy the read and please drop a note on your thoughts! I would love to read it when I come back from my long-deserved vacation…

Peter Stigson (Saltsjö-Duvnäs, 2 March 2007)
Till Elli och Tilda

För all kärlek och glädje
Abstract

The aim of the thesis is to analyze the design of the present climate and energy policies. The main focus is on how the policy instruments affect the Swedish stakeholders who are included in the European Union’s Emission Trading Scheme (EU-ETS). In-depth interviews have been carried out with representatives from the basic industry, energy utilities as well as industrial and green organizations. The purpose is to illustrate how these stakeholders view the current policy framework and what amendments that they view as necessary. Suggestions to the Government are given regarding the design of national policies and policy instruments to provide for an improved policy framework. The information and synthesis have furthermore been collected through extensive literature studies as well as participating at conferences and seminars.

The thesis is written as a monograph in order to address a larger group of readers interested in the transition of energy systems towards sustainability as well as policy makers and Swedish stakeholders. The common understanding that the global energy systems have to undergo a transition to renewables and higher energy efficiency due to the earth’s limited sources of fossil energy and uranium presents large challenges for policy makers, business sector and the society in general.

Global greenhouse gas (GHG) emissions have to be drastically reduced and the work to achieve this has started through international negotiations such as the Kyoto Protocol. As the present commitment levels are low, an important issue in a short-term perspective is to develop a more comprehensive and efficient system with a much wider participation and more stringent emission targets.

In order to achieve current national policy goals and international GHG emission commitments the Swedish Government utilizes a number of policy instruments that are either nationally self-assumed or called for by international agreements or the
European Union. The Swedish stakeholders that are included in the EU-ETS face a broad policy framework that has a large impact on their daily operations and future investment strategies. It is imperative for the policymakers, i.e. the Government, to act in accordance with the long-term perspective that the climate change issue and the transition of the energy system require. It is likewise important that any actions are in accordance with the operational and investment climate that the business sector faces. It is argued that these aspects are not fully considered as the success of the next national budget or term of public office seems to overshadow these issues. A long-term perspective is required to provide the business sector with stable and reliable incentives. This is needed to provide the economic conditions under which the businesses can realize investments that will result in emission reductions. Short-term policies reinforce the view of environmental investments as a form of risk investments. This negatively affects the possibility of the policy instruments to effectively achieve established policy goals.

Paying attention to these requirements is however not a simple task for policymakers as it will require agreements between the political parties. This demonstrates the main political difficulty with climate change – the requirement of a long-term and full commitment by all state authorities. It should be noted that the thesis does not attempt to describe the Swedish policy makers as neglecting the urgency of acting to mitigate climate change. The national agenda is far to advanced from an international perspective for such statements. The thesis however pinpoints some important issues highlighted by stakeholders, within the business sector and other organizations, who are concerned with the present climate and energy policy framework.

Some of the findings are as follows:

- Reducing GHG emissions in order to combat climate change must include a long-term perspective
• The design of policy instruments should consequently be long-term to increase the support for investments in GHG emission reducing technologies
• The design of policies that promote low GHG production alternatives within the energy utilities should be improved
• The large potential for reduced GHG emission available through fuel switching and energy efficiency improvements in the Swedish basic industry should be promoted by amended policies
• Reformulate or abandon the national GHG emissions target goal with the current formulation
• Strive for an emission rights allocation system that is as transparent, fair and predictable as possible
• The policy framework should aim for a high level of stability through interaction with the affected stakeholders
• These factors are inherently important for the overall efficiency of the policy framework

Keywords: climate change, climate policy, energy policy, EU ETS, Kyoto Protocol, emissions trading, renewable energy certificates, energy tax, carbon dioxide tax, voluntary agreements, environmental law
Sammanfattning


Avhandlingen är skriven som monografi för att rikta sig till en bred grupp läsare som är intresserade i hållbar omställning av energisystem så väl som till politiker och svenska aktörer. Den allmänna uppfattningen att de globala energisystemen måste undergå en omställning mot förnybara energikällor och högre energieffektivitet med anledning av jordens ändliga resurser av fossila bränslen och uran ställer höga krav på politiker och företag samt samhället i stort.

De globala växthusgasutsläppen måste minskas kraftigt och arbetet för att åstadkomma detta har startat genom internationella diskussioner och överenskommelser som Kyotoprotokollet. Då de nuvarande åtagandekraven är låga är en viktig del i det kortsiktiga arbetet att utveckla ett mer omfattande och effektivt system som inkluderar ett utvidgat antal länder och högre åtagandekrav.

För att uppfylla de nationella politiska målen och internationella utsläppsåtaganden använder sig den svenska regeringen sig av ett antal styrmedel som antingen är nationellt antagna eller påkallade genom internationella överenskommelser eller av


Några av slutsatserna är som följer:

- Att minska växthusgasutsläppen för att minska klimatförändringarna kräver ett långsiktigt perspektiv
• Utformningen av styrmedel bör därför vara präglad av långsiktighet för att öka incitamenten till investeringar i växthusgasutsläppsminskande tekniker
• Utformningen av den politiska agenda som främjar energiproduktionsalternativ med låga växthusgasutsläpp kan förbättras
• Den svenska basindustrin har en stor potential för minskade växthusgasutsläpp genom bränslebyte och energieffektiviseringar vilken bör främjas genom en förbättrad politisk agenda
• Omformulera eller avskaffa det nationella utsläppsmålet som det nu är utformat
• Sträva efter ett utsläppsrättsallokeringssystem som är så öppet, rättvist och förutsägbart som möjligt
• Det politiska ramverket bör sträva efter en hög grad av stabilitet genom ett samspel med de aktörer som påverkas
• Dessa faktorer utgör väsentlig del i utformningen av ett effektivt politiskt ramverk

Nyckelord: klimatförändringar, klimatpolitik, energipolitik, EU ETS, Kyotoprotokollet, utsläppshandel, el-certifikat, energiskatter, koldioxidskatt, frivilliga avtal, program för energieffektivisering, miljöbalken
Contents

LIST OF FIGURES .............................................................................................................................................. 1

LIST OF TABLES ............................................................................................................................................... 2

LIST OF ABBREVIATIONS .............................................................................................................................. 3

1. INTRODUCTION .............................................................................................................................. 5
   1.1 Background ......................................................................................................................................... 5
   1.2 Aim ..................................................................................................................................................... 10
   1.3 Scope ................................................................................................................................................ 11
   1.4 Methods .......................................................................................................................................... 16
   1.5 Thesis Outline ................................................................................................................................... 18
   1.6 Ethics ................................................................................................................................................ 21
   1.7 Basis of data and uncertainties ....................................................................................................... 21
   1.8 Highlights of Results and Findings .............................................................................................. 24

2. CLIMATE CHANGE ........................................................................................................................ 26
   2.1 Stakeholders ...................................................................................................................................... 28
       2.1.1 Swedish Stakeholders ............................................................................................................. 29
       2.1.2 International Stakeholders ................................................................................................... 30
   2.2 The Greenhouse Effect .................................................................................................................... 32
       2.2.1 The Theory of Climate Change ............................................................................................... 32
       2.2.2 Greenhouse Gases .................................................................................................................. 35
   2.3 Emissions of Carbon Dioxide .......................................................................................................... 38
       2.3.1 The International Situation .................................................................................................... 38
       2.3.2 The Swedish Situation ............................................................................................................ 40
   2.4 Effects on the Environment ............................................................................................................ 44
       2.4.1 Changing the Global Climate System ........................................................................................ 44
       2.4.2 Present and Predicted Effects .................................................................................................. 45
   2.5 Summary .......................................................................................................................................... 48
# 3. THE SWEDISH ENERGY SYSTEM AND UTILITIES

## 3.1 Stakeholders

### 3.1.1 Agencies and Institutions

### 3.1.2 Energy Utilities

### 3.1.3 International Stakeholders

## 3.2 Electricity Production

### 3.2.1 Nuclear Energy

### 3.2.2 Hydropower

### 3.2.3 Cogeneration and Industrial Back Pressure Steam Turbines

### 3.2.4 Wind Power

### 3.2.5 Other

## 3.3 Heat Production, Cogeneration and District Heating

## 3.4 Import and Export of Electricity

## 3.5 Security of Energy Supply

## 3.6 Price Developments

## 3.7 Carbon Dioxide Emissions

## 3.8 Future Production of Electricity and Heat

## 3.9 Summary

# 4. THE SWEDISH BASIC INDUSTRY

## 4.1 Stakeholders

### 4.1.1 Institutions

### 4.1.2 Basic Industry

### 4.1.3 International Stakeholders

## 4.2 Carbon Dioxide Emissions

## 4.3 Energy Consumption

## 4.4 Energy Efficiency and Energy Management

## 4.5 Basic Industry Sectors

### 4.5.1 Iron and Steel Industry

### 4.5.2 Mineral Industry

### 4.5.3 Pulp and Paper Industry

### 4.5.4 Mineral Oil Refineries

## 4.6 Auxiliary Systems

## 4.7 Summary
List of Figures

Figure 2.1 IPCC SRES for atmospheric carbon dioxide concentrations ...................................................... 39
Figure 2.2 Scandinavian mean year temperature climate scenarios (1961-2100) ........................................... 47
Figure 3.1 Energy input in Swedish electricity production (1974-2005) .......................................................... 67
Figure 3.2 Swedish nuclear energy opinion (1986-2004) ............................................................................... 70
Figure 3.3 Pluvial scenarios in Scandinavia (1981-2100) ................................................................................. 73
Figure 3.4 Fuel supply in Swedish electricity production (1983-2005) .......................................................... 76
Figure 3.5 Annual wind power production in Sweden (1997-2005) ............................................................... 78
Figure 3.6 Input of non-fossil fuels in Swedish CHP plants (1980-2003) ......................................................... 84
Figure 3.7 Energy input in Swedish district heating and cogeneration (2003) ............................................... 86
Figure 3.8 Swedish net import and export of electricity (1970-2005) ............................................................ 92
Figure 3.9 Electricity price developments for 10 GWh/year industrial consumers (1997-2005) .............. 97
Figure 3.10 Carbon dioxide emissions from energy utilities, incl. hydropower production (1990-2004) .......... 102
Figure 4.1 Carbon dioxide emissions in the Swedish industry (1990-2004) ................................................... 125
Figure 4.2 Energy consumption in the Swedish industry (1970-2005) .......................................................... 127
Figure 4.3 Areas for efficiency improvements in the basic industry ............................................................... 133
Figure 4.4 Energy consumption and sources in the Swedish steel and metal industry (1992-2001) .......... 139
Figure 4.5 Energy consumption and sources in the Swedish mineral industry (1992-2001) ....................... 146
Figure 4.6 Energy consumption and sources in the Swedish pulp and paper industry (1992-2001) .......... 154
Figure 4.7 Consumed fuels in the pulp and paper industry (2000) ............................................................... 156
Figure 4.8 Production and specific emissions in the pulp and paper industry .............................................. 157
Figure 5.1 Swedish Parliamentary Party positions ......................................................................................... 177
Figure 5.2 Structure of control instruments in Sweden ................................................................................ 221
Figure 5.3 Control instrument design characteristics .................................................................................... 223
Figure 5.4 Regulatory strength of policy instruments .................................................................................... 230
Figure 6.1 Price development and trade of EU emission allowances ......................................................... 258
Figure 6.2 Number of approved installations under REC scheme with reference to RES (2006) ............. 273
Figure 6.3 Issued RECs (thousands) with reference to RES (December 2005 - December 2006) .......... 274
Figure 6.4 Price (SEK) and turnover of certificates (2003-2006) ................................................................. 277
Figure 7.1 Participation in the Programme for Energy Efficiency (2006) ...................................................... 320
List of Tables

Table 1.1 Operations included in the EU-ETS ........................................................................................................ 13
Table 1.2 Policy instruments included in the analysis ............................................................................................ 16
Table 1.3 Stakeholder interviewees .......................................................................................................................... 22
Table 2.1 Earth’s carbon dioxide budget (1989-1998) .......................................................................................... 34
Table 2.2 Data for GHGs under the Kyoto Protocol ............................................................................................... 36
Table 2.3 Global warming potential (GWP) of various GHGs .................................................................................. 37
Table 2.4 Historic and future Swedish carbon dioxide emissions per sector (1990-2020) ....................................... 41
Table 3.1 Stakeholders within the energy utility sector ............................................................................................ 53
Table 3.2 Key figures for Vattenfall 2005 .................................................................................................................. 61
Table 3.3 Key figures for Sydkraft/E.ON Sverige (2005) .......................................................................................... 63
Table 3.4 Key figures for Fortum and Fortum Värme (2005) ..................................................................................... 64
Table 3.5 District heating customers and deliveries (2003) .................................................................................... 82
Table 3.6 Swedish foreign electricity connections (2001) ....................................................................................... 91
Table 4.1 General data for the basic industry sectors included in the EU-ETS (2004) ........................................... 113
Table 4.2 Stakeholders in the basic industry sector ................................................................................................. 115
Table 4.3 Swedish pulp and paper mills and production (2002) .......................................................................... 151
Table 4.4 Production (kton) and electricity consumption (GWh) in the Swedish pulp and paper industry (2000) ................................................................................................................................. 153
Table 5.1 Main climate and energy policy agendas of Swedish Parliamentary Parties ......................................... 179
Table 5.2 Organization of Swedish Agencies with climate and energy policy responsibilities ................................ 184
Table 5.3 Goals and targets in EU climate and energy documents ......................................................................... 200
Table 5.4 Annex II countries according to the UNFCCC ....................................................................................... 218
Table 5.5 Classification of Swedish policy instruments .......................................................................................... 222
Table 6.1 Different emission rights units in KP and EU-ETS .................................................................................. 239
Table 6.2 The Kyoto Protocol flexible mechanisms ............................................................................................... 241
Table 6.3 Sectors and sources included in the Kyoto Protocol’s Annex A ............................................................. 246
Table 6.4 Greenhouse gases included in the Kyoto Protocol’s Annex A ............................................................... 247
Table 6.5 Policy measures promoted by the Kyoto Protocol .................................................................................. 248
Table 6.6 Operations included in the EU-ETS ......................................................................................................... 251
Table 6.7 Number of Swedish operations included in the NAP2 (2008-2012) ..................................................... 254
Table 6.8 Renewable energy sources permitted under the REC scheme .............................................................. 272
Table 6.9 Quota liabilities per consumed MWh under the REC scheme ............................................................... 275
Table 7.1 Swedish energy and carbon dioxide tax levels (2006) ............................................................................ 300
Table 7.2 Fuels with minimum tax levels in EU ...................................................................................................... 308
Table 7.3 Energy tax deductions for wind turbine installations (öre/kWh) ............................................................ 313
Table 8.1 Basic industry and energy utility operations under certain conditions liable for Governmental permissibility consideration .................................................................................................. 329
# List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAU</td>
<td>Assigned Amount Unit</td>
</tr>
<tr>
<td>BAT</td>
<td>Best Available Technology</td>
</tr>
<tr>
<td>BREF</td>
<td>Best Available Technique Reference Documents</td>
</tr>
<tr>
<td>CCS</td>
<td>Carbon Capture and Storage</td>
</tr>
<tr>
<td>CDM</td>
<td>Clean Development Mechanism</td>
</tr>
<tr>
<td>CER</td>
<td>Certified Emission Reductions</td>
</tr>
<tr>
<td>CHP</td>
<td>Combined Heat and Power</td>
</tr>
<tr>
<td>CSE</td>
<td>Confederation of Swedish Enterprise</td>
</tr>
<tr>
<td>DG</td>
<td>Directorate-General (under the EU Commission)</td>
</tr>
<tr>
<td>EC</td>
<td>European Commission</td>
</tr>
<tr>
<td>EEA</td>
<td>European Environment Agency</td>
</tr>
<tr>
<td>EEC</td>
<td>Energy Efficiency Certificate</td>
</tr>
<tr>
<td>EIS</td>
<td>Environmental Impact Statement</td>
</tr>
<tr>
<td>EMAS</td>
<td>Eco Management and Audit Scheme</td>
</tr>
<tr>
<td>EMS</td>
<td>Energy Management System</td>
</tr>
<tr>
<td>EP</td>
<td>European Parliament</td>
</tr>
<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
</tr>
<tr>
<td>ERU</td>
<td>Emission Reduction Unit</td>
</tr>
<tr>
<td>ESCO</td>
<td>Energy Service Company</td>
</tr>
<tr>
<td>ETS</td>
<td>Emission Trading Scheme</td>
</tr>
<tr>
<td>EUA</td>
<td>European Union Allowance</td>
</tr>
<tr>
<td>EU-ETS</td>
<td>European Union Emission Trading Scheme</td>
</tr>
<tr>
<td>EU SDS</td>
<td>European Union Sustainable Development Strategy</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GHG</td>
<td>Green House Gas</td>
</tr>
<tr>
<td>GWP</td>
<td>Global Warming Potential</td>
</tr>
<tr>
<td>IEA</td>
<td>International Energy Agency</td>
</tr>
<tr>
<td>ITL</td>
<td>International Transaction Log</td>
</tr>
<tr>
<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
</tr>
<tr>
<td>IPPC</td>
<td>Integrated Pollution Prevention and Control</td>
</tr>
<tr>
<td>JI</td>
<td>Joint Implementation</td>
</tr>
<tr>
<td>KLIMP</td>
<td>Climate Investment Programme</td>
</tr>
</tbody>
</table>
LCC  Life Cycle Cost
LIP  Local Investment Programme
MIEC  Ministry of Enterprise and Communications
NGO  Non-Governmental Organisation
NUTEK  Swedish Business Development Agency
OECD  Organisation for Economic Cooperation and Development
ppb  parts per billion, \(10^9\) (concentration of GHGs in the atmosphere)
ppm  parts per million, \(10^6\) (see above)
ppt  parts per trillion, \(10^{12}\) (see above)
PFE  Programme for Energy Efficiency
REC  Renewable Energy Certificate
RECS  Renewable Energy Certificate System
RES  Renewable Energy Sources
SEA  Swedish Energy Agency
SFIF  Swedish Forest Industries Federation
SFS  Swedish Statute Book
SKGS  Skogen, Kemin, Gruvorna och Stålet (Industry NGO)
SMHI  Swedish Meteorological and Hydrological Institute
SNI  Swedish Standard Industrial Classification
SOU  Swedish Government Official Report
SPI  Swedish Petroleum Institute
SRES  IPCC Special Reports on Emission Scenarios
SSNC  Swedish Society for Nature Conservation
SvK  Svenska Kraftnät
SweMin  Swedish Association of Mines, Mineral and Metal Producers
UNFCCC  UN Framework Convention on Climate Change
1. Introduction

1.1 Background

We live in a world which is increasingly shaped by sustainable development issues, perhaps most strongly regarding climate change. Climate change and other energy issues related to a sustainable development have since the Rio Conference in 1992 become increasingly important to policy makers at all levels as well as stakeholders from the business sector, NGOs, academia and the public. These issues are today at the top of the agendas at international forums and their importance have lately been further emphasized by an increased intensity of extreme weather events such as the hurricane Katrina as well as soaring oil prices.

The emissions of anthropogenic greenhouse gases (GHGs) have been addressed by a number of international institutions, but most importantly from a Swedish perspective by the European Union by the EU Emission Trading Scheme (EU-ETS) and the United Nations by the Kyoto Protocol (KP). Sweden is involved in the
international climate change mitigation agenda as part of and working within the EU-ETS as well as through ratifying the KP. There is also a strong national agenda and sustainable development has recently been introduced as the overall goal for the work in the Government (Skr. 2003/04:129). An example of this agenda is that the Government\(^1\) has declared a national goal for reducing emissions of GHGs that is more stringent than the Swedish target under the KP and EU-ETS. Even though Sweden under the EU-ETS and KP are allowed to increase the national GHG emissions by more than +4 \% to 2008-2012, based on a 1990 baseline, the Swedish Government have in the Swedish Climate Strategy (Bill 2001/02:55) established a national target to reduce the emissions with -4 \%. The focus lies mainly on reducing emissions of carbon dioxide, which is correct considering that carbon dioxide emissions represent about 80 \% of the total GHG emissions (Swedish EPA, 2005). The policies and policy instruments aiming to accomplish these reductions are however argued to include erroneous design features.

New efforts need to be introduced within a number of societal sectors such as energy utilities, industries, buildings and transport to assure that the present and future development is sustainable. According to a report ordered by the Swedish EPA (2006a) these measures may also be financially motivated for the industry, as 79 \% of the public are willing to pay a higher price for a commodity that is produced by a company working to reduce its climate impact. Decreasing the nuclear capacity can potentially have a large impact on the consumption of fossil fuels and emissions of carbon dioxide as it responsible for roughly half of the domestic electricity production. Any phase-out must be accompanied with a comprehensive and efficient policy framework that can meet the electricity demand without increased carbon dioxide emissions. Industrial growth can have a larger impact on Swedish fossil fuel

\(^1\) The Government hereinafter refers to the various left-wing government coalitions that have been in office during 1994 to 2006 (also see Chapter 1.3).
consumption and carbon dioxide emissions than an EU average as Sweden has a large share of energy intensive basic industries with larger specific energy and electricity consumption patterns than most other European countries (SEA, 2004a). Against this background strong policy instruments are required in order to build a sustainable society. Climate and energy policies exert particular influence on the energy utilities, which can be considered as being the most politically influenced business sector in Sweden. Currently, non-market based policy instruments such as subsidies and subventions are being replaced with market based instruments such as trading with emission rights, renewable energy certificates and voluntary agreements, as these instruments are considered more effective from both a regulatory and economic perspective. The 2006 Climate Bill (2005/06:172) established the climate policy framework under which policy instruments shall be designed for the nearest future.

The international GHG emission agreements and trading schemes (ETSs) plus the phase-out of nuclear power dictate the Swedish agenda in the short-term. In a long-term perspective, the climate scenarios created by the Intergovernmental Panel on Climate Change (IPCC) and the necessity of reducing greenhouse gases that they call for, indicates that climate change will remain a top priority issue for decades and even centuries. There are no technological barriers for Swedish stakeholders to meet and surpass the emission levels set by the EU-ETS and the KP, but such a development will not be put into practice without well-structured and long-term climate and energy policies.

Climate and energy policy instruments should in the short (<5 years forward) and middle term (5 – 20 years) focus on:

- Policy instruments that provide strong incentives for change with a focus on;
GHG emission reductions through further introduction of renewable energy in utilities and industries

GHG emission reductions through improved energy efficiency in utilities and industries as well as buildings²

- Technology development (R&D) with a focus on;
  - Improved technologies for utilizing renewable energy sources in utilities and industries
  - Improving energy efficiency in both production and consumption of energy and electricity
  - Introduction of renewable energy sources in transportation

There seems to be a consensus that the above areas are central to a sustainable development and they are included in the 2002 Energy Bill (2001/02:143) which promotes that nuclear energy shall be replaced by improvements in energy efficiency, renewable energy sources (RES) as well as environmentally justifiable electricity production. Many studies (e.g. Ericsson et al (2004); Helby et al (1999); Jean-Baptiste and Ducroux (2003); Johansson (2001); Johansson (2005)) of Swedish and international climate and energy policies supports these observations. Some of the previous studies have combined these areas but most research on the policy framework focus specifically on single aspects or instruments, often by applying game or other mathematical theories or economic theories. None have however analyzed the policy framework on a broader scale, using a stakeholder approach that is argued to be important to highlight issues that are essential to establish an effective

² Studies have indicated that increased energy efficiency, resulting in reduced energy prices, may be counteracted by an increased consumption. This is called the rebound effect and is analyzed form a Swedish perspective by Brännlund et al (2007). This suggests that while energy efficiency policies could support the climate agenda this is not the case in Sweden where the emissions contrariwise may increase. A survey of rebound effects studies by Greening et al (2000) however identifies that the long-term rebound effect in the industry is small. This would thus support the inclusion of industrial energy efficiency in the analysis of policies promoting reduced carbon dioxide emissions.
agenda. Summarizing former research in a broad energy and climate policy perspective is difficult and the thesis includes references to relevant research in relation to each topic.

The thesis is an integrated part of the climate and energy policy research arena, contributing with a study of the above areas, with a focus on energy utilities and basic industries, using a cross-sectional approach by means of a stakeholder analysis. This approach is essential as it *inter alia* analyses the views and acceptance of the policy instrument designs that to a large extent decides how effectively policies will be implemented. This particular field is important to propel the transition towards sustainability through supporting the multi-stakeholder process that this requires. Studying how different stakeholders view the policy instrument designs and the development of the climate and energy agendas can provide an improved foundation for decisions by political policy makers.

The awareness of environmental issues by both the business and public sectors has been increased in recent years. Many stakeholders within the business society accept and address the issue of climate change and increasingly higher expectations regarding environmental performance are put on companies. An increasingly large number of energy utilities and industries today have action plans to reduce their environmental impact and the reasons for doing so are many. Large economic benefits can be gained from addressing these issues, examples being that many consumers on Sweden’s deregulated electricity market today request electricity produced from renewable sources and working with energy efficiency tends reduce resource consumption on many levels.
1.2 Aim

This thesis aims to analyze how the climate and energy policy framework affects different groups of Swedish stakeholders and the work to curb the national and individual carbon dioxide emissions. This includes the policy framework on climate change, energy efficiency and renewable energy. The main aim is to investigate how the development of the climate and energy policy agenda, including the setting of policy goals and design of policy instruments, can be improved. The thesis also aims at contributing to a better understanding of the concerned stakeholders individual standpoints and visions of the future through elucidating the present situation. The thesis furthermore provides an overview of the current production situation in the included business sector and the possibilities to reduce carbon dioxide emissions through fuel switching and energy efficiency improvements, which aims to outline the conditions that the climate and energy policy framework must consider and comply with.

The work of the thesis is relevant and important due to that an immediate multi-stakeholder approach is needed in order to highlight obstacles in the design of an efficient agenda to mitigate climate change and meet future emission targets. Analyzing the stakeholder positions with a cross-sectional approach, instead of a one-dimensional, is necessary to study how the different actors interact and view the discourse. A secondary aim of the thesis is to give the reader a comprehensive overview of the wide range of institutions, stakeholders and policies involved in Sweden’s climate work, as I have found this to be missing and that acquiring this information can be a cumbersome process. The thesis is, due to these aims, meant to attract a wide range of stakeholders and is consequently written as a monograph in order to improve its explanatory aspects.

The work with the thesis started out with an unbiased point of view but during the course of the work some key issues have been identified. These issues have been
identified through the interviews as well as through scientific journals and other sources, where the latter has provided a strong support for the main findings. Against this background the thesis aims to prove the hypothesis that the climate and energy policy framework has an erroneous climate goal formulation and lacks a long-term perspective, resulting in low policy stability associated with lower cost and steering efficiencies.

1.3 Scope

The stakeholder groups that the thesis includes can be divided in different ways. A coarse stakeholder division is political, energy utility, basic industry and other actors. The political stakeholders are the Parliament, Government and other political agencies and bodies that take part in the development of climate and energy policies on national and international levels. Some political stakeholders are of peripheral importance and are thus not explained in detail, while others that are important to the policy framework design process are presented as stakeholders and their role in the process is explained. The political stakeholders that are most concerned are besides the Parliament and Government, the Ministry of Sustainable Development, the Ministry of Finance, the Ministry of Industry, Employment and Communications as well as the Swedish Energy Agency (SEA) and Swedish EPA. The thesis mainly includes the work of the former left-wing governments that were in office 1994-2006.\footnote{This means that the arrangement of ministries under the former Government is used except in the references where the new arrangement is used as the bills and official reports have been reorganized according to the new system. More information on the changes in ministries is available in Chapter 5.1.2.} Due to the strong position of the Social Democratic Party in these governments they are the main actor behind many of the decisions and bills produced during this period. The new right-wing Government is only briefly included and then with short

................................................

3
references to announced or taken policy changes. The reason for not having a stronger inclusion of the new Government is that the decisions taken by the new Government has not yet had any analyzable outcomes. The policy framework established by the former Government is consequently largely still operative.

The thesis thus focuses on how the climate and energy policy work in a present perspective, as regards to official reports and suggested legislative measures in Government bills. Descriptions on how the policy framework and past emission situations have developed, leading up to the current state-of-affairs are also included. Analyses of the present situation for the included stakeholders provide an explanation to the possibilities to reduce emissions of carbon dioxide. This underpins the thesis aim to provide suggestions on what potential improvements that the policy framework should seek to accomplish through moving the agenda forward in a new and improved manner. Future prospects of positive technological breakthroughs that can assist in curbing emissions and are dealt with in the thesis.

The included stakeholders within the business sector are those that have activities that are included in the Annex I of the European Union’s Emissions Trading Directive (2003/87/EC) establishing the EU-ETS (Table 1.1). These stakeholders are jointly referred to as the Trading Sector. The Trading Sector must comply with an emission quota, which can be found in National Allocation Plans (NAPs) that the Emissions Trading Directive stipulates that all Member States shall publish in order to establish how the emission rights under the EU-ETS will be allocated among the Trading Sector for each commitment period. The total and individual quota volume shall consider the national commitment and pay attention to the Trading Sector’s and operation’s share of the total national emissions. The stakeholders included for the first (2005-2007) trading period are included in NAP1 (MIEC, 2004) and the
stakeholders included in the second (2008-2012) period in the NAP2 (Ministry of the Environment, 2006b).

Table 1.1 Operations included in the EU-ETS

<table>
<thead>
<tr>
<th>Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ENERGY ACTIVITIES</strong></td>
</tr>
<tr>
<td>- Combustion installations with a rated thermal input exceeding 20 MW (except hazardous or municipal waste installations)</td>
</tr>
<tr>
<td>- Mineral oil refineries</td>
</tr>
<tr>
<td>- Coke oven installations</td>
</tr>
<tr>
<td><strong>PRODUCTION AND PROCESSING OF FERROUS METALS</strong></td>
</tr>
<tr>
<td>- Metal ore (including sulphide ore) roasting or sintering installations</td>
</tr>
<tr>
<td>- Installations for the production of pig iron or steel (primary or secondary fusion) including continuous casting, with a capacity exceeding 2.5 tonnes per hour</td>
</tr>
<tr>
<td><strong>MINERAL INDUSTRY</strong></td>
</tr>
<tr>
<td>- Installations for the production of cement clinker in rotary kilns with a production capacity exceeding 500 tonnes per day or lime in rotary kilns with a production capacity exceeding 50 tonnes per day or in other furnaces with a production capacity exceeding 50 tonnes per day</td>
</tr>
<tr>
<td>- Installations for the manufacture of glass including glass fibre with a melting capacity exceeding 20 tonnes per day</td>
</tr>
<tr>
<td>- Installations for the manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain, with a production capacity exceeding 75 tonnes per day, and/or with a kiln capacity exceeding 4 m³ and with a setting density per kiln exceeding 300 kg/m³</td>
</tr>
<tr>
<td><strong>OTHER ACTIVITIES</strong></td>
</tr>
<tr>
<td>- Industrial plants for the production of pulp from timber or other fibrous materials and paper and board with a production capacity exceeding 20 tonnes per day</td>
</tr>
</tbody>
</table>

Source: Directive 2003/87/EC

---

4 The 2006 NAP had not received approval by the European Commission at the time of printing the thesis and may consequently be subject to changes.

5 Installations that are used for R&D and testing are excluded from the scheme according to the Annex I of the Trading Directive (2003/87/EC) establishing the scheme.
This definition means that not all companies in the energy utility and basic industry sectors are included in the Trading Sector. It also means that some companies that do not belong to these industry groups have been included due to the size of their combustion installations (>20 MW). Sweden has also decided (MIEC, 2004; Ministry of the Environment, 2006b) to use the option provided by the Emissions Trading Directive to opt-in combustion installations smaller than 20 MW for district heating systems if the entire system exceeds the 20 MW limit.

The emissions that are included in the scope of the thesis are the carbon dioxide (CO₂) emissions from the activities included in Table 1.1. The EU Emissions Trading Directive includes a number of greenhouse gases but during the current and upcoming period (2008-2012) only carbon dioxide emissions are targeted. The European Union and all Member States have agreed to meet the Kyoto Protocol commitments jointly according to a burden sharing agreement (European Council, 2002). The emission level that Sweden must comply with under the Kyoto Protocol is consequently that of the national obligation under this European agreement, which is +4 % (ibid). The burden sharing agreement thus sets the framework for the volume of allocations allowed to be allocated to the Trading Sector under EU-ETS. Sweden has however adopted a stronger emissions target of -4 % (Bill 2001/02:55), which is an important target as it affects the stringency of policy instruments other than the EU-ETS.

The main reason for choosing system boundaries with respect to the EU-ETS is that emissions trading is the policy instrument that currently receives most attention while also including the majority of the Swedish stakeholders that are the largest

---

6 The EU Member States as a whole are under the Kyoto Protocol (UNFCCC, 1997) committed to reduce the emissions with -8 %. All commitments refer to carbon dioxide equivalents and are due to be met during 2008-2012 compared to a 1990 baseline.
7 The KP allows the parties under protocol to account for carbon sinks in for example forests and the Swedish emissions can due to this be higher than +4 %.
emitters within the energy utilities and basic industry. The focus of the interviews lies towards the stakeholders with the highest emission levels in their respective sectors. The industry associations Confederation of Swedish Enterprise and Swedenergy represent the stakeholders with smaller emissions. The sector associations are usually part of European alliances where the European counterparts cooperate on sector specific issues. These associations can be strong European stakeholders and have different focuses. The main associations that work with policy issues and are of interest here are mentioned in connection to the Swedish association.

The reason for focusing on the large emitters in each industry sector is that a limited number of companies and operations are responsible for the greater part of the emissions from energy utilities and basic industry as well as within their respective sectors. Many of the basic industries produce large volumes of heavy goods which make transports to depots, retailers and end-customers a potentially important issue but as this is a matter of transport it is not discussed in the thesis.

Other stakeholders of interest are academia and non-governmental organizations (NGOs). The academic sector is significant due to its knowledge base and representing the science society. NGOs are a diverse group of stakeholders that ranges from abovementioned business organizations to environmental groups which often have a strong influence on the public opinion. The most influential environmental NGO in Sweden is the Swedish Society for Nature Conservation (SSNC), which has been included in the interviews.

The policy instruments included in the analysis are those affecting the emissions of carbon dioxide as part of the present climate and energy policy framework. The inclusion of energy efficiency certificates diverges from this definition as such a scheme is not currently implemented. The instrument is nevertheless included due to a possible EU-level introduction (Chapter 6.3). The instruments that are included
(Table 1.2) focus on carbon dioxide emissions, renewable energy sources and energy efficiency according to the required policy focuses identified above (Chapter 1.1).

Table 1.2 Policy instruments included in the analysis

<table>
<thead>
<tr>
<th>Emissions Trading</th>
<th>Technology Procurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable Energy Certificates</td>
<td>Environmental Code</td>
</tr>
<tr>
<td>Energy Efficiency Certificates</td>
<td>Municipal Energy Planning</td>
</tr>
<tr>
<td>Energy Taxes</td>
<td>Information Campaigns</td>
</tr>
<tr>
<td>Carbon Dioxide Tax</td>
<td>Labeling</td>
</tr>
<tr>
<td>Subventions and Subsidies</td>
<td>Research Funding</td>
</tr>
<tr>
<td>Voluntary Agreements</td>
<td></td>
</tr>
</tbody>
</table>

The scope of the thesis is national albeit a certain element of international influence is inevitable. The international aspects are highlighted through Sweden’s membership in the EU and consequently also the EU-ETS, the ratification of the KP and the overall global nature of the climate agenda.

1.4 Methods

The study in this thesis has been conducted by analysis and observation of data collected through in-depth interviews and an extensive research of present literature, journals, sector publications and Internet as well as through visiting a number of seminars and conferences. Much information can also be found in the media, as this is the arena for much of the public debate between the business sector and Government. The stakeholders that have been interviewed work as case studies which bring important first-hand information to this study. The interviewees were
selected on the basis of their position at the respective companies and organizations and interviewed as representatives for the company or organization. The questions presented to the interviewees (Appendix I) were furthermore formulated to analyze the company’s or organization’s opinions and the expressed opinions of the interviewees in the thesis should thus be interpreted as coherent with that of their company/organization. There is however a possibility that personal opinions revealed during the interviews may have been mistaken for an official position on the subject. In order to minimize this and other errors, the interview results have been circulated to the respective interviewees for approval.

The industrial sectors that are included in the EU-ETS have different emission intensities and in many cases one of the included operations, for example cement production in the mineral industry represents the majority of the sector’s carbon dioxide emissions. Most interviews have therefore been selected with respect to the stakeholders’ share of the different sectors’ total amount of emission rights allocated in the Swedish NAPs (MIEC, 2004; Ministry of the Environment, 2006b). This selection means that interviews include the stakeholders that represent the lion’s share of the allocated emission rights. It furthermore serves the purpose to ensure that the stakeholders interviewed have a broad knowledge base of the current policy instruments and technological developments, as these issues are of outmost importance and interest to the large operations due to their economic implications. The thesis does not aim at providing an exhaustive description of all included stakeholders but uses the selected interviewees as case studies, representing the different sectors. The other stakeholders included in the NAPs are represented in the interviews through the Confederation of Swedish Enterprise and Swedenergy. The share of energy utilities in the interviews is higher than the other sectors due to the higher representation of this sector in the NAPs. The opinions of environmental NGOs are voiced through interviewing the Swedish Society for Nature Conservation.
The interviewed stakeholders have played a significant role in relation to the selection of the research methods and data for the analysis. This is because the interviews are an interactive process which also helps the study to obtain feedbacks from the stakeholders on the interview interpretations and the latest developments. This in turn has further influence on the research process. The focus of the thesis results are thus to a large extent associated with the policy framework issues that were highlighted by the stakeholders. The interview results and issues regarding the policy designs are analyzed in relation to the individual policy and policy instrument and the main issues are further discussed in the concluding discussions. The analyses of the policy instruments are thus largely descriptive and problematizing, being based on the policy design process, interview results as well as other stakeholder opinions and scientific data. The final discussions are normative and reflect the aim of the thesis with a focus on the issues highlighted by the interviewees.

Since the thesis is concentrated around a stakeholder analysis it has been important to take into consideration how the actors position themselves in their work and their commitment to climate and energy issues in a wider perspective. The data of the political background and positions has been easier to collect, being assembled in a number of public governmental publications and reports. The present information on the positions of different political parties and coalitions are established by political programmes that are available through their respective information departments and in the reports from media. Interviewing political parties have consequently not been considered necessary.

1.5 Thesis Outline

The thesis outline is based on different stakeholder and policy instrument groups. Stakeholders are presented at the beginning of the chapters. Which stakeholders that are presented and where, is a result of which stakeholders that have been
interviewed as well as others institutions that support policy makers in the development of climate and energy policies. As an example, most political stakeholders are explained in the Chapter 5 – The Political Climate – even though their work is of obvious relevance both to the energy utilities and the basic industry.

The interview results are in most instances aggregated under the heading “Stakeholder Perspectives”, as to provide the reader with an easy overview. References to interviewed stakeholders are in most occasions elucidated through including the full name of the interviewee and the company or organization that he/she represents. The references are furthermore dated with the year of the interview (all during 2005). References to chapters are written in Italic. Each chapter includes a summary that highlights the findings that are related to the contents thereof.

Chapter 2 provides a background to the urgency of mitigating climate change. The Chapter includes background descriptions of the present trends and future scenarios of Swedish carbon dioxide emissions and climate change issues as well as information on the international context of these issues.

Chapter 3 describes the Swedish energy system and energy utilities. The chapter discusses the current electricity and heat production and future potentials, the Nordic and European energy infrastructure, security of energy supply and energy price developments. This aims to provide a picture of how the energy system can develop and maintain the low carbon dioxide emissions.

Chapter 4 discusses the basic industry sectors present and future trends with regards to carbon dioxide emissions and energy consumption, the possibilities to reduce

---

8 Minor changes may have occurred at later dates through the iterative method used to allow for the interviewees to comment on the interview interpretations and the latest developments
emissions through improved energy efficiency and energy management. The Chapter furthermore provides an insight to the different sector’s specific production processes and potentials for emission reductions. The Chapter finally discusses the role of auxiliary systems in improving the operational efficiency of not only the basic industry but also the energy utilities.

_Chapter 5_ gives a thorough insight into the present focus of the Swedish, EU and International political agendas on climate change and carbon dioxide emissions. The Chapter also outlines different policy instrument characteristics that have been identified as important in the instrument design. This Chapter provides the reader with a background to the following discussions of the policy instruments.

_Chapters 6-9_ analyze the four major policy instrument groups and highlight the key interview results regarding the design of these instruments. The different instruments are explained with respect to decisions, history, design characteristics, interaction with other instruments and interviewee viewpoints.

_Chapter 10_ discusses the Trading Sectors work to reduce carbon dioxide emissions are affected by the policy framework. This includes positive and negative aspects of the current policy designs and the dialogue on policy development.

_Chapter 11_ concludes the thesis by summing up the main viewpoints on the climate and energy policy agendas in relation to an effective mitigation regime that is found. This consequentially also point towards future research areas.

_Chapter 12_ contains the list of references. I have refrained from providing a chapter of further reading due to the large amount of references (>400) included. I therefore direct the reader to this section and information available at the presented stakeholders’ websites (website addresses provided as footnotes by the presentation of the stakeholders).
1.6 Ethics

The area where ethical considerations are of main importance is how the interviews are carried out. I have made an effort to present interviewees with the questions in advance of the interview. The information has included:

- The aim of the research
- The interview questions
- How I would like the interview to be carried out as regards to *inter alia* recording the interview
- How I intend to use the material
- That they will receive a transcript of how I have used their information so that any misunderstandings can be sorted out (informed consent)

In some cases it has been difficult to reach the person for the interview and have therefore needed to seize the opportunity for a telephone interview when possible.

I consider that this method has led to a full understanding between me and the person to be interviewed on the conditions of the interview. I believe that this situation and the nature of the thesis and questions have minimized possible causes for unethical behavior on my behalf as regards to the execution of the interviews and the use of interview material. This method has been utilized in all occasions except for personal communications with single questions that are not part of the main stakeholder analysis.

1.7 Basis of data and uncertainties

An analysis of a subject that is intensely debated is difficult, as the situation can change rapidly and significantly. This certainly applies when focusing on the
development of energy and climate change policies, which are undergoing a paradigmatic shift. The possible outcomes of climate change have become apparent to a larger extent of the society, resulting in a flood wave of different institutional responses on mitigating measures on all global levels and in an array of areas. Producing a picture of the overall dynamic political structure on energy and climate change is a part of the thesis but not its main focus.

Table 1.3 Stakeholder interviewees

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Company/Association/Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leif Brinck</td>
<td>Senior Manager Strategy and Development</td>
<td>Preemraff</td>
</tr>
<tr>
<td>Göran Carlsson</td>
<td>Vice President Technology</td>
<td>SSAB</td>
</tr>
<tr>
<td>Peter Chudi</td>
<td>Head of Environmental Business</td>
<td>E.ON Sverige</td>
</tr>
<tr>
<td>Mikael Hannus</td>
<td>Vice President, Energy</td>
<td>Stora Enso</td>
</tr>
<tr>
<td>Raine Harju</td>
<td>-</td>
<td>Vattenfall</td>
</tr>
<tr>
<td>Gunnar Käck</td>
<td>Advisor</td>
<td>Fortum Värme</td>
</tr>
<tr>
<td>Thomas Levander</td>
<td>Head of Division, System Analysis Department (Policy Analysis Unit)</td>
<td>Swedish Energy Agency</td>
</tr>
<tr>
<td>Anders Lyberg</td>
<td>Technical Director</td>
<td>Cementa</td>
</tr>
<tr>
<td>Birgitta Resvik</td>
<td>Director of Climate and Energy Policies</td>
<td>Confederation of Swedish Enterprise</td>
</tr>
<tr>
<td>Ylva Rylander</td>
<td>Project Coordinator, Climate Change</td>
<td>Swedish Society for Nature Conservation</td>
</tr>
<tr>
<td>Maria Sunér Fleming</td>
<td>Senior Advisor Environmental and Climate Policies</td>
<td>Swedenergy (Svensk Energi)</td>
</tr>
<tr>
<td>Johan Tollin</td>
<td>R&amp;D Programme Manager</td>
<td>Vattenfall</td>
</tr>
</tbody>
</table>
Specific empirical data required for the thesis have been collected through 12 in-depth interviews with representatives for different stakeholders and stakeholder groups (Table 1.3). The interview results, as intended to be used in the thesis, have been sent to the interviewees to allow for feedback and updating of opinions. This has reduced the uncertainties in the interpretation of the interviews.⁹

A limitation of using interviews as a method for collecting data is that the stakeholders may in different situations and through different measures present an inadequate picture of themselves based on how they want to be perceived. This is however the case for all interviews as well as for other methods where the interviewee are allowed to answer freely to questions. This negative influence is limited by the transparency of today’s society where misconduct in many cases is brought to public attention by media and NGOs. The research of public media should thus be seen as an attempt to reduce the impact of such misrepresentations. Information could potentially also be inadequate due to misunderstandings but presenting a transcript to the interviewees with intended use of the interview results is used as a method to avoid this.

The aim has been to be consistent and providing comparable information for the different industries and stakeholders. This has in relation to technical data, such as detailed emission statistics, only been possible to achieve to a certain extent due to lack of available data and data with different background with regards to for example carbon dioxide emissions and energy consumption. A problem in the compilation of data is that the definition of the trading parties by the EU Emission Trading Scheme differs from that of most official Swedish data, which are classified

---

⁹ All interviewees in Table 1.3, as well as Hedström (2005), Nilsson (2005) and Rummukainen (2005), except Göran Carlsson (2005) at SSAB, have responded to the interview feedback. The comments by Göran Carlsson should thus be interpreted with caution. Maria Sunér Fleming (2005) at Swedenergy had been on a longer leave at the time of responding to the feedback but had contact with the office regarding the interview results.
according to the Swedish Industrial Classification code (SNI). I have aimed to collect the most accurate and reliable data as to present the current situation in a way that is clear and concise. Finding the specific data has however been difficult since the SNI-code is used by for example Statistics Sweden and most governmental bodies, meaning that I have sometimes fallen short of this undertaking. It should however be noticed that the basic industry operations within the SNI codes are responsible for the majority of the energy consumption and carbon dioxide emissions in their respective sector due to the size of their operations. Using SNI data thus corresponds reasonably well in depicting the situation for the EU-ETS sectors. When more specific data has been found from other sources, for example sector organizations, these have been used. This means that the same data cannot always be found for the different stakeholders, which naturally would have been preferable.

Predicted outcomes of the present and future policies are to a large extent based on my opinions and are as such not objective but a result of my personal views.

1.8 Highlights of Results and Findings

The interview results indicate that a large share of the stakeholders within the basic industry and energy utilities are discontent with the current climate and energy policies. The three main objections are the lack of a long-term perspective in the design of policy instruments, resulting in low policy stability and predictability. This hampers a positive development through reducing the stability for environmental investments that are affected by the analyzed policy instruments. The second major objection is a lack of harmonization, causing negative competitive effects. The third objection is the design of the national climate goal. The inclusion of the operations included in the EU-ETS is identified as causing a number of negative effects on both the policy agendas and many of the policy instruments thereof.
One of the most important aspects in the current policy instrument designs are identified as the allocation of emission rights under the EU-ETS. The views on how to carry out the allocation differ – benchmarking is favored by some stakeholders but not all – and the novelty of large-scale emissions trading induces an element of inherent uncertainty. An increased level of transparency and harmonization between Member States is requested and important for higher stability.

It is due to these reasons important to establish an effective arena for dialogue on policy instrument aspects, as to ensure a policy instrument mix with high cost and goal compliance efficiencies. An effective dialogue would also offer the possibility to strengthen the stability of policy instrument designs through increased stakeholder interaction.
2. Climate Change

The discovery of climate change was made by the Nobel Prize laureate Svante Arrhenius in 1896. The political concern for a changing climate arose much later in 1985 at the International Conference on the Assessment of the Role of Carbon Dioxide and of Other Greenhouse Gases in Austria, which was organized by among others the World Meteorological Organization (WMO) and United Nations Environment Programme (Elliot, 1998). There has since been a great deal of discussions about climate change controversies, which used to focus on whether we were experiencing global warming at all, which later has turned to whether the climate change is natural or caused by anthropogenic activities. There is however
today a consensus to the fact the humankind can affect, and has affected, the global climate.¹⁰

When discussing or analyzing how greenhouse agents (gases, aerosols etc.) affect the climate and environment it is important to remember three things; one, that deforestation also contributes, two, that the majority of the greenhouse effect is natural and caused by natural greenhouse agents and three, that the climate systems are very complex and in many respects also stochastic. Deforestation has only minor effects as of today and the anthropogenic change to the greenhouse effect is large enough to create changes to the climate. The complexity of the climate systems makes general and/or detailed scenarios very difficult to produce albeit the used climate models have improved. Scenarios are mainly used to identify trends and to create scenarios based on a limited number of variables. Scenarios that try to predict future levels of greenhouse agent emissions must therefore be seen as possible outcomes of strictly defined conditions – simplifications and assumptions do not account for the array of possible policy, economic and technological developments. This can be exemplified by suggesting that an unforeseen large increase of extreme weather events irrefutably related to climate change, leading to higher levels capital loss or loss of human lives, would accelerate mitigating efforts through stricter policies.

There are a number of agents that enhance the greenhouse effect in the atmosphere, most of which are greenhouse gases (GHGs), with the exception of aerosols. Water vapor is the largest natural GHG, while carbon dioxide is the largest anthropogenic gas. According to the IPCC (2001b) the levels of carbon dioxide in the atmosphere

¹⁰ Much data within this chapter is based on the different publication within the IPCC Third Assessment Report – Climate Change 2001 (IPCC, 2001a, 2001b), on the present global situation. A new IPCC Assessment Report was published in conjunction with the printing of the thesis. This report has slightly changed scenarios but the main difference and perhaps of most importance, is the stronger assignment of climate change to anthropogenic activities.
has risen from of 228 ppm in 1750 to 365 ppm in 1998 and there are no signs that the increase in concentration are slowing off, on the contrary it seems as if the levels are rising increasingly faster. The Swedish Government and EU have set the goal that the concentration of carbon dioxide equivalents (explained below) shall remain below 550 ppm as this has been considered limit the global mean temperature at approximately +2.5°C limiting changes to the global environment (Bill 2001/02:55; EC, 2002; IPCC, 2001b). This level will result in a changed global environment with altered climate patterns and sea level rise, but the prognosis is that it will not cause greater impacts than the global community can handle (IPCC, 2001b). Levels high above 550 are likely to cause such adverse effects to the climate that it is difficult to oversee the possible outcomes. Scenarios include that some areas will become inhabitable due to for example droughts or flooding of lowlands with large migrations in its footsteps, changed weather patterns with larger occurrence of extreme weather conditions etc.

The most commonly used climate scenarios are the Special Reports on Emission Scenarios (SRES) produced by the IPCC. These scenarios are also used in Sweden parallel to scenarios produced by SMHI and the Rossby Centre under the Swedish Regional Climate Research Programme (SWECLIM). Carbon dioxide emission scenarios come from a wider range of sources.

2.1 Stakeholders

The political stakeholders in Sweden that focus on the impact of climate change are besides the Ministry of Sustainable Development the Swedish Environmental Protection Agency (EPA). On an EU level various bodies at different levels have responsibilities related to climate change and energy. In the UN the issue of climate change impact is the responsibility of the Intergovernmental Panel on Climate Change. On non-political levels these focuses are shared by environmental NGOs.
2.1.1 Swedish Stakeholders

The Swedish Environmental Protection Agency

The Swedish EPA is the Government’s central environmental authority reporting to the Ministry of Sustainable Development. The EPA’s main objective is to work with environmental issues on national and international levels. The most important tasks are to develop the Government’s environmental work with respect to:

- Suggesting targets, measurements and policy instruments for environmental protection policies and activities
- Implementing the political environmental agenda regarding such as policy decisions on Government grants and application of laws
- Monitor the environmental situation and environmental work
- Collects information about GHG emissions and report to the Government, EU and UNFCCC

The EPA is also, in cooperation with the Swedish Energy Agency, responsible for evaluating the Swedish climate strategy at the control stations.

The Swedish Society for Nature Conservation (SSNC)

The SSNC is Sweden’s most influential environmental NGO, engaged in all parts of the Swedish society with respect to environmental and health issues. The concern for climate change has given this issue highest priority. The SSNC works by influencing the public opinion and the Government towards environmental considerations as well as exposing environmental improprieties. The SSNC run an environmental labeling scheme called “Bra Miljöval” (eng. Good environmental choice) which

11 Further information is available at http://www.naturvardsverket.se
12 Further information is available at http://www.snf.se
among other commodities labels electricity. Only electricity that is produced with renewable energy sources according to certain requirements is approved. This scheme is identified as a non-governmental control instrument within the scope of the thesis (Chapter 5.6 and 9.1). The SSNC also promotes the Polluter Pays Principle and technology procurement and works for the removal of energy subsidies.

The SSNC has the general view that the industry and large energy utilities do not take enough responsibility in their work to reduce their environmental impact and emissions of GHGs (Rylander, 2005). The organization argues that the environmental work in the industry is essential and must be allowed to cost. The SSNC’s aim for GHG emission reductions are -15 % to 2010 as the short-term goal and -75 % to 2050 as a long-term. The SSNC (Rylander, 2005) has also established a medium-term goal, promoting -35 – 40 % reductions to 2020, as large reduction should be achieved promptly or they will be become increasingly costly to achieve. The organization views the business sector’s profit objectives and discussions on the business sector’s competitiveness in relation to policy instruments as main obstacles in realizing carbon dioxide emission reductions.

2.1.2 International Stakeholders

European Union\textsuperscript{13}

The EU bodies that have the main responsibilities on climate change are positioned at different institutional levels. The Environment Directorate-General (DG), one of 36 DGs in the Commission, has the main responsibility to initiate and design environmental legislation as well as to ensure that the agreed legislation is enforced in the Member States. The Environment DG covers several areas such as climate

---

\textsuperscript{13} Further information is available at http://www.europa.eu.int
change, health, industrial environmental issues, emissions etc. The responsibilities include the EU-ETS (Chapter 6.1) and the European Climate Change Programme (ECCP). The ECCP was initiated by the Commission to identify and design policies and other measures necessary for the EU to implement the Kyoto Protocol (KP). The European Parliament decides on legislative proposals and approves international agreements. The Parliamentary Committee on Environment, Public Health and Food Safety has these responsibilities with respect to, among other issues; climate change, sustainable development, the UNFCCC/KP and the European Environment Agency (EEA). The Environment Council is comprised by the environmental ministers of the Member States. The Council works for a sustainable development and promotes environmental policies to be based on the Precautionary Principle, the Polluter Pays Principle and the Preventive Action Principle. The EEA is a decentralized agency with the task to provide decision makers and public within the EU with information on environment and sustainable development. The work of the EEA is carried out by using various indicators, on for example climate change, which evaluates how the environmental development is consistent with EU policies. The EEA itself do not decide on any policy actions, as this is the job of the Commission and other institutions.

**Intergovernmental Panel on Climate Change**\(^{14}\)

In 1988, following the International Conference on the Assessment of the Role of Carbon Dioxide and of Other Greenhouse Gases, the Intergovernmental Panel on Climate Change (IPCC)\(^ {15}\) was formed as a UN body under the WMO and the UN Environment Programme. The IPCC is commissioned to assess scientific, technical and economic information concerning the understanding of climate change, its

---

\(^{14}\) Further information is available at http://www.ipcc.ch

\(^{15}\) IPCC should not be confused with an EU Directive called IPPC, which stands for the Integrated Pollution Prevention and Control. Both are a subject to the thesis.
potential impacts and the options for adaptation and mitigation. The IPCC findings are regularly published in Assessment Reports that encompass the global GHG emission situation as well as SRESs that analyze future emission levels. Their findings create the foundation for the work of the UNFCCC.

2.2 The Greenhouse Effect

The greenhouse effect means that some of the energy that the earth receives from the sun is trapped in our atmosphere, and especially within the surface-troposphere\(^{16}\) system. How much energy that is trapped, is controlled by the concentration of greenhouse gases (especially water vapor and carbon dioxide) in the atmosphere. The amount that stays in our atmosphere due to natural processes is in general terms what makes the earth inhabitable as we know it. Without the natural greenhouse effect the global climate would be quite harsh, with overall temperatures considerably lower than present (Rummukainen, 2005). Lately human activities have begun to change the atmosphere and earth’s constitution by for example burning fossil fuels and changing the land cover.

2.2.1 The Theory of Climate Change

All bodies that have a higher temperature than absolute zero will emit radiation, which is an energy carrier. The sun’s surface temperature reaches approximately 6,000°C and consequently radiates vast amounts of energy. This energy reaches the earth by penetrating our atmosphere as high-energy short-wavelength radiation that affects the earth’s climate by heating the atmosphere and the earth’s surface. The

\(^{16}\) The troposphere is the lowermost part of the atmosphere, between the earth’s surface and around 10 km altitude.
earth then radiates low-energy long-wavelength radiation out in space again. The greenhouse effect however creates a more complex system.

Gas molecules and aerosols in the outer part of the atmosphere reflect x-rays and ultraviolet radiation as well as causing scattering and diffuse reflection. This results in approximately a 20% reflection of the sun’s radiative energy. On a clear day when there are no cloud formations this means that some 80% of the sun’s energy reaches the earth’s surface, while on an overcast day clouds will both reflect and absorb energy. A factor that describes how much of the radiation that is reflected by the earth is the albedo. With a high albedo most of the radiation is reflected and consequently a low albedo absorb more energy – the earth’s mean albedo is about 0.3 with contributions from clouds, the earth’s surface and atmospheric constituents (Rummukainen, 2005). Changes in the earth’s albedo can also affect the climate, in the sense that a higher albedo reduces available energy and tends to lower the mean temperature of the earth and vice versa. The earth consequently absorb and reflect radiation energy both in the atmosphere and at the surface – climatological and meteorological variations affect how much and where. Energy that is absorbed by the earth’s vegetation, soils and surface waters is however not accumulated indefinitely but is emitted as long-wave radiation. Most of this radiation is absorbed by GHGs in the atmosphere and is reflected back to earth, thus making the atmosphere work as insulation. The GHGs thus allows short-wavelength radiation to pass through while they absorb long-wavelength radiation. As this effect is similar to a greenhouse, the phenomenon has received the name greenhouse effect.

It is vital to have an insulating layer of carbon dioxide and other GHGs in order for biological life as we know it to survive on earth. The earth has a carbon dioxide

---

17 Examples for surface albedos are: ice and snow 0.5-0.9, forests and fields 0.050-0.3, water at vertical radiation is very low (approx. 0.02) while it is high for low angular radiation (Strahler and Strahler, 1992).
balance where carbon emissions from the combustion of fossil fuels, cement production and tropical deforestation are offset by uptake in oceans as well as increasing biomass and accumulation in the atmosphere (Table 2.1). The increased atmospheric carbon dioxide level of 3.3 Gt per year have however affected the insulation level and amplified the greenhouse effect (IPCC, 2000).

Table 2.1 Earth’s carbon dioxide budget (1989-1998)

<table>
<thead>
<tr>
<th>Source</th>
<th>Gt/year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Emissions</strong></td>
<td></td>
</tr>
<tr>
<td>Fuel combustion and cement production</td>
<td>6.3</td>
</tr>
<tr>
<td>Land-use change</td>
<td>1.6</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td>7.9</td>
</tr>
<tr>
<td><strong>Uptake</strong></td>
<td></td>
</tr>
<tr>
<td>Oceans</td>
<td>2.3</td>
</tr>
<tr>
<td>Terrestrial</td>
<td>2.3</td>
</tr>
<tr>
<td>Atmosphere</td>
<td>3.3</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td>7.9</td>
</tr>
</tbody>
</table>

*Source: IPCC, 2000*

Skeptics to the belief that humans contribute to global warming and the greenhouse effect often turn to other explanations and there are a number of global and astronomical factors that have, or seem to have, an impact on the climate. The Milankovitch theory suggests that environmental changes such as the ice ages have been caused by variations in the earth’s orbit around the sun (Strahler and Strahler, 1992). The oceans are believed to be able to change the atmospheric conditions due to alterations of plankton activity and carbon lockup. Some believe that solar phenomenon’s such as varying energy output is responsible for climate change. Another suggestion is that volcano activity would be the cause. While the two first seem to affect the climate and the latter two inarguably do, the latest warming have
such a strong correlation to the concentration of carbon dioxide in the atmosphere that it cannot be overlooked.

2.2.2 Greenhouse Gases

The earth thus has a natural greenhouse effect maintained, by water vapor and some amount of carbon dioxide in the atmosphere, controlled by the geological and biological processes of the natural carbon cycle. The natural greenhouse effect has evidently also varied some over longer timescales. The pre-industrial level of the natural greenhouse effect is often given as 30°C, meaning that the global mean surface temperature would be so many degrees colder without it. Depending on how one considers the effect of water vapor and clouds on the albedo and the natural greenhouse effect in such budget calculations, the effect could also be argued to be somewhat smaller, but nevertheless both considerable and most significant (Rummukainen, 2005).

Water vapor exists as clouds in our atmosphere as a natural part of the earth’s hydrologic cycle and is more effective as a GHG at higher altitudes. Aerosols, which mainly originate from volcanic eruptions, work as a cooling agent due to its ability to collect moisture and facilitate the creation of clouds that are more reflecting than normal clouds as its content of sulphur compounds contributes to the reflection efficiency. Methane (CH$_4$) is developed through decomposition of organic material under anaerobic conditions as well as through digestion by livestock. Nitrous oxide (N$_2$O) is released by nitrification in soils, wood and grasslands. Carbon dioxide is occurring in large concentrations naturally but the rise in concentration that our anthropogenic emissions create is enough to generate variations in our climate.

All anthropogenic greenhouse agents are gases except for aerosols, which if caused by combustion do not have a very large affect on the climate as they occur on low altitudes and have low suspending times due to precipitation. Combustion in
aviation has special implications as the emissions from the combustion contribute to cloud formation at high altitudes.

The anthropogenic GHGs that are included in the KP are carbon dioxide (CO$_2$), methane (CH$_4$), nitrous oxide (N$_2$O), hydrofluorocarbons (HFC’s), perfluorocarbons (PFC’s) and sulphur hexafluoride (SF$_6$). The largest anthropological contributor is carbon dioxide followed by methane and nitrous oxide. The main source of carbon dioxide emissions is combustion of fossil fuels and the other GHGs have various sources such as for example livestock and waste (CH$_4$), land use, fertilization and combustion (N$_2$O), home appliances (HFCs), aluminum production (PFCs), heavy electric appliances (SF$_6$). The main data for these emissions in described in Table 2.2 below.

Table 2.2 Data for GHGs under the Kyoto Protocol

<table>
<thead>
<tr>
<th></th>
<th>CO$_2$ (ppm)</th>
<th>CH$_4$ (ppb)</th>
<th>N$_2$O (ppb)</th>
<th>HFC (ppt)</th>
<th>PFC (ppt)</th>
<th>SF$_6$ (ppt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-industrial concentration$^i$</td>
<td>228</td>
<td>700</td>
<td>270</td>
<td>0</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>Present concentration (1998)</td>
<td>365</td>
<td>1,745</td>
<td>314</td>
<td>22</td>
<td>83</td>
<td>6</td>
</tr>
<tr>
<td>Rate of concentration change</td>
<td>1.5</td>
<td>7.0</td>
<td>0.8</td>
<td>1.5</td>
<td>0.9</td>
<td>0.24</td>
</tr>
<tr>
<td>Atmospheric lifetime</td>
<td>5-200$^{ii}$</td>
<td>12</td>
<td>114</td>
<td>1-260$^{ii}$</td>
<td>&gt;10,000$^{iii}$</td>
<td>3,200</td>
</tr>
</tbody>
</table>

$^i$ About 1750  
$^{ii}$ Exact lifetime depends on different uptake processes  
$^{iii}$ Differs between different gases

Source: IPCC, 2001b

The Kyoto Protocol measures the total emissions of anthropogenic GHGs in carbon dioxide equivalents, which are calculated through using the agents’ global warming potential (GWP) compared to carbon dioxide. The GWP thus that describes the gaseous agents’ ability of to trap energy. To calculate the amount of carbon dioxide equivalents the respective GHG emissions are multiplied with its respective GWP
(Table 2.3). The GWP varies depending on the preferred time horizon as some gases have larger effects in a short-term perspective than in the long-term and vice versa. The UNFCCC has decided that parties to the Kyoto Protocol should use a 100-year perspective when reporting their emissions.

Table 2.3 Global warming potential (GWP) of various GHGs

<table>
<thead>
<tr>
<th>Gas</th>
<th>GWP&lt;sup&gt;100&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO&lt;sub&gt;2&lt;/sub&gt;</td>
<td>1</td>
</tr>
<tr>
<td>CH&lt;sub&gt;4&lt;/sub&gt;</td>
<td>21</td>
</tr>
<tr>
<td>N&lt;sub&gt;2&lt;/sub&gt;O</td>
<td>310</td>
</tr>
<tr>
<td>HFC 134a</td>
<td>1,300</td>
</tr>
<tr>
<td>CF&lt;sub&gt;4&lt;/sub&gt;</td>
<td>5,700</td>
</tr>
<tr>
<td>SF&lt;sub&gt;6&lt;/sub&gt;</td>
<td>23,900</td>
</tr>
</tbody>
</table>

Source: IPCC, 2001b (HFCs and PFCs are present in many forms that have different GWPs; two examples for common varieties are described.)

The EU-ETS primarily only includes carbon dioxide in the first commitment period but the system is designed to handle the GHGs included in the KP. Since the Linking Directive (2004/101/EC) however allows the use of the KP flexible mechanisms all KP gases are included through the Clean Development Mechanism and the Joint Implementation mechanism.
2.3 Emissions of Carbon Dioxide

2.3.1 The International Situation

The anthropogenic increase of carbon dioxide in the global atmosphere began with the industrialization a couple of centuries ago and the concentration of carbon dioxide has risen from a level of 228 ppm in 1750 to 365 ppm in 1998 (Figure 2.1) and is increasing by about 2 ppm per year (IPCC, 2001a). Until around mid 20th century, the emissions grew rather slowly. Since then, the use of energy, fossil emissions and atmospheric carbon dioxide concentration have increased considerably. The present atmospheric levels seem unique at least over the past 20 million years (IPCC, 2001a). The anthropogenic increase in atmospheric greenhouse gases expressed as carbon dioxide equivalents is to date 50-60 % compared to the pre-industrial times (Rummukainen, 2005). The amount of water vapor responds to a warming due to increasing amounts of the other greenhouse gases, which gives rise to additional warming.\(^{18}\) World Meteorological Organization (WMO, 2006) recently identified that the 2005 levels were 379 ppm setting a new record since the measurements started.

The IPCC SRES look at the future from a number of different standpoints such as social, economic, technological and environmental developments but do not include any environmental or climate schemes such as the KP or the EU-ETS. The SRES A2 and B2 scenarios are those most readily used. The A2 scenario is based on a business-as-usual assumption with the same acceleration of carbon dioxide concentration as we experienced during the end of the 20th century. The result of this scenario is that the global levels of carbon dioxide in the atmosphere will reach over 800 ppm by

\(^{18}\) A so-called positive feedback in the sense that an initial warming as a direct response to emissions gives rise to climate processes that drive forth an additional warming.
2100. The B2 scenario is more positive and predicts a slower rise to a level of about 600 ppm and thus also exceeding the 550 ppm goal.

Figure 2.1 IPCC SRES for atmospheric carbon dioxide concentrations

![Figure 2.1 IPCC SRES for atmospheric carbon dioxide concentrations](source: IPCC, 2001a)

According to an EU inventory of the emissions of GHGs carried out by the EEA (2006) in 2005, EU-15 emissions rose by 1.3 % in 2003 and 0.3 % in 2004 after a period of declining and are currently 0.9 % below the 1990 baseline. Given this and the EU’s KP commitment, stronger policy actions on reducing the GHG emission levels on an EU level are likely. There are different outlooks on the possibilities for the EU-25 to reach the KP targets the inclusion of the EU-10, with substantially reduced emissions based on the 1990 baseline due to economic recession, will have a positive contribution. The 2005 EEA (2005a) inventory also finds that reaching the EU KP commitments will probably require that some Member States lower their emissions.
more than their national targets and that the KP project based mechanisms could be used to create a buffer resulting in emission levels that surpass the KP commitment.

2.3.2 The Swedish Situation

The Swedish emissions of GHGs were drastically raised after the WWII but had after a peak in 1970 been steadily decreased; foremost due to establishing a nuclear programme to handle the increasing electricity demand as well as parliamentary resolutions to steer energy supplies away from oil dependence. The Swedish anthropogenic GHG emissions pattern correspond to the general international situation where the emissions of carbon dioxide are responsible for approximately 80 % of the carbon dioxide equivalent emissions (Swedish EPA, 2005) followed by nitrous oxide and methane. Sweden was in 2001 on 1st place when listing EU-15 and OECD countries with lowest GHG emission volumes per GDP and on 4th place per capita (SEA, 2004a). The latest report on the Swedish GHG emissions, released by the national EPA, point to continuous emission reductions of all GHGs with 2005 emission levels being 7.3 % lower than 1990 levels (Swedish EPA, 2006b). While 2005 was a wet-year with high hydropower the emissions was reduced also after being corrected to a normal year.

Due to increasing electricity demand in the 1960s and the oil crises of the 1970s Sweden faced the challenge to ensure security of supply while reducing oil dependence, which was met by establishing a programme for nuclear energy. Of the 12 rectors that were deployed within this programme all except two are still running today, supplying almost 50 % of the produced electricity in Sweden. Another share, also close to 50 % of the electricity production, is produced in hydropower plants. The rest of the electricity is produced with renewable energy sources (RES) and fossil fuels in CHP plants as well as other production forms (Figure 3.1). These production characteristics result in relatively low carbon dioxide emissions from the energy
utilities. See Chapter 3.7 for more information on carbon dioxide emissions in the Swedish energy system.

Table 2.4 Historic and future Swedish carbon dioxide emissions per sector (1990-2020)

<table>
<thead>
<tr>
<th>Sector emissions (kton)</th>
<th>1990</th>
<th>2001</th>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial combustion</td>
<td>11,090</td>
<td>10,453</td>
<td>11,868</td>
<td>12,047</td>
</tr>
<tr>
<td>Transport</td>
<td>18,302</td>
<td>19,506</td>
<td>21,717</td>
<td>23,975</td>
</tr>
<tr>
<td>Electricity and district heating production</td>
<td>7,663</td>
<td>8,077</td>
<td>10,077</td>
<td>13,999</td>
</tr>
<tr>
<td>Other heating (buildings and service)</td>
<td>10,512</td>
<td>6,924</td>
<td>4,426</td>
<td>3,065</td>
</tr>
<tr>
<td>Other energy</td>
<td>1,813</td>
<td>1,350</td>
<td>1,656</td>
<td>1,970</td>
</tr>
<tr>
<td>Oil refineries</td>
<td>2,133</td>
<td>2,548</td>
<td>3,499</td>
<td>3,561</td>
</tr>
<tr>
<td>Industrial processes</td>
<td>4,012</td>
<td>4,192</td>
<td>4,605</td>
<td>4,767</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>55,526</strong></td>
<td><strong>53,050</strong></td>
<td><strong>57,678</strong></td>
<td><strong>63,067</strong></td>
</tr>
<tr>
<td>Difference compared to 1990</td>
<td></td>
<td>4 %</td>
<td>14 %</td>
<td></td>
</tr>
</tbody>
</table>

Source: SEA and Swedish EPA, 2004d

The current political agenda however advocates a phase-out of nuclear energy. The phase-out of the first reactor, Barsebäck 1 in November 1999, did not result in a large raise of carbon dioxide emissions as the short-term shortfall could be met by increased electricity import and higher hydropower production. The second reactor, Barsebäck 2, was phased-out in May 2005 and the combined shortfall will be replaced by power uprating (Chapter 3.2.1) in the remaining reactors while policies also promote RES and energy efficiency. Any further nuclear phase-out of reactors is likely to prove more difficult to replace with nuclear power, as the potential for further uprating is reduced, or increased hydropower utilization is limited by the Environmental Code. In the energy utilities, as well as in the basic industries, RES and energy efficiency thus hold the main potential for reducing the specific carbon dioxide emissions while also supporting the national energy policy goal of a secure
and environmentally friendly supply\textsuperscript{19}, i.e. not relying on electricity import or fossil fuels. Promoting this development will require a set of well-functioning and long-term policy instruments.

Other large GHG emission sources in Sweden are transport, industry, buildings and energy, as is the case in all developed countries. Transport and buildings are despite their importance in this context due to large emissions, not included in the EU-ETS and consequently not in the scope of the thesis. The Swedish basic industry however is, making their energy utilization and processes of interest to the thesis. The basic industry has relatively high carbon dioxide emissions per production value in an EU comparison, which largely can be seen associated with the industrial sectors and their large share of low-refined raw material as well as climate and other regional reasons. This does however not reflect on the emission efficiency of the industrial processes where the Swedish industries are internationally competitive. (\textit{Chapter 4 includes more detailed information on the Swedish basic industries present situation of carbon dioxide emissions}.)

Swedish carbon dioxide emissions have been reduced by about 40% during the period 1970-1997 (SOU 2000:23), which is mainly a result of reduced oil consumption. Both the basic industry and energy utilities have contributed to this development by for example utilizing a higher share of RES and switching to electricity produced by nuclear energy. Other contributions are the continuing development of district heating systems and CHP production as well as improved industrial production technologies and energy efficiency improvements. This and other efforts have according to a governmental communication (Ds 2005:55) uncoupled the carbon dioxide emissions from the GDP, which are usually seen as correlating. The current emission targets are in the short term to lower the Swedish GHG emissions with -4 %

\textsuperscript{19} Established in the 2002 Energy Bill (2001/02:143). See \textit{Chapter 5.3.1 for more information}. 

42
comparing to a 1990 baseline and in the longer term to reach 4.5 tons per capita and year in 2050 and to thereafter continuously decreasing (Bill 2001/02:55). The long-term goal means that the present emissions of about 7.9 tons per capita have to be reduced by about 1% per year. See Chapter 5.3.1 and 10.1 for more information about the Swedish climate goals.

The SEA expects emission levels to be stable in the short term until 2010. During this period the emissions from electricity production are expected to be fairly constant while industrial emissions are believed to rise and the buildings and service sector are believed to decrease their emissions (SEA, 2000b). A projection until 2020, by the SEA and Swedish EPA (2004b) in the evaluation of the climate strategy, expects the carbon dioxide emissions to increase with 5.7%. In a longer perspective to 2050, Elforsk scenarios however expect the carbon dioxide emissions to decrease by 25 Mton per year (Elforsk, 1996).

The Swedish emission scenario in Table 2.4 could change if the nuclear energy phase-out is accomplished without climate considerations. This means that the negative effects of a non-sustainable nuclear phase-out could possibly be two-fold; leading to increased utilization of fossil fuels in both energy utilities and basic industries. What is interesting to note is that the scenario in Table 2.4 does not account for any further nuclear phase-out until the remaining reactors have reached the age of 40 years. The SEA (2000b) scenario to 2010, which prognoses relatively stable emissions during that period, does not account for any phase-out at all – including Barsebäck 2.

Both scenarios indicate that the emission targets set by the political agenda could be difficult to reach and that additional efforts to reduce GHG emissions are likely to be necessary. Sweden as well as the EU has concluded that effective policy instruments promoting RES and energy efficiency are an essential part to accomplish emission reduction. This is further discussed in Chapter 5.
2.4 Effects on the Environment

2.4.1 Changing the Global Climate System

The global climate system is, as mentioned earlier in the chapter, very complex and it is therefore difficult to predict what levels of greenhouse agents and carbon dioxide that is required to change the climate. It is likewise difficult to predict what such a change could lead to in respect to changes in weather systems, environmental and biological conditions etc. The IPCC has identified a rise in carbon dioxide after the industrialization that they with absolute certainty connect to human activity which has lead to a mean global temperature rise of about 0.6°C during the 20\textsuperscript{th} century (IPCC, 2001b). Bearing in mind that the mean global temperature at the latest ice age was about -4°C lower than present, it is clear that a small change in temperature can cause large effects, so the present change in temperature not as insignificant as it might seem. So what could this change in atmospheric carbon dioxide equivalents concentrations climate mean in terms of climatologically modified conditions? The answer to this is not easy since there are many different interpretations.

There are a number of basic changes that can play a vital role in a changed climate – either supporting or counteracting continued global warming. Melting ice caps changes the world’s albedo, leading to a larger direct reflection of short-wave radiation due to sea level rise and larger sea surface. Melting ice caps could also change the ocean’s salinity, which could cause altered ocean currents and to some beliefs even a new ice age. Colder oceans would furthermore lock-up more carbon dioxide. A sea level rise would on the other hand lead to drowning of lowlands, which would give large methane emissions due to decomposition. This is also the case for melting permafrost regions. A higher sea temperature would lead to unlocking of carbon dioxide and thus reinforcing climate change. These are merely a few short illustrations of what might happen as a result of changed climate conditions and the list could be made...
much longer. There are also worries that changes can lead to irreversible threshold effects. Evidence has been found in ice cores that alterations of atmospheric conditions can occur in a matter of years and alterations of the global climate in decades.

Barrow (1995) sets three limitations on the predictions of climate change, and thus the creation of scenarios, based on past variations:

1. Human pollution and its influence on the climate may enforce or counteract natural changes (as seen above)
2. Unpredictable events such as volcanic eruptions may affect the climate
3. Climate variations can be faster than in the past

The oceans are important in this discussion as they have the capability to incorporate 70 – 80 % of all carbon dioxide that is emitted (IPCC, 2001b). This process however takes centuries due to slow ocean mixing meaning that carbon dioxide that is emitted today will be affecting the climate under a long period. This calls for emission cuts that are significant both in the short and long term.

The various trends of climate change that has been identified can be compared to each other to produce evidence for the theory that change is occurring. Such a comparison carried out by the IPCC (2001b) found that the evidence for an increasing global temperature is very strong, concluding that even if natural factors have had an influence, anthropogenic forcing is largely responsible.

### 2.4.2 Present and Predicted Effects

The list of international publications establishing climate scenarios and pinpointing possible future effects from acclaimed institutions and stakeholders could be made very long. This is one of the foundations for establishing that there is a consensus
around the fact that climate change is occurring and that the emissions of carbon
dioxide are contributing to this development. The main scientific body on the climate
issue is however the IPCC and their publications are consequently used here.

The IPCC concludes that the global temperatures has changed in many regions,
warming has occurred in some and cooling in others, but the global mean
temperature has risen with about 0.6°C under the 20th century (IPCC, 2001b). During
the same period the sea level has risen with 0.1 – 0.2 m, which is likely to be the
result of melting ice caps and expanding oceans due to warmer water. Precipitation
has increased in most parts of the northern hemisphere while it has decreased in
most subtropical regions. The IPCC has also identified an increase in the intensity of
extreme weather events in many regions.

The future effects are analyzed and explained with the SRES scenarios and the
predicted effect are, for example; sea level rise, loss of biodiversity, and increased
pests to increased costs due to different kinds of property damage. The increase in
global mean temperature will according to the different SRESs be 1.4 – 5.8°C to 2100
resulting in a 0.1-0.8 m sea level rise (ibid). If the emissions would be stabilized at 550
ppm the scenarios indicate that the temperature rise would stabilize at about +3°C
around year 2300. At a constant rate of the 2000 emission levels the temperature rise
would initially be slower albeit it will coincide with the 550 ppm scenario around
year 2300 and thereafter continue to rise with approx 1°C per century. There are
studies that show that the climate systems could be much more sensitive and that the
increase in temperature in the future could be as high as 11°C (Stainforth et al, 2005)
albeit there is not a scientific consensus on this. The Arctic Council has assembled an
Arctic Climate Impact Assessment (ACIA, 2004) that concludes that the arctic ice will
melt by the end of this century and others report that this may occur as soon as 2040
(Holland et al, 2006).
There are fears that future effects of a changed climate are likely to be worst for those regions that already suffer from poor environmental conditions such as scarce resources, desertification and flooding, as these conditions are expected to worsen. This situation is regarded as a threat to the stability and peace of those regions due to the risk for conflicts and migration. Sea level rise is likely to have a devastating effect on Small Island States of which many may simply meet Atlantis futures. One report on the effects of climate change that recently have received a high level of attention is the Stern Report to the United Kingdom’s HM Treasury, identifying that avoiding the worst effects could cost about 1 % of global GDP, while the costs of climate
change could be as large as 5-10% of GDP (Stern, 2006). According to the report the main response to this threat is low-carbon policies.

Sweden and the Nordic region have, as the rest of the world, experienced a number of weather records during the recent time period. A changed climate in Sweden would cause many of the same negative effects as would occur globally. But besides these negative effects it is also likely to include some relatively positive outcomes. Future national effects include higher temperatures (Figure 2.2) and higher precipitation. Sweden’s biomass yield would rise due to growing regions migrating north and hence creating more arable land. This can have an effect on the energy system, as it would lead to a higher availability for biomass. The higher precipitation is likely to be more evenly distributed over the year creating improved conditions for Swedish hydropower as it facilitates a higher production and easier management of dams and reservoirs. Both these would probably also cause positive economic outcomes. Climate change risks include introduction of new pesticides as well as changes to biological species of national cultural values such as herrings and cloudberries.

2.5 Summary

Carbon dioxide is the largest anthropogenic GHG and should thus be the main target in climate policy measures. The current emission levels are larger than the uptake and thus result in a net contribution to the atmosphere, which will remain in the atmosphere and contribute to the greenhouse effect for a substantial time period. The international emission levels are rising and the EU emissions are not being reduced in a way that will reach the KP commitments. The Swedish emissions have however been uncoupled from the economic development and are substantially lower than the KP commitment and close to the stronger national emissions target.
The only natural process that counteracts the increase of concentration of carbon dioxide in the atmosphere is carbon sinks in oceans and terrestrial biomass. The uptake in the oceans is difficult to influence but avoiding deforestation and engaging in reforestation have a positive impact through increased carbon sink volumes. In the context of this thesis and the stakeholders herein, the areas where measures can be taken to lower emissions of carbon dioxide lie in industrial processes as well as utilization and production of electricity.

These measures can be categorized according to four main focuses; (1) switching to renewable energy sources, (2) efficient energy production, (3) efficient energy consumption and (4) carbon capture and storage (CCS). Technologies to separate carbon dioxide have been developed making CCS a possibility but the technology has not yet fully commercial. The focus hereinafter is therefore on the former three areas.

The international emission situation and the nature of climate change calls for a long-term climate and energy policy framework with significant effects also in the short-term.
3. The Swedish Energy System and Utilities

Sweden was after the WWII increasingly depending on oil as an energy source in the electricity and heat production, industrial operations and other societal sectors. The rapid development during the 1960s was associated with steadily increasing electricity demand. This sparked the introduction of a nuclear programme, which was aimed at forming a stable foundation for the energy infrastructure together with hydropower. The following 1970s oil crises demonstrated the vulnerability of energy infrastructures relying on oil supply and made it apparent that Sweden had to improve the security of energy supply – a challenge that provided increased support for the nuclear programme. The nuclear and hydropower production pattern still forms the basis of the Swedish electricity system, while also including cogeneration utilizing fossil and biofuels. Renewable energy sources (RES) are also represented by a small share of wind power. The current Swedish energy agenda is outlined in the 2002 Energy Bill (2001/02:143) promoting a secure, efficient and environmentally-
friendly energy supply. A recent addition to the agenda is the governmental initiative to eradicate the use of fossil fuels in Sweden to 2020. Albeit this may seem as, and indeed is, a tremendously bold initiative, its Achilles heel will most probably prove to be the transport sector.

The three markets for energy in Sweden are electricity, district heating and gas, which are all deregulated. The Swedish electricity system is not isolated as it is connected to both Nordic and European systems, which offer increased flexibility and security of supply within the larger system. A positive environmental influence of this is the possibility to substitute non-efficient and polluting electricity production in other countries if feasible. Both the electricity and gas markets are subject to the creation of internal markets within the EU. The establishment of Swedish district heating systems began in the 1950s and the systems today supply a large share of the heat deliveries to buildings. The gas market in Sweden is very limited supplying only 2% of the national energy consumption, mainly in the south-western parts of Sweden (SEA, 2004c). The development of the district heating and gas markets are promoted in the Energy Bill (2001/02:143), as they are seen as supporting the climate and energy policy goals.

The energy prices in Sweden and the rest of the world are rising. The reasons are mainly the scarcity of oil supply and recently also natural disasters. This has had a significant impact on the price for oil as well as coal, gas and other energy commodities. In the EU case the price increase has been strengthened by the EU Emissions Trading Scheme (EU-ETS), having resulted in higher electricity prices. Future price developments are difficult to predict due to, for example, policy developments and the emergence of multilateral energy markets.

The situation where the main part of the energy is produced in nuclear and hydropower plants, as well as in cogeneration with a high rate of renewable fuels, result in low carbon dioxide and other GHG emissions from the Swedish energy
utilities. The current political agenda however advocates a phase-out of nuclear energy and the Environmental Code limits the possibilities for increased hydropower utilization. There is consequently a need for restructuring the energy system once again this is part of the background against which the thesis aims to highlight stakeholder opinions on climate and energy policy decisions.

Within the Swedish business sectors, the energy utilities are possibly the sector that are most influenced by policy decisions. The reason for this is the importance of the energy infrastructure in a societal context. This situation highlights the importance of an effective dialogue with the Government to collaborate in the design of a policy framework that is effective in reaching the policy goals that are set by the parliament and international climate commitments.

This chapter explains the energy system in Sweden with respect to the energy infrastructure and future production. The chapter starts with short presentations of the key institutions and stakeholders in the energy sector. Thereafter the fundamentals of the Swedish electricity production are explained followed by heat production and cogeneration, mainly in the light of district heating systems. These chapters analyze the current production, possibilities for increased capacity and the policy instruments relating to the production. Thereafter security of energy supply is discussed, as it is one of the main energy policy goals in Sweden as well as the EU. This is followed by a description of the GHG emission situation and future energy production, as the relationship between these two is essential to the development. The chapter does not aim at including all potential technologies and improvements but rather to establish that several production technologies can contribute to reducing the GHG emissions from the energy utilities.

20 The gas market is mainly explained in Chapter 3.8 regarding future production due to its minor share of the energy market at present.
3.1 Stakeholders

The main stakeholder groups in the energy system are governmental institutions, the power grid administrator, energy utilities and the different electricity and heat market actors. Some stakeholders are included due to their work with the climate change issue within the energy system. Energy consumers are also stakeholders and the basic industry, being the main consumers within the scope of the thesis, is analyzed in Chapter 4.

Table 3.1 Stakeholders within the energy utility sector

<table>
<thead>
<tr>
<th>Political</th>
<th>Non-Political/Utility/NGO</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Ministry of Industry, Employment and Communications</td>
<td>- Confederation of Swedish Enterprises</td>
</tr>
<tr>
<td>- Ministry of Sustainable Development</td>
<td>- Swedenergy</td>
</tr>
<tr>
<td>- Swedish Energy Agency</td>
<td>- Svensk Fjärrvärme</td>
</tr>
<tr>
<td>- Swedish Environmental Protection Agency</td>
<td>- Elforsk (50%)</td>
</tr>
<tr>
<td>- Svenska Kraftnät</td>
<td>- Värme forsk (50%)</td>
</tr>
<tr>
<td>- Elforsk (50%)</td>
<td>- Vattenfall</td>
</tr>
<tr>
<td>- Värme forsk</td>
<td>- Fortum</td>
</tr>
<tr>
<td>- Nordel</td>
<td>- E.ON</td>
</tr>
<tr>
<td>- Nord Pool</td>
<td></td>
</tr>
<tr>
<td>- International Energy Agency (IEA)</td>
<td></td>
</tr>
<tr>
<td>- EU DG - Energy and Transport</td>
<td>- Numerous sector organizations within different energy sectors such as Eurelectric, Euroheat &amp; Power, and European Transmission System Operators (ETSO)</td>
</tr>
<tr>
<td>- EU Parliamentary Committee on Industry, Research and Energy</td>
<td></td>
</tr>
<tr>
<td>- EU Transport, Telecommunications and Energy Council</td>
<td></td>
</tr>
</tbody>
</table>

1 Elforsk and Värme forsk are governmentally and privately co-financed.

The table is non-exhaustive but defines stakeholders of importance in the thesis.

---

21 The table is non-exhaustive but defines stakeholders of importance in the thesis.
3.1.1 Agencies and Institutions

The main Governmental agency, besides the Swedish EPA (Chapter 2.1.1) that concern climate and energy policies is the Swedish Energy Agency. The energy utilities are also represented by organizations working as representatives for the utilities interests regarding climate and energy policies. The different stakeholders are cooperating on various levels – the business sector through sector organizations and the agencies through ministries. A variety of forums for sharing experience and opinions between the different sectors include for example the yearly conference “Energitinget” held by the Swedish Energy Agency, consideration of official committee reports, formal and informal meetings initiated by either political or non-political stakeholders as well as debate in the media.

**Swedish Energy Agency**

The Swedish Energy Agency (SEA), reporting to the Ministry of Sustainable Development, has the main responsibility to secure the supply of electricity and energy in both the short and long term through supporting the energy policy agenda and its policy instruments. The work also includes promoting effective and sustainable energy production and consumption. The agency’s responsibilities include:

- Coordinating the development of the energy system and markets, especially regarding its influence on climate, environment, business competitiveness and economic growth
- Working for rational production, distribution and usage of energy
- Development and management of policy instruments on climate and energy

Further information is available at http://www.stem.se
• Following the international climate and energy agenda and promoting Swedish participation
• Collecting climate and energy statistics
• Supporting research, development and introduction of energy techniques

The agency hosts two bodies – Energikutvecklingsnämnden, EUN (eng: the energy development board) and Insynsrådet (eng: the control council). The former body work for an increased cooperation with the business sector on R&D issues and to decide on research support, while the latter is responsible for safeguarding consumer interests on the electricity market.

Due to SEA’s role as a central agency for the energy and climate policy instruments, the agency promote, support, manage and evaluate many of the instruments that are of concern within the scope of the thesis, for example Emissions Trading, Renewable Energy Certificates (RECs) and the programme for energy efficiency (PFE). The agency is also, in cooperation with the Swedish EPA, responsible for evaluating the Swedish Climate Strategy at the control stations.

Confederation of Swedish Enterprise

The confederation (CSE) represents some 55,000 Swedish enterprises sharing the goal that Sweden should regain a strong position in the international prosperity league. The CSE’s main function is to work with shaping public opinion, knowledge dissemination as well as developing ideas and suggestions for a better business climate. The confederation has expressed the opinion that the Swedish society cannot develop in a positive and sustainable direction without a successful business sector and promote cooperation with the Government on this issue. They also stress the fact that the Government bears a heavy responsibility for upholding a well functioning

23 Further information is available at http://www.svensknaringsliv.se/
business climate and view the development towards market based control instruments as constructive. Emission right trading is considered positive but the importance of allowing a growing business sector is accentuated. The confederation considers that the Swedish companies are actively working to reduce their emissions of carbon dioxide and other GHGs.

The CSE identifies energy as an important sector within a sustainable development and promotes a safe and environmentally friendly energy system with reasonable prices. The confederation that this should be accomplish through ensuring a high level of competitiveness on Swedish and European electricity markets. The competitiveness of the Swedish basic industry is considered to depend on the electricity price. The confederation objects to a continued phase-out of the nuclear energy plants and are open for the development of new plants. Natural gas is believed to become an important energy resource in the future if the price becomes more favorable.

**Svenska Kraftnät**

The Swedish grid is administered by the governmentally owned Svenska Kraftnät (SvK). SvK’s role as the grid owner includes a range of responsibilities in the administration of the electricity system. This includes operating the system, ensuring a secure electricity supply and contingency planning. SvK is also responsible for issuing certificates under the Renewable Energy Certificates (REC) scheme. Svenska Kraftnät is a shareholder in Nord Pool and Elforsk (see below). SvK is a member of Nordel and the European Transmission System Operators (ETSO).

---

24 Eng: Swedish power grids. Further information is available at http://www.svk.se
**Nordel**

Nordel is a collaboration organization among the Nordic power grid operators. The organization’s aim is to promote and further develop an efficient and harmonized Nordic electricity market. Nordel works with issues regarding system operations, security of supply as well as pricing. The organization also publishes statistics and reports on the state of the Nordic market.

**Nord Pool**

Nord Pool ASA was established to work as a joint power exchange after the deregulation of the Norwegian and Swedish electricity markets. The company is today the trading place for the Nordic power market, licensed as an exchange and clearinghouse for commodity derivatives. Nord Pool is represented in Sweden by Nord Pool Sweden, which has the responsibility for the national trading of emission rights and RECs. Nord Pool ASA is fully owned (50/50) by Norwegian Statnett SF and Svenska Kraftnät.

**Swedenergy (Svensk Energi)**

Swedenergy is the main sector organization within the electricity utility sector with about 350 members of which the majority is corporations. The members are active in electricity production as well as distribution, grid management, trading and other energy related areas. The main objective of the organization is to safeguard the sector’s interests in both a national and an international context. The prioritized work areas are strengthening the confidence for utilities, emphasizing the value of electricity, creating reasonable conditions for grid operations, further developing the Nordic electricity market in a European context. The work also includes promoting

---

25 Eng: Nordic electricity Further information is available at http://www.nordel.org
26 Further information is available at http://www.nordpool.com
27 Further information is available at http://www.svenskenergi.se
well-functioning and internationally harmonized conditions for Swedish electricity production. The organization has committed itself to work actively with environmental and climate issues. Swedenergy is a member of the European energy organization Eurelectric and is the major shareholder in Elforsk.

**Elforsk**

Elforsk was founded by the Swedish electricity utilities to rationalize the R&D within the sector. The work is divided into five programme areas: hydropower, electricity and heat production, transmission and distribution, utilization and strategies and energy system, which among other things work with policy issues. Environmental and climate issues, increasingly related to the EU agenda development, are integrated in all Elforsk programmes. Elforsk is fully owned by Svenska Kraftnät and Swedenergy.

**Svensk Fjärrvärme**

Svensk Fjärrvärme is the sector organization for Swedish district heating companies, which together are responsible for 99% of all national deliveries. The goal of the organization is to promote district heating and cooling as well as cogeneration and Combined Heat and Power (CHP) production and emphasizes the positive climate and environmental effects of these technologies. Svensk Fjärrvärme is the Swedish representative in the European district heating/cooling and CHP association Euroheat & Power.

---

28 Eng: Electricity research. Further information is available at http://www.elforsk.se
29 Eng: Swedish district heating. Further information is available at http://www.svenskfjarrvarme.se
30 The two terms are often used interchangeable - cogeneration can however also be heat production in connection to other energy commodities than electricity, e.g. fuels.
Värme forsk\textsuperscript{31}

The organization Värme forsk has a wider scope than Elforsk, joining the forces of cogeneration producers and district heating companies, electricity producers, energy related consultants, manufacturers and industries as well as the forest industry in R&D on electricity and heat production. The members of the organization are working together to improve production and business conditions with a focus on \textit{inter alia} new fuels, improved efficiencies, adapting to policy instruments and reducing the environmental impact. The organization is financed by the Government through the SEA, as well as and the business sector.

\subsection*{3.1.2 Energy Utilities}

Three large companies – Vattenfall, E.ON and Fortum – are dominating the Swedish energy utility sector, assuming an oligopoly position on the Swedish electricity market. Their share of the Swedish electricity market is 85\% (SEA, 2004a) while their share of the heat market is smaller, supplying 36\% of the distributed heat in 2002 (SEA, 2004c). The three companies have homogenous characteristics as all produce, distribute and sell electricity and district heating plus use nuclear and hydropower for the main part of their production. All three companies work with sustainable development issues and offer different energy management services to their customers. The three interviewed utilities are all members of the European Federation of Energy Traders (EFET)\textsuperscript{32}, which works for the creation of a European energy market.

According to the classification of operations in the EU-ETS (Directive 2003/87/EC), oil refineries and coke works are also included in the energy sector. As these

\textsuperscript{31} Eng: Heat research. Further information is available at http://www.varmeforsk.se

\textsuperscript{32} Further information is available at http://www.efet.org
operations are not utilities they are presented in Chapter 4 as basic industries. Many operations not falling under the energy utility and basic industries are also included in the EU-ETS definition of energy operations due to installed combustion capacity with a larger rated thermal input than 20 MW – these are represented by the Confederation of Swedish Enterprises. Part of the EU-ETS as energy utilities are also combustion installations with a smaller rated thermal input than 20 MW due to installations in district heating systems being opted-in if the installations in the system in total exceed 20 MW. These are represented by interviewing Swedenergy and the Confederation of Swedish Enterprise.

Vattenfall

Vattenfall is the largest energy utility company in Sweden and the fifth largest in Europe. The company is fully owned by the Swedish Government that has given the company the mission to be the leading company in the transition to a sustainable Swedish energy supply, but do not otherwise control the business operations. The main sources of production in Sweden are nuclear and hydropower with additional production in cogeneration, CHP, gas turbines and wind power. The company identifies coal as an important energy source, globally and on Vattenfall’s core markets outside Sweden, in the mid-term future. The company is currently pursuing the possibilities that lie in clean-coal technology by investing in a 30 MW coal plant with carbon capture and storage in Germany (Harju, 2005). Vattenfall has after the expansion of hydropower and nuclear power reduced the carbon dioxide emissions in their Swedish operations by increasing the rate of

33 Further information is available at http://www.vattenfall.com
34 Vattenfall have received critique for operating coal power plants in Germany which has been considered inconsistent with the mission that they have from the Government. Johan Tollin (2005) meets this critique by stating that Vattenfall now operate improved plants, resulting in a 40 % reduction of carbon dioxide emissions.
biofuels in the CHP production and by closing old inefficient operations that did not meet environmental requirements (Tollin, 2005). Vattenfall have also introduced an internal system for carbon dioxide emission abatement which has promoted feasible measures throughout the company. The company has not established any goals for carbon dioxide emissions or energy efficiency (ibid).

Table 3.2 Key figures for Vattenfall 2005

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total net sales Nordic market (MEuro)</td>
<td>4,317</td>
</tr>
<tr>
<td>Employees in Sweden</td>
<td>8,350</td>
</tr>
<tr>
<td>Electricity production overall (TWh)</td>
<td>174</td>
</tr>
<tr>
<td>Electricity production in Sweden (TWh)</td>
<td>90</td>
</tr>
<tr>
<td>Heat production in Sweden (TWh)</td>
<td>4.9</td>
</tr>
<tr>
<td>Renewable electricity production (%)</td>
<td>41</td>
</tr>
<tr>
<td>Share of the Swedish market (%)</td>
<td>47</td>
</tr>
</tbody>
</table>

Sources: Ericsson, 2005; Vattenfall, 2005

Vattenfall’s vision is to become a leading energy company in Europe and as such be the leader in sustainable energy systems. Vattenfall has joined the Swedish Partnership for Global Responsibility and has committed itself to the OECD guidelines for multinational companies and the UN Global Compact. The company has also signed the ICC’s Business Charter for Sustainable Development. Most Swedish business units are certified according to ISO 14001 or EMAS and the company produces a Corporate Social Responsibility report based on the Global Reporting Initiative (GRI) guidelines. The company has furthermore brought
forward suggestions for a future emissions trading system called “Curbing Climate Change”.35

E.ON Sverige36

The energy utilities Sydkraft and Graninge were renamed E.ON Sverige in September 2005 forming Sweden’s second largest utility company. The company is mainly owned by the German E.ON group (55 %) and Norwegian Statkraft (45 %). The Swedish production sources are nuclear and hydropower with minor contributions from back pressure steam turbines, cogeneration, gas turbines and wind power. E.ON Sverige is active in R&D on future sustainable energy systems such as hydrogen and solar-PV technologies.

The company’s new production investments have mainly been wind power as a result of the introduction of the REC system (Chudi, 2005). The company’s work to reduce carbon dioxide emissions is promoted by marketing, policy and business considerations and originates in the scarcity of energy supply and the climate change problem (ibid). The company offers energy efficiency services, as they have identified that many customers do not have sufficient knowledge about this work. The business area is not part of the core business but is offered due to the need for these services on the market. E.ON Sverige has no goals on carbon dioxide emissions but has accomplished reductions through an increased share of biofuels (ibid).

35 For more information on this, see the company’s home page.
36 Further information is available at http://www.eon.se
Table 3.3 Key figures for Sydkraft/E.ON Sverige (2005)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total net sales (MSEK)</td>
<td>25,000</td>
</tr>
<tr>
<td>Employees</td>
<td>5,000</td>
</tr>
<tr>
<td>Electricity production in Sweden (TWh)</td>
<td>36</td>
</tr>
<tr>
<td>Heat production in Sweden (TWh)</td>
<td>7.6</td>
</tr>
<tr>
<td>Renewable production (%)</td>
<td>50</td>
</tr>
<tr>
<td>Share of the Swedish electricity market, generation (%)</td>
<td>24</td>
</tr>
<tr>
<td>Share of the Swedish electricity market, retail (%)</td>
<td>18</td>
</tr>
</tbody>
</table>

Source: Chudi, 2005

E.ON Sverige states that the company sees business opportunities in working with sustainable development and that the prospects to contribute to a better environment lies both within the company and in its contacts with customers and other stakeholders. The company is certified according to ISO 14001.

**Fortum Värme**

Fortum is based in Finland with the Finnish Government as the major owner, holding 60% of the shares. The main production sources in Sweden are hydro and nuclear power with the addition of cogeneration. The R&D is focused on finding carbon dioxide neutral production techniques, improved hydropower and safe nuclear power. The subsidy Fortum Värme is a major district heating actor with the main operations in Stockholm. The company is planning a new large biofueled CHP plant in the area.

---

37 Further information is available at http://www.fortum.se
Table 3.4 Key figures for Fortum and Fortum Värme (2005)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total net sales Fortum Värme (MEuro)</td>
<td>600</td>
</tr>
<tr>
<td>Employees Fortum Värme</td>
<td>500</td>
</tr>
<tr>
<td>Electricity production Fortum (TWh)</td>
<td>51</td>
</tr>
<tr>
<td>Electricity production in Sweden Fortum (TWh)</td>
<td>25</td>
</tr>
<tr>
<td>Heat production in Sweden (TWh)</td>
<td>10</td>
</tr>
<tr>
<td>Share of the Swedish heat market (%)</td>
<td>20</td>
</tr>
</tbody>
</table>

Sources: Käck, 2005; Hult, 2005

The company works towards reducing the specific carbon dioxide emissions from the operations, mainly through fuel switching to biofuels and increased CHP production (Käck, 2005). The motive power behind this work has been twofold, divided on economic optimizations and governmental control through policy instruments (ibid). Fortum Värme has no quantified goals regarding carbon dioxide emissions or production efficiency and Gunnar Käck at the company’s strategic department, identifies that strong goals can sub-optimize the operations with regards to dry-years and subsequent need for operating top load plants with higher emission levels.

Fortum states that they strive to find a balance between the different areas of the sustainable development concept and to be a responsible company that respect the environment of the countries they work in. The company is selected for the Dow Jones Sustainability Index and uses ISO 14001 to promote a structured development of their environmental work.
3.1.3 International Stakeholders

European Union\textsuperscript{38}

The EU has several different bodies at various institutional levels that are of importance for the Swedish energy utilities and their carbon dioxide emissions. The main body that works with the development and implementation of energy and transport policies in the Commission is the Directorate-General (DG) for Energy and Transport. The DG has the responsibilities for accomplishing the internal energy markets (Chapter 5.4.2), a sustainable development of the energy sector as well as international cooperation. At a Parliamentary level the Committee on Industry, Research and Energy is responsible for general energy policy issues, security of energy supply and energy efficiency plus the establishment and development of trans-European energy markets. In the European Council, the Transport, Telecommunications and Energy Council, focus on the creation of internal energy markets, security of energy supply, renewable energy and energy efficiency. Most policy decisions on energy are however remitted to the Member States for implementation in the national code of laws.

International Energy Agency\textsuperscript{39}

The International Energy Agency (IEA) works as an international energy forum, linked to the OECD, for 26 industrialized countries (including Sweden). While initially focusing on issues related to oil supplies, the IEA has widened the agenda to work as a policy advisor for its member states on different issues such as diversity, efficiency and flexibility in the energy supply, energy efficiency, price stability and sustainable development. The countries that are members in the IEA are committed

\textsuperscript{38} Further information is available at http://www.europea.eu.int
\textsuperscript{39} Further information is available at http://www.iea.org
to cooperate on these areas as well as to share energy statistics and other information. The IEA run a number of collaboration programmes that focus on R&D in different areas such as bioenergy, hydrogen, clean coal, pulp and paper as well as other energy production and management areas.

3.2 Electricity Production

The Swedish electricity market was deregulated in 1 January 1996 with the intention to promote competitiveness in production and distribution of electricity. At the time both the Norwegian and Finnish markets had already been deregulated and in 1999 Denmark followed this development. The Swedish deregulation prompted a joint Swedish-Norwegian electricity market and a joint exchange called Nord Pool, which now works as the power exchange for the interconnected Nordic electricity market that includes Denmark and Finland. The Swedish electricity system is today also connected to Germany and Poland and the Swedish energy and electricity systems must consequently be viewed in this larger system context. The larger system boundaries should however not be seen as supporting the goal of security of energy supply stipulated in the Energy Bill (2001/02:143) and the system is therefore analyzed also from the capacity of being self-sufficient in electricity production.

The deregulation of the Nordic electricity markets and the creation of a common power exchange have resulted in a pricing of electricity on the marginal cost to produce electricity – in the Nordic as well as EU markets set as coal back pressure. This has several important market implications, for example in the case of Emission Trading, which is discussed in Chapter 3.6, 6.1 and 10.3.
The Swedish energy system was in the 1960s strained due to a steadily increasing electricity demand. To meet this challenge and to ensure a more stable energy supply to the Swedish electricity production, the oil dependence was mainly replaced with a programme to develop a nuclear energy infrastructure. Of the 12 reactors that were deployed within the programme (1972-1985) all except two are still operating today, supplying almost 50% of the produced electricity in Sweden. Another share, approximately 40% of the electricity production, is produced in hydropower plants. The remaining 10% are produced in CHP plants and industrial back pressure steam turbines with the addition of wind power at roughly 0.5%. This production pattern is identified by Jean-Baptiste and Duceroux (2003) as holding a positive present and future potential to deliver large amount of electricity with low carbon dioxide emissions at a competitive price. These production characteristics have also resulted in improved security of supply in the Swedish energy system, while keeping the consumption of fossil fuels and emissions of GHGs low. This has also affected the
industry emissions, as the prospect of inexpensive and reliable electricity deliveries resulted in large-scale industrial conversions from oil to electricity.

3.2.1 Nuclear Energy

Political decisions based on a 1980 referendum\textsuperscript{40} has established that the nuclear energy shall be phased out in a pace that does not jeopardize the energy supply and in 1997 a law (SFS 1997:1320) was passed that allows the Government to annul the right to carry out nuclear operations at a specific date. The first reactor, Barsebäck 1, was phased-out in 1999. The Energy Bill of 1997 (1996/97:84) had earlier established that the phase-out should continue with Barsebäck 2 when the reactor could be shut down with no obvious negative effects on either the electricity price, the electricity supply to the industry or the environment and emissions of GHGs. As these conditions later were considered to be met, the Barsebäck 2 reactor was phased out in May 2005.

The technical life span of a reactor is estimated to 40 years and since the Swedish reactors are soon approaching this age they are undergoing safety improvements that can be considered life-span prolongations. The current nuclear power capacity is 8,635 MW in 10 reactors that produced 75 TWh of electricity in 2004 setting a new national production record. The decrease in production capacity after the phase-out of Barsebäck 2 is expected to be met by continuous power uprating\textsuperscript{41} in the remaining reactors raising the total effect with about 10 %, meaning an increase of

\textsuperscript{40} In 1980 a public referendum was held to decide on the future of Swedish nuclear power. Three options were possible, where all promoted phasing-put nuclear energy albeit at different paces. Of these the option number two won, meaning that no more than 12 reactors that were in operation, completed or under constructed could be operated. The Socialist Democratic Party added that the phase-out should be completed by 2010.

\textsuperscript{41} When the capacity of nuclear plants is increased with more than 5 % through redesigns it is called power uprating or power uprate. A smaller increase of approx. 2 % is called power increase, which is usually a matter of improved effect measurements (Nilsson, 2005).
approximately 1,000 MW or the equivalent of one nuclear reactor. This development has been supported by the Government in the light of the target to eradicate the use of fossil fuels by 2020 (Sahlin, 2005). Johan Tollin (2005) at Vattenfall identifies the uprating to hold a significant potential for reducing the share of fossil fuels in the Nordic power system. The SSNC (Rylander, 2005) is negative towards uprating the nuclear reactors and identify that within a sustainable energy system all reactors must be phased out.

An important aspect of nuclear energy is the public acceptance. Goldemberg and Johansson (2004) identify that future of nuclear energy in the global energy system is a question of whether a number of issues regarding the production. The important issues relate to the real costs of nuclear energy, public acceptance, safety, waste management and transport as well as use of spent fuels in weaponry. Goldemberg and Johansson argue that the views on these issues should be included in decisions on whether nuclear energy is a viable production alternative or not.

The Swedish public opinion towards nuclear energy has in recent polls shown a much larger acceptance for nuclear energy than at the time of the referendum (Figure 3.2). In fact numerous evidence can be found that nuclear energy seems become more accepted on a global level as a means to mitigate climate change – one example is the positive attitude towards nuclear energy at the recent EU Council Meeting and in the recent Green Paper for a European Energy Strategy (COM(2006) 105 final). The IEA is also highly supportive in the 2006 edition of the World Energy Outlook (IEA, 2006) where increased nuclear energy production is identified as one of main tools to combat climate change. The picture is however distorted as there are strong voices on each side of the spectrum. A recent Eurobarometer (EC, 2006d) for example indicates the exact opposite with a meager 12 % of the European public supporting a nuclear development, albeit 32 % of the Swedish respondents were positive. The Swedish public is however more positive towards a continued utilization of the existing
nuclear facilities (Figure 3.2). The recent incidents at Swedish plants may on the other hand have changed the national public opinion.

The agenda on whether nuclear energy should remain as one of the major contributors to the Swedish energy system has been one of the large political disagreements since the referendum. While some Parties of the Parliament promote a continued utilization of the nuclear capacity as long as the operations are safe, others call for a phase-out with different closing dates. Further discussions on this topic are found in Chapter 5.1.1.

![Figure 3.2 Swedish nuclear energy opinion (1986-2004)](image-url)

Source: Holmberg and Weibull, 2006. Based on SOM Institute research.

The phase-out of Barsebäck 2 means that nuclear electricity production can be expected to decrease in the short-term albeit being successively replaced with power uprating. Further reductions in nuclear capacity will however be difficult to replace in a similar fashion. Depending on how the phase-out is accomplished, it may consequently result in reduced security of supply as well as substantially increased GHG emissions and the reasons for this are twofold. Firstly, this risk is emphasized
by the fact that increased hydropower utilization is limited by legal decisions protecting the environmental value of certain rivers. Secondly, replacing the large amount of nuclear energy that is utilized today is associated with a significant risk of introducing energy sources with higher GHG emission levels. The phase-out must therefore be carried out taking into consideration the achieved introduction of renewable energy production and reduced energy demand due to efficiency improvements. Peter Chudi (2005) at E.ON considers that the current focus on climate change will affect the policies on nuclear energy, making the phase-out less probable under current conditions and in any case slow the phase-out pace down. Former Prime Minister Göran Persson (2006) also said in a preparatory meeting for the March 2006 EU Council meeting that nuclear energy will remain a large contributor in the Swedish energy system for a long period. The SSNC (Rylander, 2005) challenge the view that the phase-out bears a significant risk of raising the carbon dioxide emissions through imports of coal based electricity production, as they identify large potentials in wind power and energy efficiency improvements in the built environment that could be utilized to meet the shortfall. While this agreed upon it is argued that these potential improvements will not be accomplished within the current short-term policy framework that does not effectively promote large-scale RES and energy efficiency investments in the utilities and basic industries.

One of the main issues in the nuclear discussion, which is often forgotten, is the availability of nuclear fuels. An IAEA (2001) report finds that the supply of uranium to nuclear facilities will only be met to 2050 in the low and middle nuclear intensive scenarios. A significant short-fall of supply occurs in the high intensity scenario unless conventional and unconventional sources are exploited at very high costs

42 This position is not likely to change under the new Government, considering the overall position of nuclear energy in the coalition party agendas. Also see Chapter 5.1.1.
The future of conventional nuclear reactors is thus uncertain in a long-term analysis.

A technology called transmutation exists that reduces the amount of long-lived radionuclides in used nuclear fuels that are deposited in ultimate waste storages. The technology will however not be available for large-scale operations for several decades. Another technology that far exceeds the efficiencies of present reactors is breeder reactors which also result in less radioactive wastes. The technology is however associated with large volumes of plutonium handling making it a doubtful alternative from a security perspective. In the long-term future, fusion reactors may revolutionize how we look at energy production but as the technology is in an early state of R&D its possible contribution in energy utilities is very uncertain.

3.2.2 Hydropower

The large share of hydropower in the Swedish electricity system, which contributes to the low specific GHG emissions of the utilities, is accompanied by two special characteristics. One, stochastic pluvial patterns result in fluctuating annual availability of hydropower. The SEA estimates that the average yearly hydropower production, called a normal year, is 65 TWh while the maximum production has been 79 TWh and the minimum 51 TWh. The fluctuations are accompanied by variations in use of fossil fuels – dry years such as 1996 means higher utilization of fossil fuels (Figure 3.1), higher carbon dioxide emissions (Figure 3.10) and higher electricity prices. Due to this, Swedish energy system statistics and emission levels are often adjusted to a normal year to facilitate balanced comparisons. The availability of hydropower will also have large effects on the Emission Trading as it has implications for the allocation of emission rights as well as emission levels. Two, hydropower has the capacity to meet and adjust for variations in the production of
less reliable production alternatives such as wind power due to reserves in dams and reservoirs.

Figure 3.3 Pluvial scenarios in Scandinavia (1981-2100)

Source: Rossby Centre, 2005

The installed hydropower capacity is 16,200 MW and about 98 % of the hydropower production originates from 700 installations larger than 1.5 MW while the other 2 % is produced in 1,200 small-scale installations (IVA, 2002c). The technological potential for improved efficiencies in present hydropower installations, valued to about 3 TWh, lies in improved turbine designs and more efficient generators (Bernhoff et al, 2004). Peter Chudi (2005) at E.ON Sverige estimates the potential in efficiency improvements to about 5 TWh and that this potential could be realized due to the REC system which approves efficiency improvements to be issued RECs.
Johan Tollin (2005) at Vattenfall however estimates the REC contribution to be lower at about 0.5-1 TWh. Climate scenarios produced by different stakeholders, such as the SMHI Rossby Centre (2005) scenario above, indicates that the possible changes to the future climate will mean 20-40 % higher precipitation which would facilitate higher and more reliable hydropower production.

The potential for new installations is limited by the Environmental Code (SFS 1998:808) that protects the environmental values of certain rivers. This means that, while the overall technical potential is around 24 TWh, the possible additional production is only 2 TWh (IVA, 2002c). Lately the possibilities for the water rights court\textsuperscript{43} to reconsider decisions have been improved which potentially can increase the investment risk for new and present operations. Another policy decision that may have impeded increased hydropower production was the suggestion by the Ministry of Sustainable Development (2005) to exclude small-scale hydropower production from the REC system – a decision that was criticized by several stakeholders. The suggestion was supported by the Council on Legislation\textsuperscript{44} and the Ministry of Sustainable Development states in the Bill (2005/06:154) on the REC system that they will decide on this issue at a later occasion. This is a negative example of a situation where political decisions may postpone investments in a utility production category that has been, and may depending on upcoming decisions continuously be, promoted by the Government. The new government has however annulled this decision (Chapter 6.2). Further new installations could be established if new policy decisions promoting this are taken but then at higher production costs compared to present production (IVA, 2002c). Further regulation of hydropower installations is stipulated through the EU Directive on Water Policy

\textsuperscript{43} The court that has the jurisdictional responsibility to administer the national water resources.

\textsuperscript{44} See appendix 7 in the Bill 2005/06:154 for the proposal by the Council on Legislation.
(2000/60/EC) that establishes a framework for the protection of different water bodies.

3.2.3 Cogeneration and Industrial Back Pressure Steam Turbines

Cogeneration in CHP plants produces the third largest amount of electricity, at 7.5 TWh in 2004 (SEA, 2005a), after hydro and nuclear power. The production is closely interconnected to the district heating systems and the production is depending on economic optimizations based on a complex set of variables including heat demand, electricity prices and policy instruments. While the CHP technology is not as feasible if there is no need for heat, CHP plants can exclusively produce electricity to maximize profit during periods of high electricity prices. The production of electricity in CHP plants is expected to rise to 9 TWh in 2007 (ibid). This is supported by the EU that has established a goal to double the electricity generation in CHP plants from 9 % in 1997 to 18 % in 2010 (COM(97) 514 final). Industrial back pressure steam turbines45 produced the fourth largest amount electricity in 2004 with 5.4 TWh (SEA, 2005a). Electricity is produced in the industry mainly in the pulp and paper sector, which utilizes renewable by-products such as black liquor for this purpose. The production is subject to operational optimizations, depending on the market state as well as the electricity price. An increase of the electricity production capacity with 1.3 TWh is expected up to 2007 as a result of the REC system (SEA, 2005a).

Both CHP plants and the industries are important for renewable electricity production in the light of the non-fossil goal, having the potential for increased utilization of RES. The assessment of the REC system showed that during the first

45 Also called industrial cogeneration.
year the production with RES in existing installations increased to about 10 TWh (SEA, 2005h). The assessment report furthermore identifies the potential for increased renewable electricity production in the future to be positive, estimating that the maximum level in 2012 is about 23 TWh and in 2015 being 26 TWh. It is therefore established that there is enough potential to motivate a higher goal in the REC system of 15 TWH to 2015 (ibid).

**Figure 3.4 Fuel supply in Swedish electricity production (1983-2005)**

![Figure 3.4 Fuel supply in Swedish electricity production (1983-2005)](image)

*Source: SEA, 2006d (Data excludes nuclear power)*

The CHP production mainly utilizes biofuels while the industry also utilizes production by-products from fossil fuels, such as gases resulting from coal used in metallurgical processes. See Chapter 4.3 for more information on the energy consumption in the industry. As is seen in Figure 3.4 the share of biofuels in the electricity production was slowly increasing prior to the large increase after the introduction of the REC scheme (Chapter 6.2). What is most notable is the data for dry-years of 1996 and 2003, indicating the large dependence on a stable hydropower production. Looking at the dry-year of 1996 Figure 3.4 also point towards the possible short-term
effects on fossil energy use and carbon dioxide emissions \textit{(Figure 3.11)} of a Swedish energy system with reduced base-load production with nuclear energy. \textit{For more information on energy sources in CHP production see Chapter 3.3.}

### 3.2.4 Wind Power

Wind is a prioritized RES by the Swedish Government and a goal to increase the installed capacity to 10 TWh per year by 2015 has been declared (Bill 2001/02:143). The goal is referred to as a planning goal and thus not a development or expansion target but rather meant as a foundation for decisions on the support to wind power. The installed wind turbine capacity as of December 2004 was 452 MW in 723 turbines, producing 850 GWh during that year (Elforsk, 2005). This contribution is distant from the planning goal, and the increase in capacity has been hindered by low production feasibility and policy instrument designs. The development is promoted in the 2006 Climate Bill (2005/06:172) where it is established that further investments in wind power is essential in view of the goal of 10 TWh new RES electricity production by 2010. In an EU context the wind power development has been successful and the European Wind Energy Association reports that the EU goal of 40 GW installed effect by 2010, established in the 1997 EU renewable energy White Paper (COM(97) 599 final), has been met five years early.

A positive characteristic for Swedish wind power is that the annual wind patterns allows for the largest production to occur during the cold winter months \textit{(Figure 3.5)}. A negative characteristic is the unpredictability of the supply and the need for grid enhancements as wind turbines are often installed in remote areas or at sea. The feasibility is higher for large sea-based turbine installations and the development of new establishments has consequently moved in this direction.
Several policy instruments have been, and continuously are, used to support wind power investments and production. All new installation previously received an investment subsidy and turbines below 1.5 MW have been eligible for a production support. These two have however been replaced with the REC system (Chapter 6.2) since 2003. Wind power is also continuously supported by a technology development and market support. An environmental bonus in the form of a tax deduction was part of the old support to wind power installations and is still used albeit it is being reduced to 2009.\footnote{For more information on the subsidy reduction see Chapter 7.2.} Peter Chudi (2005) at E.ON Sverige argues that the planning goal will not be reached in the absence of supporting policy instruments unless a high price level on electricity is established. Johan Tollin (2005) at Vattenfall identifies a low interest rate as an important factor to promote an increased rate of operational wind turbines. Ek (2005) identifies that reaching the 10 TWh goal will require the
REC scheme as well as additional policy instruments as the market for “green” electricity is limited by public attitudes towards, for example, wind power installations. The REC scheme however hampers the increase of new wind power installations as the energy utilities and investors have criticized the long-term perspective and the political influence over the REC market (SEA, 2005h). Åstrand and Neij (2006) concludes a study of the Swedish wind power programmes by identifying that the national policies have been effective in achieving the governmental goals but at a higher cost compared to Spain and Germany that have utilized feed-in tariffs. The main reason has according to Åstrand and Neij been that the policies – for example R&D and subsidies – have supported two different technology courses. Söderholm et al (2007) identify that wind power goal is negatively affected by a lack of policy stability, regional resistance to wind power developments as well as the Environmental Code and the Planning and Building Act. The Government has however reduced the requirements under the Environmental Code through raising the limit where operational permissions for wind power establishments under the Code are required from 1 MW to 10 MW (Chapter 8.1). The SEA and the Swedish EPA has recently initiated a programme called Vindval, which will establish a scientific baseline of the environmental impact of wind power production to facilitate a better application process for operational permits. A working committee on wind power was appointed by Government in October 2005 to coordinate the continuing policy efforts to support the expansion of wind power in the Swedish electricity system.

The total Swedish wind power potential is estimated in a SEA (2005a) report to be >150 TWh per year divided on 30-75 TWh on land and >100 TWh to sea. The technical potential is in the same report estimated to 30 TWh. The economic potential

\[\text{total potential} = \text{technical potential} \times \text{economic factor}\]

\[\text{economic factor} = \frac{\text{price per kWh in the market}}{\text{cost per kWh in production}}\]

The economic potential is dependent on various factors including the cost of production, the price of electricity in the market, and the availability of subsidies or other incentives. The total potential can be further refined by considering the specific characteristics of the wind resource in different regions, as well as the technical feasibility of converting the wind energy into electrical energy.

47 Eng. Wind choice
48 “Vindkraftsberedningen” (Swedish).
is equivalent at a production compensation level of 45-65 öre/kWh (ibid). The potential for electricity production with wind turbines differs in different regions. According to SMHI surveys several areas have too low production potentials to be considered for wind turbine installations (SEA, 2003). The SSNC (Rylander, 2005) identifies that the technical potential should be reached in the long-term and promotes a wind power production of 30 TWh in 2030. E.ON Sverige is planning for wind park installations in the Baltic Sea of 1,000 MW with the potential to deliver 3-4 TWh yearly (Montel Powernews, 2005a). Vattenfall is planning a 110 MW wind park installation in Öresund between Sweden and Denmark. The wind park is planned to be fully operational in 2007, which would make it the largest installation in Sweden. Lately off-shore wind mills have been subject to a price increase, which may delay or stall investments in the short-term.

3.2.5 Other

Small-Scale Production

Small-scale electricity production in for example wind and hydropower plants that can deliver a maximum effect of 1.5 MW to the grid is supported in the Electricity Code (SFS 1997:857) by a reduction of the grid connection costs – these installations only pay for the connection to the grid plus the measurement, calculation and reporting to the net owner, meaning that they do not have to pay for the management and maintenance of the grid.

Backup Power

Backup power plants are operated when the electricity consumption reaches extreme levels or there is shortage of electricity due to other factors. They can also be used commercially when the electricity prices reach very high levels – this was for example occurred in the winter 2002/2003 (Figure 3.9 on price developments). Backup
plants are often oil cold condensing power plants or gas turbines that can be started with short notice. Only minor production in the cold condensing plants and none in gas turbines is expected up to 2007 (SEA, 2005a). The backup power is difficult to handle from an Emission Trading perspective as they are not operated on a regular basis. They are however included in the EU-ETS if they have a rated thermal input exceeding 20 MW.

Other

Photovoltaic (PV) electricity production could be making a large contribution in the long-term future energy systems but the technology is at present responsible for a very small part of the global production. Sweden’s northern position with dark winters offers poor conditions for PV production but minor installations exist. One example is Mälarenergi in Västerås that has installed a production capacity of about 2.5 MWh per year. Various other technologies that can become important in the energy production are for example biomass gasification and geothermal energy. See Chapter 3.8 for a discussion on future production.

3.3 Heat Production, Cogeneration and District Heating

The development of Swedish district heating systems started in the 1950s and were initially constructed and publicly owned by municipalities. The forthcoming oil crises made it profitable to move away from oil and reconstruct heating plants for a more diverse energy input, which strengthened the systems’ market position and profitability. As the Government viewed this development as positive, district heating subventions was introduced in the energy policies in 1991 to reduce oil and electricity for heating purposes. The possibility to steer the development in the CHP and district heating sector is much larger than in the electricity utilities as the fuel
flexibility is higher and market conditions makes facilitates larger possibilities to lay out additional costs on end-customers. Today, most district heating systems are owned as companies by local authorities or energy utilities. District heating has undergone a strong development and currently supplies 40 % of the heat on the heat market and 50 % of the heating in apartments and public buildings (SEA, 2004c). The Swedish potential is much higher than this and is strengthened by the climatic conditions creating a high level of heat demand. District heating is furthermore the most efficient way to supply this heat, with respect to for example low specific GHG emissions.

Industries are potential major customers for district heating companies. Important factors in determining the potential are, apart from whether or not an industry has waste heat, how policy instruments target district heat production in comparison to industrial in-house production, with for example oil and electricity. The industry can benefit from reduced fuel and electricity consumption while the GHG emissions are reduced both in an individual company and national context.

**Table 3.5 District heating customers and deliveries (2003)**

<table>
<thead>
<tr>
<th>Sector</th>
<th>Used energy (TWh)</th>
<th>Share of market (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small houses</td>
<td>3.7</td>
<td>7.9</td>
</tr>
<tr>
<td>Apartment buildings</td>
<td>24.2</td>
<td>51.7</td>
</tr>
<tr>
<td>Properties¹</td>
<td>14.5</td>
<td>31.0</td>
</tr>
<tr>
<td>Industry</td>
<td>4.4</td>
<td>9.4</td>
</tr>
</tbody>
</table>

¹ Including public buildings

*Source: SEA, 2004c*

Due to the large investments associated with developing district heating systems, only one supplier act on each market. This situation, in combination with a large cost
for building owners to change heating alternatives, has sparked criticism towards the district heating market as being inert and holding local monopolies (SEA, 2004c). The Government has met this criticism by instigating official inquiries on how to improve the state of the markets (Chapter 3.6).

In several municipalities the industry contributes to the district heating systems through successful agreements with district heating companies. The potential is however much larger than the 6.1 TWh (Swedish District Heating Association, 2006) that the industry supplied in 2004. One of the reasons that the full potential is not utilized is, according to Birgitta Resvik (2005) at the CSE, that a competitive situation is created between the industry and district heating companies with regards to production of heat. This issue is also raised by Leif Brinck (2005) at Preem, who highlights an example were the company’s waste heat has failed to be utilized due to what is identified by Brinck as a lack of cooperation at municipality and district heating company levels. This is the focus on Municipal Energy Planning (Chapter 8.2), which aim to utilize the opportunities for improved energy system efficiency. An analysis by EnerGia (Fors, 2004) finds that an effective strategy for the cooperation between the district heating companies and the industry, which focus on the mutual benefits and win-win situations, would unlock a larger potential and enable an increased utilization of waste heat. Profu (2005) identifies several obstacles in this development, such as valuating the waste heat and system connections difficulties. Sundberg and Sjödin (2003), analyzing the cooperation between a pulp and paper industry, identify potential savings in reduced system cost of 7-11 %. These types of collaborations should benefit from the PFE (Chapter 7.3) and theoretically also from the introduction of an Energy Efficiency Certificates system (Chapter 6.3).

Möllersten and Sandberg (2004) have studied the situation from a pulp and paper industry perspective, finding that both the industry sector and utilities identify large benefits from energy collaborations, where utilities operate the power systems in the
industry. These types of collaborations are seen as increasing as the industry is positive towards outsourcing non-core business operations. The main barriers identified are that utilities must improve their business case regarding what services they can offer in relation to the energy processes in the operations, plus that there is lack of competition in the utility energy service sector.

The total district heating deliveries in 2003 were 47.5 TWh with an efficiency of 88 % (Swedish District Heating Association, 2005). The total fuel input to district heating systems in 2004 was 53.6 TWh, resulting in 6 TWh system losses (SEA, 2005a). CHP plants have previously utilized a large share of fossil fuels but after a peak of 30.9 TWh in 1980 the fossil fuel consumption has decreased to 2.9 TWh during a production increase (SEA, 2004b). The fossil fuels have to a large extent been replaced by biofuels and most CHP plants today have large fuel flexibility. The use of heat pumps is depending on the feasibility, which is decided by the correlation between electricity and fuel prices.

**Figure 3.6 Input of non-fossil fuels in Swedish CHP plants (1980-2003)**

![Graph showing input of non-fossil fuels in Swedish CHP plants from 1980 to 2003](chart.png)

*Source: SEA, 2004b*
The shift from heavy oil dependence to utilizing a high share of biofuels in the district heating production is to a very large extent a result of policy instruments, mainly the carbon dioxide tax, steering in this direction (Chudi, 2005; Käck, 2005; Sunér Fleming, 2005). Taxation and use of other policy instruments to control the production in CHP plants has however proven difficult. The reason for this is that most operations use a wide range of fossil and renewable fuels as well as heat pumps to produce two different commodities – heat and electricity. CHP operators could previously also assign different fuels to the production of either heat or electricity to optimize the production from a tax perspective, resulting in fossil fuels be assigned to electricity production. Another issue was that an extra tax for the heat production was levied on backpressure operations that were converted to CHP production. Old tax exemptions also resulted in limiting the electricity production due to changed market prices on oil, gas and coal. The Government therefore amended the Energy Code (1994:1776) to promote CHP production in general and the use of RES in specific. 49 This was accomplished by setting the same lower tax levels for CHP production as for the industry, introducing a proportional assigning rule for the fuels while also introducing the REC system. The rule dictates that the fuels used shall be proportionally assigned to the heat and electricity produced.

The heat input to the district heating systems can be produced in either district heating plants, which only producing heat, or in CHP plants. Of the input to the Swedish systems about 70 % is produced in district heating plants and the rest in CHP plants, heat pumps and industrial secondary heat (SEA, 2005g). The main sources of energy in district heating systems are renewable fuels (Figure 3.7) which accounts for approximately 75 % of the total energy inputs (SEA, 2004a). The situation is different when looking at the cogeneration production but this is a result of old taxation rules that allowed for fuel input in cogeneration to be assigned to

49 The amendments were introduced through the law SFS 2003:810 amending the Energy Code.
either the heat or the electricity produced.\textsuperscript{50} To promote production in CHP plants an investment support has previously been given that obligated the plants to utilize a certain amount of biofuels during a set time period (Bill 2001/02:143). This system has today been abandoned and CHP production will instead be supported by the REC system.

Figure 3.7 Energy input in Swedish district heating and cogeneration (2003)

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure3.7}
\caption{Energy input in Swedish district heating and cogeneration (2003)}
\end{figure}

Source: Swedish District Heating Association, 2005

\textsuperscript{50} Cogeneration utilities could with the old rules optimize their tax levies through assigning fossil fuels to electricity production, as fossil fuels taxes was levied for end-consumers and not for the utilities.
The SEA (2005a) has in a report on the energy supply in the future Swedish energy system identified other policy instruments that will affect the development of the production in CHP and district heating systems:\footnote{These instruments are further discussed in Chapter 6 and 7 analyzing the Swedish energy and climate policy instruments.}

- The new CHP taxation
- The introduction of peat into the REC system
- The EU Emission Trading Scheme (EU-ETS)

Besides these instruments there are prohibitions towards deposition of sorted combustible wastes as well as organic wastes, which result in a higher use of waste fuels in municipalities. The SEA (\textit{ibid}) estimates that these policies will favor CHP production overheat plants but find it more difficult to analyze which specific effects that the instruments will have on the used fuel mix.

The influence of the tax system on the production pattern is also supported by Marbe and Harvey (2005) who identify that the tax system must favor power production compared to heat production to support the higher investment cost of a CHP plant compared to a heat plant. The study furthermore identify that the feasibility of introducing natural gas combined cycle (NGCC) in the energy system is heavily depending on how the energy and carbon dioxide taxes are levied.

Whether peat shall be classified as a renewable biofuel or not has been the subject for an occasionally intense debate. The fact that peat is slow growing, positions it between a biofuel and a fossil fuel. The viewpoints on this subject vary between different stakeholders and peat is classified differently in different systems. Professor Arne Jernelöv (2005) consider that peat is a biofuel due to that its rate of growth is larger than its extraction, while Professor Bert Bolin (2005) means that peat is a fossil
fuel, as it results in net emissions of carbon dioxide. These are merely two of many contradictory opinions on the subject. The Government has classified peat as a RES in the REC system if it is utilized for electricity production in CHP plants (Bill 2003/04:42). Most international organizations view peat as a fossil fuel and EU did not include peat in the Directive on Promotion of Renewable Electricity Production (2001/77/EC) and has later classified it as being fossil (EC, 2004a). Emissions originating from peat combustion are consequently, in contrast to other biofuels, accounted for within the EU-ETS. As this differs from the Government’s alternative definition within the REC system, imperfect market signals are created. The EU decisions may in the future lead to EU regulations on the classification of peat as a fossil fuel, forcing this view into the Swedish policy instruments. Peat is furthermore considered a fossil fuel also in the reporting under the UNFCCC (IPCC, 1996). These combined factors are likely to reduce the use of peat through economic incentives. Due to the implications of the EU-ETS on the peat industry, the SEA and Swedish EPA as well as other institutions will be commissioned to analyze the future development (Larsson, 2005). Ylva Rylander (2005) at the SSNC regards that it is unfortunate that the Government has decided to use a different categorization of biofuels, through including peat, than the EU as this reduces the effectiveness of the climate and energy policies from a carbon dioxide emission perspective.

Knutsson et al (2006) highlights the REC and emissions trading systems as two policy instruments that are highly supportive of the CHP development and identify a potential for increased production in highly profitable investments which could result in 13 Mton/year reductions of carbon dioxide emissions.

The prohibition of depositing combustible wastes was in 2005 expanded to include depositing of organic wastes (SFS 2001:1063). This decision is likely to result in a

52 Zetterberg et al (2004) includes a thorough analysis of the subject from a Swedish perspective.
larger use of these waste fractions in the district heating production.\textsuperscript{53} The SEA (2005a) however finds that the current combustion capacity in municipal CHP plants is insufficient in handling the expected waste volumes and that additional installations are consequently necessary. This is supported by Holmgren and Gebremedhin (2004) who identify that the utilization of waste would be supported by a stronger cooperation between industries and utilities as well as the inclusion of waste in the REC system (\textit{Chapter 6.2}), which should be mitigated by the introduction of a waste incineration tax.

Much indicates that the position of CHP and district heating in the energy system will be strengthened in the future. The main reasons for this are the high efficiency of the technology, the high rate of RES utilization and policies supporting these characteristics. For instance, Peter Chudi (2005) at E.ON Sverige, identified CHP production as the holding the main potential for improvements of the energy efficiency in the energy utility sector. He furthermore concludes that CHP production also hold the main potential for replacing any further reduction of nuclear capacity \textit{(ibid)}. The EU-ETS will benefit efficient production of heat and electricity as well as RES. New constructions of CHP plants are however hindered by uncertainties regarding the development of the current policy instruments that at present support investments (ÖPwC, 2005). Decisions to prolong the REC system have been taken, which will raise the estimated economic potential for CHP production in 2015 from 12.5 TWh\textsuperscript{54} to 15.6 TWh \textit{(ibid)}. The increase of CHP production is also supported by the EU in the Directive 2004/8/EC on the Promotion of Cogeneration and the EU goal to double the electricity production in CHP plants (COM(97) 514 final). The governmental measure to comply with the Directive is a

\textsuperscript{53} Upcoming EU waste decisions, possibly including binding targets, on whether incineration should be classified as disposal or recovery, could however challenge this development.

\textsuperscript{54} The estimated potential if the system would abandoned in 2010.
suggested (Bill 2005/06:83) introduction of a labeling scheme that would proof the origin of electricity produced in high-efficiency CHP plants. This Bill however includes a different definition of the approved production which is criticized by the energy utilities (Chapter 9.1). In the short-term the SEA (2005a) estimates that the heat demand will rise with 2.5 % between 2005-2006 and 1.1 % between 2006-2007. The technical possibilities for increasing production is however much larger than this considering that only 30 % of the heat supply in the district heating systems are supplied by CHP plants (SEA, 2005f). A report by Svensk Fjärrvärme on the future potentials for district heating and CHP production estimates a long-term potential for district heating to increase the heat deliveries to 75 % of the demand, which today would correspond to 80 TWh (Swedish District Heating Association, 2004).

Sweden also has operative district-cooling systems since 1992. In 2003 30 systems, including Europe’s largest system in Stockholm, distributed 640 GWh of district cooling (Swedish District Heating Association, 2005). District cooling has the potential to have a substantially reduce the environmental impact of cooling in the industries as well as the built environment in the future. The systems are however not included in the EU-ETS and thus not further discussed here.

3.4 Import and Export of Electricity

The Swedish electricity system must, as mentioned in the beginning of the chapter, not be analyzed only in a domestic perspective. The fact that the Swedish power grid is connected to Norway, Finland, Denmark, Poland and Germany means that the electricity system in many perspectives have to be analyzed and viewed in a larger system perspective. The system boundaries will in the future be further increased as the EU has decided to create internal electricity and gas markets, governed by the Electricity Directive (2003/54/EC) and the Gas Directive (2003/55/EC). The Swedish electricity market, in contrast to the system, is currently only expanded to the Nordic
countries, with Nordel working as collaborating body for the Nordic grid administrators and Nord Pool as the main electricity trading place.

Table 3.6 Swedish foreign electricity connections (2001)

<table>
<thead>
<tr>
<th>Country</th>
<th>Import/Export to Sweden</th>
<th>Trading Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway</td>
<td>Import: 2,400-2,800</td>
<td>Export: 2,400-2,800</td>
</tr>
<tr>
<td>Finland</td>
<td>Import: 1,350-1,650</td>
<td>Export: 1,850-2,050</td>
</tr>
<tr>
<td>Denmark</td>
<td>Import: 2,310</td>
<td>Export: 1,700-1,910</td>
</tr>
<tr>
<td>Germany</td>
<td>Import: 370</td>
<td>Export: 460</td>
</tr>
<tr>
<td>Poland</td>
<td>Import: 600</td>
<td>Export: 600</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>Import: 7,030-7,730</strong></td>
<td><strong>Export: 7,010-7,810</strong></td>
</tr>
</tbody>
</table>

*Source: Svenska Kraftnät, 2002*

The current cross-border transmission capacity is 9,000 MW (SEA, 2005d) and another 1,150 MW\(^{55}\) is projected in order to improve the situation where bottlenecks in the system currently exist (Svenska Kraftnät, 2005). The projected connection to Finland has been criticized by several stakeholders on the grounds that Sweden invests in the possibility to access new Finnish nuclear power reactors while having

\(^{55}\) A new sea cable with a transfer capacity of 800 MW will be built between Sweden and Finland, starting in 2009, and a new cable between Sweden and Norway will add about 300 MW capacity in the same year.
taken the decision to phase out nuclear power. The connection has also been seen as an indirect support to the enlargement of the Finnish nuclear system, as it will benefit economically from an increased connection capacity to Sweden. According to a Nordel (2006) report the Nordic power balance will strengthened in 2009 through an increase in power generation capacity of 6,350 MW.

The import/export of electricity, as shown in Figure 3.8, show large variations from 1995 and forward. While this can be an indication of reduced security of energy supply, it may also be considered that the Nordic electricity system and market offers such flexibility that the security is not reduced and an import is chosen due to for example economic rationales. See discussions in Chapter 3.6 for a discussion on security of energy supply.

Figure 3.8 Swedish net import and export of electricity (1970-2005)

As a result of the interconnected electricity systems, non-Swedish stakeholders, such as the other Nordic governments, have opinions on Swedish energy policies and the development of the electricity system. Vattenfall (2004) for example mentions in an electronic newsletter that Finland, according to the Director General of Energy at the
Finnish Ministry for Trade and Industry, “could consider restricting export of electricity to Sweden if Sweden continues to close its power plants”.

3.5 Security of Energy Supply

The Swedish electricity systems transmission possibilities with other Nordic and European countries consequently give rise to a number of circumstances that are essential to the Swedish energy system. The fact that Sweden can import electricity strengthen the security of energy supply from a larger system perspective due to diversified production characteristics, such as different utility categories and transmission possibilities, but not necessarily from a domestic perspective. This was highlighted by the Russia – Ukraine gas conflict in January 2006 when Russia without warning halted gas supplies to Ukraine thus limiting the gas deliveries to the EU. This situation is not an imminent threat in the Nordic power system but there have been recent controversies also between Sweden-Finland and Finland-Russia. These incidents are an indication that the goal regarding security of supply in the 2002 Energy Bill (2001/02:143) is potentially at risk. Sweden must have the capacity to meet consumption peaks with domestic resources or the energy infrastructure and the political agenda is at risk. It is important to recognize that this is most efficiently accomplished through the contribution of several energy sources. This is supported by Gunnar Käck (2005) at Fortum Värme, who from a company perspective identifies that utilizing a large variety of available fuels and other energy sources reduces the risk of fluctuations in energy costs for.

The 2002 Energy Bill (2001/02:143) established that the power balance is strained at cold weather conditions. The highest consumption loads will occur during cold winter days and the conformity of the climatic conditions of our neighboring countries must be considered – a cold day in Sweden will mean a relatively cold day in the Baltic region – meaning that if the Swedish system is strained so may also our
neighboring countries’ be. An analysis of this situation by Svenska Kraftnät (2005) support these views and conclude that the potential import of electricity from Norway, Finland, Denmark and Germany is very limited, especially during extreme winter conditions. Nordel predictions of the Nordic power balance during the winter 2005/2006, indicated that Sweden neither would have a sufficient effect capacity nor a sufficient energy capacity (Nordel, 2005a, 2005c). Another Nordel report reach the conclusions, when looking at the Nordic system in a 2008 perspective, that parts of the electricity system will be subject to rationing and other measures during years with extremely low hydropower generation (Nordel, 2005b). A more recent Nordel (2006) report however suggests that the situation may improve in 2009 through an increase in production capacity. The analysis by Svenska Kraftnät (2005) furthermore finds that the power supply is not only at risk during the coldest months but that strain may be put on the system also during autumn and spring. The security of supply is also threatened by the domestic transmission capacity, especially in southern Sweden where the phase-out of the Barsebäck reactors has led to a large production shortfall and a potential power shortage at cold weather conditions as a transmission bottleneck then occurs. The EU decisions on the creation of a common electricity market (Directive 2003/54/EC) could have a positive effect on this situation, as it will further increase the system flexibility by connecting countries with other climate patterns and production characteristics than our neighboring countries.

Sweden increases the security of energy supply during the winter months by purchasing a transitional capacity through a power reserve. This is governed by the Code on Power Reserve from 2003 (SFS 2003:436), which stipulates that Svenska Kraftnät has the responsibility to purchase a reserve of maximum 2,000 MW each winter. The reserve can be achieved by contracting electricity producers to increase production, or place production at Svenska Kraftnät’s disposal, as well as through contracting large consumers to reduce the consumption if a power shortage occurs.
The power reserve measures shall according to the Code be additional to the commercial production capacity on the electricity market (i.e. managing the security of supply should not rely on these measures). The Code will only be in effect until spring-2008 after which the market stakeholders are responsible for managing that the required production is available. An analysis of the power reserve situation by Svenska Kraftnät concludes that the Swedish system could handle a normal winter with normal electricity consumption without being particularly strained (Svenska Kraftnät, 2005). The system could also handle the power supply in the case of an extreme winter if all 10 nuclear plants are running, all hydropower, all other production in CHP and industry is utilized plus a full 2,000 MW reserve power is activated, but that the system then would be extremely strained and vulnerable. It should in this context be noted that a strained system will lead to increased electricity prices that would counteract, but not neutralize, the power shortage.

Many companies in the Swedish basic industry consider that there is a lack of competition on pricing of electricity and disapprove of the phase-out of nuclear power. A Royal Swedish Academy of Engineering Sciences project on increased competitiveness in the Swedish processing industry highlighted the security of energy supply and increasing energy prices as main concerns for the industry (Martin-Löf, 2006). Due to this Martin-Löf (ibid) and the project participants\(^{56}\) raised the possibility of a regulating the electricity market as an opportunity to amend this situation.

As a result of the electricity market situation 15 industry companies, including for example Cementa, Stora Enso and SSAB, has established a utility company called Basel i Sverige AB, with the aim to introduce an additional 8-12 TWh Swedish

\(^{56}\) Several processing industry representatives, e.g. Jernkontoret, Swedish Forest Industries and SweMin.
electricity supply to the electricity intensive companies by investing in new production or by importing electricity (Dagens Industri, 2005a). The first move by Basel was to sign a 15 year electricity delivery contract with the energy consortium United Power (Dagens Industri, 2005b). The electricity will be produced in Russia, mainly at CHP plants, and delivered by a new 1,000 MW underwater cable. The annual deliveries of 8.7 TWh per year will commence in 2009 (ibid). Basel is also planning to invest in some 150 wind mills with the aim to have a yearly production of 1 TWh/year in five years (Dagens Industri, 2006). The situation where the industry invest in electricity production can also be found in Finland where the industry has started an own utility company, TVO, which has invested in a fifth Finnish nuclear plant.

3.6 Price Developments

The Electricity Market

Both the Nordic and Swedish electricity prices has, due to the large share of hydropower in the common system been more sensitive to pluvial patterns and the inflow to Swedish and Norwegian water storages than other factors, such as the oil, gas and coal prices as well as the emissions trading and the economic situation. During dry-years the electricity price has surged to levels that would not have occurred during normal years, due to the increased utilization of marginal production alternatives (Figure 3.9). The correlation between hydropower and the electricity price has however, since the introduction of the EU-ETS, been weakened as the price of emission rights have a large price influence. Another factor that will affect the future price of electricity is the creation of the Internal Markets for electricity and gas, meaning that the prices will be set in reference to a larger European power system. The pricing of electricity in Sweden is set on the Nordic electricity exchange Nord Pool and is based on the marginal production, which
during 70 % of the year is oil condense (SEA, 2005f). This means that the average price per produced kWh in Sweden in many cases is substantially lower than the retail price.

**Figure 3.9 Electricity price developments for 10 GWh/year industrial consumers (1997-2005)**

![Electricity Price Development Graph](image)

Source: SCB, 2005. Data includes tax. It should be noticed that most industries, especially electricity intensive, have individual long-term agreements with electricity retailers.

The Swedish electricity prices have from a European perspective historically been low and while the margin has decreased, they still are. The deregulation of the Swedish electricity market in 1996 initially resulted in decreasing prices, but in 2000/2001 the prices started to increase (Figure 3.9). The electricity market has received criticism (SKGS, 2005) for being an oligopoly with a distorted market situation due to the dominance of the three large energy utilities. The Swedish basic industry, using low-refined materials in energy intensive processes, are discontented with this development and views low electricity prices as a prerequisite for maintaining competitiveness on the international market. The electricity price for a
domestic consumer consists of the cost of electricity at Nord Pool (about 40 %\textsuperscript{57}), net commission (20 %), the energy tax (40 %) and the costs for RECs (approx 2 %, SEA, 2004c). Thus only 40 % of the electricity price is subject to competition for domestic stakeholders and slightly more for non-domestic consumers.

The price development in the winter of 2003 was a result of low precipitation in the second half of 2002 and low inflow to the water storages in 2003, leading to a low hydropower potential. This development visualizes the vulnerability of both the electricity system and market. One extreme example of this, within the Nordic market, is the Danish electricity spot prices that during a disturbance of the production in the Öresund region in November 2005 reached as high as 6.60 DanishKr/kWh, while the autumn mean price was 0.30 DanishKr/kWh (SvD, 2005a).

While the deregulation of the electricity market is a common explanation to the increase in electricity prices Brännlund and Kriström (2006) argue that it is a result of Swedish and EU policy decisions on for example the energy taxes, RECs and trading with emission rights.

This situation where the electricity price is linked to the EU-ETS is expected to continue during the operation of the scheme, and mean a stronger correlation to the price of coal and gas, as the price difference thereof sets the price of emission rights\textsuperscript{58}. This has also been identified in an official report (SOU 2003:60) on the EU-ETS, but it must be considered that the EU-ETS is in an early state of trial and that future developments are uncertain. The influence of the EU-ETS is indicated by the price increase seen in end-2005, which is probably a result of the introduction of the

\textsuperscript{57} More for an industrial consumer that does not pay energy tax or REC costs.

\textsuperscript{58} This is due to that switching to gas from coal holds the largest potential for reducing carbon dioxide emissions in the EU, i.e. the marginal abatement cost.
scheme. The initial prices of emission rights rose to higher levels than anticipated and thus influenced the electricity price more than expected. It can however be discussed if it is specifically the EU-ETS that has resulted in the increase in prices or the EU climate commitments. While the latter certainly is the main factor, the design of the EU-ETS in relation to energy utilities is considered to have negative effects on the electricity pricing for electricity consumers (Brinck, 2005; Hannus, 2005; Lyberg, 2005; Resvik, 2005; Sunér Fleming, 2005). The criticism is directed towards the marginal price setting and the fact that the cost of emission rights is not separate from the electricity price. This results in a situation where the whole production, and not only the share that is included in the EU-ETS, benefit from large windfall profits. The utilities meet the criticism by viewing this as a natural result of the current electricity market design, which is partly supported by the SEA in a report on the price developments (SEA, 2005d). 

This is found to be one of the major positions by the interviewees from the basic industry and more information on this is available in Chapter 6.1.6 and in the discussions in Chapter 10.3.

The prices on the oil, gas and coal markets are likely to increase, foremost due to security of oil supply, which will result in higher electricity prices in the foreseeable future. As seen above many factors influence the electricity prices and scenarios predicting the future developments are consequently difficult to make. This emphasized by the novelty of the EU-ETS and the upcoming Internal Markets of energy. A Montel Powernews (2005b) article identifies that the prices on electricity will not rise due to the phase-out of Barsebäck 2 but that it will put further stress on the electricity system. The improving possibilities for import and export of electricity will level the prices between the connected countries which can have a price reducing effect. The price leveling can however naturally also result in higher prices (SEA, 2005d).

The Government (Ministry of Sustainable Development, 2006a) is aware of the problems that the increasing electricity price is causing the society and basic industry
while the utilities report large profits. They have therefore appointed a commission that *inter alia* will investigate the possibility to separate the expensive fossil power and less expensive production in two different markets. Another public effort that may be underway is measures to decrease the co-ownershipship in nuclear and hydropower facilities. Similar efforts are also taken in EU through a market competition inquiry.

**The District Heating Market**

The pricing of district heating has been criticized for not being market related as they are set on monopoly markets – district heating systems are cost intensive investments and there is consequently only one supplier available in a specific region. The pricing has also been found to vary between different regions.\(^{59}\) This situation has resulted in a Governmental inquiry into the pricing situation and how to improve the situation for the customers. The official report (SOU 2004:136) from this inquiry compared the district heating prices to a general price index but did not find any unjustifiable differences in price developments. The report nevertheless established that it would be advantageous with higher financial transparency in the district heating production and supports an earlier suggestion, where companies will have to account for the district heating part of the business separately from other business activities (SOU 2003:115). It also promotes establishing a District Heating Board with the responsibilities to *inter alia* analyze the pricing situation.

The price of district heating will, similarly to the electricity price, be influenced by changing oil, gas and coal markets as well as the EU-ETS. The many production

---

\(^{59}\) There are no statistics over the development of the district heating prices but general calculations can for example be found in SOU 2004:136. The Nils Holgersson investigation has also analyzed the pricing situation and the report is available at http://www.nilsholgersson.nu.
alternatives will however allow for the sector to meet this development with a higher
degree of flexibility.

3.7 Carbon Dioxide Emissions

Sweden has an energy utility sector with low specific emissions due to the large
share of nuclear and hydro electricity production. The share of hydropower
production however results in large fluctuations in yearly emission volumes due to
intermittent precipitation patterns. This is exemplified by the dry-year 1996 when the
emission levels rose (Figure 3.10). This illustrates that replacing any large-scale
production shortfall will at present result in higher emission levels. This furthermore
supports the argument that a phase-out of nuclear energy with careful attention to
GHG emissions could lead to substantially higher carbon dioxide emissions due to a
higher stress on the electricity system. The production shortfall from a phase-out
could however, if accompanied with a well-designed policy framework, be replaced
by electricity production with RES and energy efficiency improvements. Policy
instruments promoting RES should consider the macroeconomic cost-efficiency of
RES utilization, in order to assert that the instruments do not allocate the mitigating
efforts to the areas where the emission reductions are realized at a high societal
cost.60

An SEA (2006f) report analyzing about 50 % of the emission sources within utilities
identifies that the potential is 1.8 Mton per year at a cost of 195 SEK/ton. The
development of the district heating systems has resulted in reduced GHG emissions
due to the transition towards RES as well as raising the efficiency of the energy

60 This issue is analyzed in a national context by Wahlund et al (2004). On an EU level, Eurelectric
(2006) identifies that the EU energy utilities have effectively reduced the emissions of carbon dioxide
and other GHGs in the recent period by implementing best practice and switching to RES and low-
carbon fuels.
production, though the emission level is greatly dependent on the heat load needs. The SSNC has the view that the energy utilities could and should be more active in their work to introduce further RES into the energy system (Rylander, 2005). Despite the relatively low emissions from the Swedish energy utilities the energy sector is the largest sector of carbon dioxide emissions due to including transports.

Figure 3.10 Carbon dioxide emissions from energy utilities, incl. hydropower production (1990-2004)

Source: SEA, 2006d (Data includes coke mills and oil refineries)

The current energy policy agenda that focuses on phasing out nuclear energy mean that the energy characteristics may change significantly. Considering the large nuclear production capacity, replacing this capacity must have a long-term perspective. If the phase-out is accomplished without thorough climate considerations it may lead to substantially increased carbon dioxide emissions if resulting in fossil energy investments. This development would not only mean that Sweden’s international emission commitments and national goals would possibly not
be met but also have negative effects on both the socio-economic system and the general environment.

Due to the large nuclear and hydropower production, and consequently low specific carbon dioxide emissions, measures to accomplish further emission reductions in the electricity utilities will be minimal. In order for the Government to promote investments in this area, any decisions on a phase-out of nuclear energy must be clear and stable in the long-term.

Table 3.7 Emission scenario in the energy utilities

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy utilities</td>
<td>6,863</td>
<td>10,100</td>
<td>14,000</td>
<td>47 %</td>
<td>104 %</td>
</tr>
</tbody>
</table>

Source: SEA and Swedish EPA, 2004b

An SEA and Swedish EPA (2004b) scenario of the carbon dioxide emission situation from energy utilities in 2010 and 2020 found that the emissions from the energy utility sector will increase, indicating that the continuing utilization of nuclear energy has a significant impact on the emission volumes and suggesting that this has a greater impact on the emission volumes than the carbon dioxide tax.

3.8 Future Production of Electricity and Heat

The future challenge of the energy system and utilities is in many ways a question of reducing GHG emissions while phasing out the nuclear capacity, substituting it with RES and efficiency improvements without an increase in utilization of fossil fuels. The reasons for this are not only climate change but also the scarcity of oil and the
policy goal (Bill 2001/02:143) to increase the security of energy supply with domestic resources. The phase-out of nuclear energy may in the short-term be stalled but as the Swedish reactors will reach their end of their operational life-time it is questionable whether new reactors will be constructed. Johan Tollin (2005) at Vattenfall identifies that biofuels and wind power – local conditions decide which is favorable – are key elements in reducing the carbon dioxide emissions from energy utilities. The utilization of the domestic biofuels for energy purposes are to a large extent competing with the pulp and paper industry. From an economic perspective it should be favorable to primarily utilize the wood products in the industry and thereafter utilize the energy by-products in internal or external utility operations.

The Swedish potential for reducing emissions of carbon dioxide in the energy sector lies in several areas and as the emission levels in the energy utilities are low, substantial emission reductions would have to entail other energy sectors such as transport as well as the basic industries and the built environment. The specific potential for reductions in electricity production is low and it is more a question of maintaining the current emission levels from rising. This is supported by Thomas Levander (2005) at the SEA who shares the view that this should be the focus of the policy agenda on carbon dioxide emissions in the energy utilities (i.e. focus more on avoiding a raise in emissions rather than decreasing them further from an already low level). Efforts to increase the production efficiency can be made at the process level or in auxiliary equipment (Chapter 4.4).

Peak Oil

Lately there have been intense discussions of different “peak oil” scenarios depicting various futures where the oil production decreases due to lack of new oil deposits. When the peak will occur, or if it in fact already has been surpassed, is uncertain. What can be said with relative certainty though is that the peak will already have occurred when undisputable evidence for this is known. The issue must therefore be
addressed in a proactive approach as less sustainable energy production alternatives may otherwise need to be employed due to urgent shortfall of energy supply.

**CHP Production**

Production in CHP plants holds a major potential for reducing the specific emissions of utility operations through improved production efficiencies and increased utilization of secondary heat\(^{61}\) (Chudi, 2005; Hannus, 2005; Resvik, 2005). Gunnar Käck (2005) at Fortum Värme also supports this view and therefore identifies that future policy instruments will continuously support the development in the CHP sector. Thomas Levander (2005) at the SEA however argues that the possibilities to improve the fuel input at existing operations are small, as only a few large boilers utilize coal.

The potential is limited in a longer perspective as CHP production is only efficient when there is a sufficient heat demand or the possibility to establish a district heating system exists. In the future biofuel gasification can become a favorable production alternative in CHP production as well as low emission electricity production. Maria Sunér Fleming (2005) at Swedenergy highlights the potential of biofuel utilization in CHP plants in the transition of the energy system, but stresses that this allows for a lesser electricity production than is the case for natural gas due to different fuel characteristics.

**Natural Gas**

Natural gas is an interesting alternative for both electricity and cogeneration production, even though it is a fossil fuel, as it typically has 25-50 % lower carbon dioxide emissions than coal. The energy density of gas also makes transports more

\(^{61}\) Waste heat is referred to as secondary heat when utilized for a useful purpose.
effective than in for example coal. A theoretical example is mentioned in a Royal Swedish Academy of Engineering Sciences report (IVA, 2002b) where a 400 mm gas pipeline would enable the same energy supply to a utility as 128 fully-loaded Lorries with wood chips.

The utilization of gas is still very limited in Sweden but several utility stakeholders are investigating the possibilities to invest in gas projects. One example is E.ON that is planning to build a gas pipeline from Oxelösund to Västmanland, Dalarna and Gävleborg counties (E.ON, 2005). Maria Sunér Fleming (2005) and Birgitta Resvik (2005) both identify large scale natural gas utilization as necessary in the case of a nuclear capacity phase-out. Birgitta Resvik highlights two important measures that should be resolved for an increased rate of investment in the natural gas infrastructure; more import connections to the Swedish system and long-term policy instruments that enables stable investment calculi. Birgitta Resvik further shares the opinion that a shown interest in gas utilization by the basic industries is essential to promote an increased rate of investment by the utilities. An improved gas infrastructure would provide a basis for the construction of high efficiency Combined-Cycle Gas Turbines (CCGT), which is promoted in the EU Green Paper on Energy Efficiency (COM(2005) 265 final).

**Carbon Capture and Storage**

The technology to remove carbon dioxide from fuels and/or exhaust gas after combustion through carbon capture and storage (CCS) is currently being developed. Clean-coal technologies, utilizing efficient air pollution control, including CCS, is by many identified as a vital technical solution for the future energy systems due to the vast amount of coal reserves available worldwide. The technology is most suitable for large stationary emission sources – coal and gas fired boilers, reduction processes in the steel industry and calcination processes in the mineral industry – as the equipment cost would otherwise be too large. Clean-coal technologies are also urgent
from an international perspective, as China and India will utilize coal in the
development of their energy systems and that this should be accomplished with a
minimum of emissions to air. Another possibility as identified by inter alia Möllersten
et al (2004) is that operations utilizing biofuel and CCS in the future can have
negative net emissions of carbon dioxide, which could contribute to achieving
upcoming emission commitments. Thomas Levander (2005) agrees on this and
highlights recovery boilers in the pulp and paper industry which due to being
biofueled are an example where a permanent carbon dioxide sink could be created.
CCS is currently only commercially operational under specific conditions and is
therefore associated with a low rate of implementation. The development towards a
larger implementation of the technology is inter alia related to the GHG emission
rights prices as well as continuous R&D efforts that can reduce the price of the
technology.

Raine Harju (2005) at Vattenfall supports the opinion that coal will be an essential
part of the energy systems in the future and Vattenfall is against that background
building the world’s first large-scale utility CCS pilot plant in Germany as a way to
meet both energy and environmental requirements. Johan Tollin (2005) at the same
company identifies that, in the future, utilizing CCS will offset carbon dioxide
emissions at a lower cost than for example CCGT. Maria Sunér Fleming (2005) at
Swedenergy identifies large-scale coal utilization as less likely but emphasizes CCS
as necessary to avoid increased carbon dioxide emissions if nuclear energy is phased
out utilizing natural gas as the substitute. Peter Chudi (2005) at E.ON Sverige sees
CCS as a necessary step in the international climate change mitigation work and
estimates that the technology will become commercial in 2015-2020, albeit already
having been feasible at some operations during periods of high EUA prices.

Birgitta Resvik (2005) at the CSE identifies the CCS technology to hold a major
potential to reduce large point sources of raw-material based emissions. Göran
Carlsson (2005) at SSAB however identifies that the storage poses a large problem for
SSAB as transporting over 6 Mton of carbon dioxide is difficult. The company nevertheless identifies the technology as interesting and the company is closely following its development due to plans to test CCS with a pilot plant at the steelwork in Luleå. The view that CCS is primarily suitable for large power plants utilizing coal and natural gas is shared by Thomas Levander (2005) at the SEA who also emphasizes the importance of storage locations at a short distance. Levander estimates that the technology will be commercial in approximately 20 years but that the timeline is much depending on the future of the international climate agenda as well as the development of the ETSs and emission rights prices. Resvik (2005) further argues that the technology will not have a breakthrough if it does not reach a political and social acceptance. Ylva Rylander (2005) at the SSNC is negative to CCS on the grounds that the technology at present largely is based on assumptions and calculations that are uncertain. The SSNC also have the basic view that the emitters shall mitigate their emissions at the source.

CCS has received criticism as an unsafe alternative, which is not in accordance with a sustainable development. The criticism is based on the uncertainties of the technology, for example where the gas should be sequestered and how stable the storage is. Advocates of the technology mean that the gas could be secured in emptied oil and gas fields as these have previously sealed its contents. It can be argued that the technology is not a favorable long-term solution but its effectiveness in the international context as an immediate and mid-term action towards the rising emission levels should not be neglected. Norway has declared that CCS will be included as a prerequisite for new gas powered utilities (Bill 2005/06:172). The Swedish position on CCS is summarized in the 2006 Climate Bill (2005/06:172) where it is established that sequestration of carbon dioxide in oceans is environmentally unacceptable but that storage in geological formations could be an acceptable option.
Hydrogen

The future energy system with a high level of renewable energy production may force a fundamental change to the energy infrastructure, as it would incorporate a wider range of energy sources. An often discussed alternative for adapting to these conditions is the creation of a hydrogen society where renewable and other energy sources are used to produce hydrogen as an energy carrier, which would be used to power fuel cells at high efficiencies. One example is the use of solar photovoltaics in sunny areas, such as Africa, where hydrogen could be effectively produced and transported to areas with less favorable renewable production conditions. The production of hydrogen is however still too costly and would have to be reduced significantly before any large scale developments could take place. The point where hydrogen systems become feasible could on the other hand be achieved earlier due to rising oil prices. Another obvious economic obstacle is the tremendous costs that are associated with establishing a new energy infrastructure. Research carried out within an EU technology platform estimates that hydrogen could be making a significant contribution to the energy system in 2030-2050 (HFP Europe, 2005).

Emerging Technologies

There are many renewable electricity production technologies under development that have not yet reached a commercial status, for example tidal power and wave power, and some of these will probably never be used in large-scale production. The renewable technology with the largest potential is solar photovoltaic, as the sun radiated energy towards the earth corresponding to >10,000 times the consumption of fossil and nuclear fuels during 2002 (Alexander and Boyle, 2004), but the Swedish potential is as mentioned limited. Another issue is the challenge on how to reduce the specific cost of energy production by renewables and other advanced energy conversion technologies. Thomas Levander (2005) at the SEA emphasizes biomass gasification as an important technology to improve the efficiency in biofuel
utilization. The technology is however still costly and the rate of commercialization is thus depending on the EU-ETS and KP to set a prize for fossil fuel utilization. There are also discussions on whether nuclear fusion will ever become a commercially viable option. The technology is currently very far from this, but if it becomes an energy production alternative it will have an immense effect on the way we view our energy supply. Other energy production that may become viable options are for example geothermal energy and electricity production.

Other

Other areas where emissions reductions can be achieved are better power management through improved grid transmission, which can result in reduced grid losses. Power technologies can also reduce the need for production through grid optimizations and reduction of negative grid characteristics that occur in grid input and output. One example of such technologies is Flexible AC Transmission Systems.\textsuperscript{62}

The Energy Bill (2001/02:143) promotes efficient production, which has been mentioned from two different perspectives; efficient production in connection to the different production alternatives and efficient transmission above. A third way of seeing this is reducing energy losses in the utilities due to inefficient auxiliary equipment, for example pumps, fans and heating. This area is more often mentioned in connection to the industries, and since the equipment is basically the same it is discussed in that context in Chapter 4.4.

\textsuperscript{62} For more information see http://www.abb.com/facts.
3.9 Summary

The Swedish energy system has developed from being heavily reliant on oil to producing about 90% of the base load with hydropower and nuclear energy. This has resulted in low carbon dioxide and GHG emissions from the utility sector. The policy agenda promotes a continued phase-out of nuclear energy and increased energy production with RES. The RES development should include a high share of CHP production with renewable fuels, as this holds the main potential in the short-term and complies with EU targets on CHP production and renewables. A positive RES development is however held back by short-term policies that are regarded as unreliable by the utilities. This is mainly attributed to the initial short time aspect of the REC scheme, the Environmental Code’s permission application processes and postponed decisions on the carbon dioxide tax for the Trading Sector. A positive development of RES is also dependant on high electricity prices and emissions trading that establish a price for carbon dioxide emissions.

The high share of nuclear energy and limited possibility for increased hydropower will however delay any major shift towards RES in the short term. This will consequently be a gradual and long-term development, which must be supported by policies that provide stable economic incitements. Any further phase-out of nuclear capacity in the short-term will strain the energy system with a high probability of higher electricity prices and increased carbon dioxide emissions. This would be in direct opposition to several climate and energy policy goals.

In the longer term a positive RES development is necessary to comply with the policy goals of a secure and environmentally friendly energy supply. The reasons are, besides the climate change issue, the limited resources of oil and uranium. The future will include a higher competitiveness of these energy commodities and an energy system reliant on oil and uranium will consequently face supply shortages and increased supply prices.
4. The Swedish Basic Industry

The Swedish industry sectors that are commonly referred to as the basic industry are the pulp and paper industry, the mining, steel and metal industry, the mineral industry and the energy intensive chemical industry including the oil refinery industry. This classification coincides well with the industrial stakeholder groups included in the EU-ETS, which have received the main emission rights allocations in the Swedish National Allocation Plans (NAPs). The basic industry sectors are important for the Swedish economy, representing about 15% of the added value in the Swedish manufacturing industry and about 20% of the value of exported industrial products (ibid).
Table 4.1 General data for the basic industry sectors included in the EU-ETS (2004)

<table>
<thead>
<tr>
<th>Sector</th>
<th>SNI-code</th>
<th>Turnover (MSEK)</th>
<th>% of GDP</th>
<th>Number of companies</th>
<th>Number of employees</th>
<th>Emissions of CO₂ (kton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic metal industry</td>
<td>27</td>
<td>95,986</td>
<td>3.7</td>
<td>456</td>
<td>35,567</td>
<td>6,756</td>
</tr>
<tr>
<td>Mineral industry</td>
<td>26</td>
<td>31,804</td>
<td>1.2</td>
<td>1,800</td>
<td>17,437</td>
<td>2,931</td>
</tr>
<tr>
<td>Pulp and paper industry</td>
<td>21</td>
<td>110,162</td>
<td>4.3</td>
<td>469</td>
<td>36,817</td>
<td>2,009</td>
</tr>
<tr>
<td>Oil refineries¹</td>
<td>23</td>
<td>8,525</td>
<td>0.3</td>
<td>53</td>
<td>2,513</td>
<td>1,793</td>
</tr>
</tbody>
</table>

Source: SCB, 2005 (¹ Including production of nuclear fuel and coke oven products. ² Data excluding emissions from biofuels for 2000.)

The Swedish basic industry was similarly to the energy utilities affected by the oil crises of the 1970s and followed the same development path with a focus on reduced oil dependence. The industries’ oil supply was largely replaced with electricity supplied through the nuclear programme, which increased the Swedish electricity production and reliable access to electricity at competitive prices. Earlier Swedish energy policies are consequently a contributing factor to a high share of electricity consumption in the energy intensive basic industry sectors.

The Swedish basic industry generally has efficient operations (OECD and IEA, 2004) with low specific GHG emissions (MIEC, 2004). The main emission sources are processes and fuel utilization. Process emissions originate from chemical reactions in the main production processes and combustion emissions originate from fuel utilization in electricity, heat and steam production. The potential to reduce the process emissions with present technologies is limited and this consequently only briefly discussed. If looking at the emissions from the latter perspective the situation is different and emissions can be reduced by switching to RES and/or improving energy management and efficiency. The potential for increased utilization of RES
varies in the different industries. The potential for improved energy management and efficiency through improved fuel and heat recovery as well as improving auxiliary equipment includes all basic industry sectors. The conclusion is that a potential for emission reductions in the basic industry lies in reducing the fuel consumption and maximizing the output of the energy utilization. The potential is often large and very cost-effective.

The basic industries continuous work with energy efficiency improvements has been motivated by economic rationale and has lately been further promoted by policy instruments and high energy prices. The main economic benefits from working with these issues are reduced production costs as well as reduced influence of fluctuating energy prices and changes in the policy framework. From a technology perspective, the work is slowed down by the long life-span and high investment costs of heavy industrial installations. From a policy perspective, short-term policies result in unstable investment calculi, which potentially hamper a positive development through increasing the investment risk. The development has nevertheless been successful and resulted in relatively stable emission levels despite increasing production (Figure 4.1). This is however to a larger extent a result of the industries’ work to reduce production costs from an energy perspective than it is a result of policies. The urgency of the climate change issue and international GHG emission agreements also puts higher requirements on the current and future policy framework.

This chapter firstly defines the specific stakeholders that are included in the thesis’s scope regarding the basic industry and its carbon dioxide emissions. Secondly, the carbon dioxide emission and energy utilization situation in the basic industry is explained to provide a background to the subsequent analysis of specific industry sectors’ potential to reduce the emissions. This is discussed mainly about the potential for emission reduction in RES and energy efficiency, as it is found that the process emissions are difficult. Thereafter improvements of auxiliary systems,
common for all basic industries as well as the energy utilities, are discussed. This is not aimed at giving a thorough analysis or summary of all technologies but rather at showing that even if the Swedish industry has made a significant progress in efficient processes there are still potentials for improvements. The chapter ends with a summary.

4.1 Stakeholders

The main stakeholder groups, with concern to the basic industries, are different agencies and institutions as well as the basic industry companies and the relevant sector organizations. The list is by no means complete but includes the main stakeholders who are related to the climate change and energy agenda in the basic industry. Most industrial stakeholders under the EU-ETS are members of the Confederation of Swedish Enterprise presented in Chapter 3.1.

Table 4.2 Stakeholders in the basic industry sector

<table>
<thead>
<tr>
<th>Political</th>
<th>Non-Political/Industry/NGO</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Ministry of Industry, Employment and Communications (MIEC)</td>
<td>- Confederation of Swedish Enterprises</td>
</tr>
<tr>
<td>- Ministry of Sustainable Development</td>
<td>- SKGS</td>
</tr>
<tr>
<td>- Swedish Energy Agency</td>
<td>- SweMin</td>
</tr>
<tr>
<td>- Swedish Environmental Protection Agency</td>
<td>- Jernkontoret</td>
</tr>
<tr>
<td>- SPI</td>
<td>- Cementa</td>
</tr>
<tr>
<td></td>
<td>- Swedish Forest Industries Federation</td>
</tr>
<tr>
<td></td>
<td>- Swedish Plastics &amp; Chemicals Federation</td>
</tr>
<tr>
<td></td>
<td>- Preem (Preemraff)</td>
</tr>
</tbody>
</table>

63 The table is non-exhaustive, however highlighting stakeholders of importance in the thesis.
### 4.1.1 Institutions

The political responsibility for basic industry lies on the Ministry of Industry, Employment and Communications (MIEC) as well as on the Ministry of Sustainable Development regarding for example energy and environmental issues. The agencies that are of specific relevance are the Swedish EPA (Chapter 2.1) and the Swedish Energy Agency (Chapter 3.1). A number of industrial organizations represent the different basic industry sectors with regard to climate and energy policies as well as other issues.

**SKGS – Skogen, Kemin, Gruvorna och Stålet**

SKGS works as a collaboration organization between the four sector organizations within the forest, chemical, mining, iron and steel industry – the Swedish Forest Industries Federation, the Swedish Plastics and Chemicals Federation, the Swedish Association of Mines, Mineral and the Metal Producers and Swedish Steel Producers’ Association. SKGS has a focus on energy supply and energy related policy

---

64 The ministries have been reorganized under the new government. The former ministerial order is used here. *See Chapter 5.1.2 for more information on ministries.*

instruments while the focus of the respective organizations is wider. The main objective is to work for an increased governmental and public understanding of the necessity for a reliable and reasonably priced energy supply for the basic industries. Despite the focus on energy SKGS has not taken a strong position regarding climate change and the basic industries’ carbon dioxide emissions.

The current Swedish energy policies are criticized for being irresponsible as they are considered to undermine the energy system and thus also the basic industries possibilities to work, invest and expand their businesses in Sweden. Predictions of the future contributions of bioenergy and wind power to the Swedish energy supply are believed to be greatly overrated and it is considered that the Swedish nuclear capacity should not be phased out. SKGS promotes an increased discussion between the business sector and Government on the future of the Swedish energy system.

**SweMin – the Swedish Association of Mines, Mineral and Metal Producers**

SweMin is the representative for the mining, mineral and metal industry as well as a number of industries associated with mining, such as cement companies. The Swedish mining industry is promoted as one of the world leaders in energy efficiency. SweMin works for its members on different focus areas, for example, energy, climate and EU policies. SweMin works on energy projects together with the other member organizations of SKGS on climate issues. One focus area is policy instruments, where emission trading lately has been the focal point. SweMin is a member of the European non-ferrous metals producers association EuroMetaux as well as the European Association of Mining Industries (Euromines).

---

66 Further information is available at http://www.mining.se
Jernkontoret – the Swedish Steel Producers’ Association

The association, Jernkontoret in Swedish, represents the steel industry in a number of areas. Energy issues such as supply and efficiency are important due to the energy intensive processes. Jernkontoret consequently has a department for climate and energy issues which protects the industry’s interests regarding energy, climate and environmental issues as well as the economical implications of governmental policies in these areas. The association identifies the Swedish steel industry as among the most modern and efficient in the world. Jernkontoret is affiliated with the European Confederation of Iron and Steel Industries (EUROFER).

The climate issue and emission rights trading are main issues for Jernkontoret as the steel industry both is energy intensive and have large processes emissions of carbon dioxide. Jernkontoret is consequently concerned about the operation and design of the EU-ETS and regards that the Swedish steel industry could be disadvantaged by the trading scheme if the efficiency and low specific emissions of the processes are not taken into account, for example through benchmark allocations.

SPI – the Swedish Petroleum Institute

SPI promotes the oil industries’ interests in many areas, such as policies and environmental issues, by being a centre of information and to carry a dialogue with public authorities. SPI works for just market conditions for all energy sources. The vision is a Swedish cost-effective and sustainable oil production with excellent environmental characteristics. Oil is seen as a vital part of the future energy system due to the Swedish consumption patterns, especially regarding the transportation sector. The environmental agenda includes reducing carbon dioxide emissions from refineries.

Further information is available at http://www.jernkontoret.se

Further information is available at http://www.spi.se
Swedish Forest Industries Federation (SFIF)\textsuperscript{69}

SFIF is one of the sector organizations for the pulp, paper and wood mechanical industry. The federation’s main aim is to strengthen the competitiveness of these industries and to promote the use of wood products. The focus is on Swedish and European market issues and policies. Energy is an important area for the federation, both internally and within SKGS. The SFIF considers that fuels used for cogeneration should not be subject to energy and carbon dioxide taxes. SFIF is a member of the Confederation of European Paper Industries (CEPI).

The SFIF considers climate change to be the most important issue on the global environmental agenda, partially due to the forests dependence on the global climate. The federation’s opinion is that forest carbon sinks should be accounted for under the national climate goals and in the compliance with international climate commitments. SFIF state that they are in favor of global commitments and long-term voluntary agreements and that these should replace taxes and regulations. SFIF also calls attention to that a growing forest industry in Sweden is positive for the national coal balance and that this should be considered in the design of policy instruments.

Swedish Plastics & Chemicals Federation\textsuperscript{70}

The federation’s focus on chemicals results in member companies from many industrial sectors including producers of for example cement, ferrous alloys, pulp and paper. The federation works with climate and energy mainly through an energy working group focusing on policies in these areas but also through a working group on environment that specifically work with issues regarding the environmental legislation. The federation is a member of, and cooperates with, the SKGS on climate

\textsuperscript{69} Further information is available at http://www.skogsindustrierna.org
\textsuperscript{70} Further information is available at http://www.plastkemiforetagen.se
and energy issues and is also associated with the European Chemical Industry Council (CEFIC).

### 4.1.2 Basic Industry

The general focus is on the different sectors included in the scheme but also in detail on companies within the respective sectors that have received the large emission right allocations. The many companies that are included in the EU-ETS but have not been selected for an interview are represented by the Confederation of Swedish Enterprise. Since the EU-ETS includes emissions from specific operations rather than companies the presentation of the stakeholders is based on a process perspective.

Many of the European industrial sector associations that work with climate and energy policies within the included industrial sectors associations have together with other sector organizations joined forces in the Alliance of Energy-Intensive Industries – an initiative that mainly focuses on policy issues that affect the competitiveness of the industries due to costs of energy.

**SSAB Svenskt Stål AB**

The SSAB group is Sweden’s largest steel industry with group net sales of about 24,600 MSEK and 9,400 employees (2004). The two steel manufacturing subsidiaries, SSAB Tunnplåt in Luleå and SSAB Oxelösund are integrated steelworks, which have received the two largest allocations of emission rights in Sweden. Since 95% of the emissions can be related to the reduction process, the company carries out and supports research on finding less carbon dioxide intensive manufacturing processes. The company also works to improve the energy efficiency of the operations since the

---

71 Further information is available at [http://www.ssab.se](http://www.ssab.se). Data based on interview with Göran Carlsson (2005) at the company.
manufacturing is highly energy intensive. The company continuously establishes goals for the consumption of coal and coke but not specifically for carbon dioxide emissions. The company also establishes yearly action plans for the improvement of energy efficiencies.

SSAB aims to be in the international vanguard of the steel and metal industry regarding environmental efficiency. Both steelworks are certified according to ISO 14001. SSAB emphasizes the LCA benefits of the high-strength steel that they manufacture, for example reducing the weight of cars and consequently also the fuel consumption.

**Cementa**

Cementa is the largest Swedish cement producer as well as the largest company in the Swedish mineral industry sector. The company has net sales of about 1,200 MSEK with 470 employees (2004) and is owned by HeidelbergCement. The head office is situated in Stockholm with three Swedish production sites at Degerhamn, Skövde and Slite – all included in the EU-ETS. The Slite plant is Sweden’s third largest carbon dioxide emission point source and three quarters of Cementa’s received emission rights is allocated to Slite.

The company started working to reduce the carbon dioxide emissions in the 1970s when a large number of old kilns were decommissioned. The company has accomplished large carbon dioxide emission reductions by switching from a wet production method to a dry method with higher energy efficiency. The main driver behind this work has been economic considerations, aiming at reducing fuel costs. From a process perspective, Anders Lyberg (2005) at the company identifies that the 

---

72 Further information is available at [http://www.cementa.se](http://www.cementa.se). Data based on interview with Anders Lyberg (2005) at the company.
The company is running efficient operations that are in level with the Integrated Pollution Prevention Control (IPPC) requirements, only holding a small potential for improvements. From a fuel perspective the company views “non-virgin” fossil fuels, such as wastes, as carbon dioxide neutral, which differs from the definition of fuels in the EU-ETS. The company aims to increase the utilization of biofuels from 2% to 10% in 2007. HeidelbergCement as a group is aiming for a -15% reduction of the group’s carbon dioxide emissions to 2010, compared to 1990 levels. Similar goals are shared by Cementa whose aim to achieve the -15% reduction to 2007 was achieved in 2005. Cementa also, since 2006, have a two-year goal to improve energy efficiency by 1% less specific thermal consumption to be achieved by 2007 compared to 2005.

Cementa have used LCAs to analyze their processes and utilize the tool to reduce their environmental influence and carbon dioxide emissions. The company is certified according to ISO 14001 and is using an internal environmental management system. The company is participating in the Programme for Energy Efficiency (PFE).

**Stora Enso**

Stora Enso is an international forest industry company in the paper, packaging and processed wood products industry. The group’s Sweden based units has net sales of about 2,820 MEUR and employs about 8,850 people (2004). The company’s Swedish head office is in Stockholm and there are seven Swedish mills that are included in the EU-ETS. The company sees climate and energy policies as a major factor in deciding business strategies. The main source of carbon dioxide emissions in these factories is fuels used for the different processes. The mills are working to reduce the carbon dioxide emissions by utilizing a high rate of biofuels and developing CHP production. Stora Enso does not have any goals for the reduction of carbon dioxide emissions.

---

emissions but the company work towards lower specific energy utilization per produced paper quality – the paper characteristics largely determines the energy consumption – but defining a goal is difficult due to varying market demand of different product qualities.

The company has committed themselves to develop their business in a sustainable fashion and is selected for the Dow Jones Sustainability Indexes DJSI World and DJSI STOXX. All mills are certified according to both EMAS and ISO 14001. The majority of the mills are participating in the PFE.

**Preem Petroleum AB**

Preem Petroleum AB is the owner of two refineries on the Swedish west coast of which Preemraff Lysekil is Sweden’s largest. Preem’s net sales are about 40,000 MSEK and have about 1,800 employees (2004). The company has received Sweden’s fourth largest single allocation of emission rights to the refinery in Lysekil. Preem has not established any goals regarding the carbon dioxide emissions from their refineries. The company has however established goals for the energy efficiency which serves also that purpose. The refinery in Lysekil conducts benchmark studies of the energy consumption every two years, aiming for a 2-3 % reduction per year.

Preemraff regulates its processes and environmental work according to orders by the Environmental Court and their ISO 14001 certification. The company does not participate in the PFE.

---

74 Further information is available at http://www.preem.se. Data based on interview with Leif Brinck (2005) at the company.
75 Previously named Scanraff AB.
4.1.3 International Stakeholders

**European Union**

The EU’s work to reduce industrial carbon dioxide emissions is carried out by various bodies at different institutional levels. In the Commission the DG for Enterprise and Industry is responsible for a sustainable competitiveness of the industry. This is accomplished through promoting sustainable development and climate policies into enterprise policies, aiming to ensure that policy instruments in these areas have tangible results. In the European Parliament the Committee on Industry, Research and Energy has the responsibility of EU industrial policies and the introduction of new technologies as well as research policies and the dissemination of research findings. On a European Council level the Competitiveness Council is responsible for driving the Lisbon Agenda forward and analyzing how policy instruments affect the competitiveness of the business community.

4.2 Carbon Dioxide Emissions

The NAP1 (MIEC, 2004) identifies that the largest potential for emission reductions lie in the housing and building sector, identifying the potentials within the industry is significantly smaller. The largest potential is found in the pulp and paper industry and the smallest in the iron and steel industry plus the oil refineries. There nevertheless exist a number of opportunities to reduce the process and combustion emissions. Process emissions of carbon dioxide occur due to chemical reactions in the process raw materials and is in some industries an inescapable element in the processes, especially in the steel and cement industries. Combustion emissions originate from fuel utilization in electricity, heat and steam production. The difference between these is important from a policy instrument perspective as the EU-ETS includes that the allocations shall regard the possibilities for the industry to
reduce the emissions. The Swedish NAPs (MIEC, 2004; Ministry of the Environment, 2006b) thus provide a full allocation for process emissions related to the raw materials. This is, according to Birgitta Resvik (2005) at the CSE, positive as it alleviates the pressure from the EU-ETS.

Figure 4.1 Carbon dioxide emissions in the Swedish industry (1990-2004)

![Graph showing carbon dioxide emissions in the Swedish industry from 1990 to 2004.](image)

*Source: SEA, 2006d (Industrial combustion includes industrial electricity production. Industrial processes include solvent and other products use. Emissions from biofuels not included. It would be beneficial to describe the specific emissions for all stakeholders in connection to the absolute emissions. This is however difficult as the base data for calculating specific emissions is difficult to attain or based on varying classifications.)*

The largest emission source for the basic industry as a whole is combustion with 80% of the total emissions while the process emissions represent 20% (SOU 2000:23). Approximately 35% of the total emissions for the Trading Sector were related to the raw materials used during 1998-2001 (MIEC, 2004). The difference between this figure and the process emissions are due to differences in accounting for the combustion of internal fuels, for example burning of coke in catalytic crackers in oil refineries. The distribution varies between the different industries sectors and so does the potential for reducing carbon dioxide emissions – the steel industries as an
example have large unpreventable process emissions while the pulp and paper industries have combustion emissions. *Figure 4.1 and 4.2* indicates that the specific emissions have been considerably reduced since 1993 and forward.

The possibilities to lower the process emissions in the Swedish basic industries are in general limited. The reason is that most industries have been successful in their work to improve the resource and energy efficiency through advanced process technologies, which have resulted low emission levels in an international comparison (MIEC, 2004). Low-carbon production technologies are a focus area for R&D in the different sectors but commercialization of groundbreaking technologies is generally decades away. There are possibilities to improve the processes in all sectors, resulting in lower emissions, but the potentials for reductions are often larger in non-process related areas.

The combustion emissions in the basic industry originate from the production of heat, electricity and steam that is used in the production processes. The work to reduce these emissions can either focus on substituting fossil fuels with RES or improving the energy efficiency and management. The transition to RES is not possible in all industries as the processes may require certain fuels. In other industries, non-renewable fuels are a by-product, making a switch to RES an economically unfeasible alternative.

The view that the basic industry has made considerable progress in reducing the carbon dioxide emission and energy intensity is not shared by the SSNC (Rylander, 2005). The NGO identify that the industry sector does not take their responsibility in reducing emissions and that the low electricity prices in Sweden has been a problem as it has not created an incitement for improvements of the energy efficiency.
4.3 Energy Consumption

The Swedish basic industry is very energy intensive due to utilizing a large share of low-refined raw materials in their production. The cost for energy and electricity therefore carries a large part of the production cost. The industries have reduced their utilization of oil through substituting it with electricity, renewable fuels, district heating and gas. One of the main reasons for the increasing the electricity consumption is that the pricing of electricity was much more stable than oil, especially when the electricity market was regulated (Levander, 2005). The continued use of coal is mainly related to production processes in the steel industry. This development has substantially reduced the industries’ specific emissions and has resulted in relatively constant emission levels while the production has increased (Figure 4.2). This development also means that the potential for further switching to less carbon dioxide intensive fuels has decreased. Following the well-known concept that the first measures of improvements are often the easiest to accomplish and most cost-effective this also implies that measures are increasingly costly.

Figure 4.2 Energy consumption in the Swedish industry (1970-2005)

Source: SEA, 2006d
It is obvious from looking at Figure 4.2 that the work to improve the industries’ energy efficiency has been particularly successful from around 1993 and onward. While the rise in production was initially associated with a higher energy consumption this development has been decoupled, resulting in lower specific energy consumption and naturally also lower specific carbon dioxide emissions. An important factor that affects the specific consumption of energy and emission levels is the level of capacity usage where a higher level leads to better production efficiency and lower specific consumption. The state of the sector and national economy consequently has an influence on the level of efficiency.

The specific electricity consumption in the Swedish basic industry is high from an EU perspective, which is largely attributable to the climate and the high level of low refined raw materials that are used (OECD and IEA, 2004; SEA, 2004a). The electricity consumption in Figure 4.2 is mainly used for powering auxiliary equipment and there is consequently a large potential for savings in this sector.\textsuperscript{76} Effective control and maintenance plus modernizing the equipment have resulted in large energy and economic savings for several industries. This also have direct effects on the national carbon dioxide emissions especially when analyzing this based on the marginal production of electricity. Maria Sunér Fleming (2005) at Swedenergy identifies that the dialogue on electricity consumption often lacks a larger system perspective. She argues that the higher specific electricity consumption in Sweden means that the there is lesser consumption of for example oil and gas than in other countries.

\textsuperscript{76} It is estimated that 78 \% of the industries total electricity consumption is consumed by electric motors (SEA, 2001b). No reports have been found that cover the basic industry’s electricity consumption on a system level and the consumption is therefore not explained in more detail.
4.4 Energy Efficiency and Energy Management

The basic industries are continuously working to improve their energy efficiency through investments and R&D. The motive power behind this work is identified rather as economic considerations due to high energy costs than a result of applied policy instruments (Brinck, 2005; Carlsson, 2005; Hannus, 2005; Levander, 2005; Lyberg, 2005; Resvik, 2005; Rylander, 2005). Thomas Levander (2005) explains that the SEA have worked more with informational campaigns to make the industry realize the potential that lies in working with energy efficiency through energy management schemes than with promoting the introduction of economic and administrative policy instruments. Levander identifies that the carbon dioxide tax is not likely to be accountable for any large carbon dioxide emission reductions or improvements of energy efficiency due to the low levels that has been levied for the industry.

A comprehensive view on energy can also be labeled as energy management. The latter concept includes, in addition to lowering the energy consumption, to optimize the energy output from the processes with regards to internal fuels, electricity, heat and steam production. This can include selling surplus energy to external energy systems, such as district heating systems, electricity grid and other industries. Energy management thus has larger system boundaries than energy efficiency that may focus on individual efficiencies.77

The progress in both energy efficiency and carbon dioxide emission reductions can be slow as much of the industrial equipment has very long investment cycles, which limits the introduction of new and improved technologies. Other limitations are that

77 This is not an established definition. It is used in the thesis to separate the work to minimize the consumption of energy (input) from the work to optimize the internal energy system (input and output).
these investments can be associated with large capital investments and long payback times. However, high specific energy consumption offers a potential for efficiency measures to shorten the payback times as a result of the relatively high savings that can be achieved. A possible tool to overcome these obstacles to improve the energy efficiency is to collaborate with a company that offers energy management services, so called Energy Service Companies (ESCOs). These companies carry out energy savings measures for an economic compensation that is linked to the actual savings that are realized. A possible policy measure for achieving the energy efficiency potential in the society is thus to promote ESCOs through different measures. While strict energy efficiency policies in general accomplish this, examples of policy instruments that can be implemented are Energy Efficiency Certificates (EECs, Chapter 6.3) and voluntary energy efficiency agreements (Chapter 7.3). Municipal energy planning (Chapter 8.2) could also be strengthened to work as a strong catalyst for ESCOs. The EU-ETS can potentially, if established as a long-term scheme and at high emission rights prices, be a strong driving force for the development and implementation of new technologies as the scheme establishes price for carbon dioxide emissions. Companies are aided in their work to improve energy efficiencies through a number of SEA projects as well as through EU projects such as ATLAS and the EU IPPC BREFs. These projects offer guidance on how this work should be carried out and which equipment that has high efficiencies.

The use of state-of-the-art IT solutions enables significantly improved operation control. These solutions can be implemented in the logic and automatic control of processes and auxiliary systems and hold a major potential for improving the energy

78 For information about ATLAS, see http://europa.eu.int/comm/energy_transport/atlas/homeu.html.
79 The Integrated Pollution Prevention Control (IPPC) Directive (96/61/EC) establishes a framework for the issuance of operational permits for the industry in order to protect the environment. The permit requirements are communicated through best available technique (BAT) reference documents (BREFs). For more information, see Chapter 5.4.1.
efficiency and management by assuring that the logic and automatic control settings are correct. This is important, as control levels in many cases are not set at the optimal operation point or does not adjust efficiently to changes. Evaluating the logic and automatic control should therefore be carried out early in the energy efficiency work – new control system or settings can affect the efficiencies of installed auxiliary equipment – to assure that the following work are proceeded with a correct focus. A continuous attention to this is also fundamental in a longer perspective to ensure that investments in improved auxiliary systems, with potentially higher efficiency, are operated at maximum efficiencies. This is important, considering that the efficiency of a system is often more depending on the way the system is designed and operated than on the single efficiencies of the installed equipment.

There are currently two policy instruments that promote energy efficiency in industrial equipment. Firstly, the Environmental Code, that stipulates that BAT is used to prevent and counteract environmental degradation. This includes the EU IPPC Directive that has been adopted into the Code. Secondly, the Programme for Energy Efficiency (PFE) that offers a complete reduction of the process electricity tax reduction for the energy intensive industries that agrees to run an energy efficiency management scheme. This programme was strongly promoted by the business sector through the CSE, to work as an incentive to introduce energy management systems. For more information on the PFE and Environmental Code, see Chapter 7.3 and 8.1. Many industries have also adopted environmental certification and management schemes, which in many cases include requirements and action plans on improving energy efficiency. In addition, the impact of demands from clients and public on how the industries should address these issues should not be neglected. The Government is also running a 5-year programme (2003-2007), initiated in the 2002 Energy Bill (2001/02:143), on energy efficiency that mainly focuses on energy efficiency
consultations and information as well as market introduction through procurement programmes.\textsuperscript{80}

Birgitta Resvik (2005) at the CSE identifies that the basic industries includes the work to improve the energy efficiency as an essential part of business strategies and that this has implications for the policy framework. Birgitta Resvik exemplifies, in reference to the carbon dioxide tax, that the economic gains that are achievable through improved energy efficiencies can be a stronger motive power than the resulting tax levy reductions. Birgitta Resvik argues that important policy instrument aspects for promoting energy efficiency are to include capacity building and investment support, as these investments compete with other projects regarding time and funds. Resvik consequently provide a strong support for the PFE as these aspects are two of the major components in the scheme. Resvik also highlights that it is important to create a long-term policy regime, which establishes a stable investment basis that effectively promotes the introduction of new technologies. Another important policy aspect is to support R\&D as proving the functioning and efficiency of new technologies is vital for disseminating them to the industries. This is emphasized in by the high investment costs of large equipment. This issue is also identified as important by Thomas Levander (2005) at the SEA.

On an EU level, energy efficiency in an industrial perspective is promoted by the IPPC Directive (96/61/EC), the Directive on Ecodesign Requirements on Energy Using Products (2005/32/EC) and the End-Use Efficiency Directive (2006/32/EC). \textit{See Chapter 5.4.2 for more information the EU agenda on energy efficiency.} The EU has also discussed the introduction of an EEC scheme. Peter Chudi (2005) at E.ON Sverige however identifies that, since there is a large potential for cost effective

---

\textsuperscript{80} The programme was initiated as a response to an official investigation on how to promote energy efficiency. The findings are presented in a report on suggested market based measures (Ds 2001:60).
improvements, no further economic support for this development is required. He concludes that this work would be better promoted through increased informative efforts.

In general terms the work to improve the energy and emission characteristics of the operations can be improved at different occasions and different sectors of the operation. Indifferent of when or where the improvements are made, it is essential to have a large system perspective as sub-optimizations can otherwise occur that reduces the efficiency for the entire operations or when applicable for a region. Figure 4.3 shows a map of how this work can be categorized within both the basic industry and energy utilities.

**Figure 4.3 Areas for efficiency improvements in the basic industry**

![Diagram of areas for efficiency improvements in the basic industry]

**Time of Investment (When)**

The efficiency of existing equipment can be improved by process integration and other energy management tools, which can detect inefficiencies in all stages of the operations. Process integration includes a development and restructuring of the processes to optimize economic costs, production capacity, energy consumption and environmental impact such as carbon dioxide emissions. This can be accomplished through for example pinch or exergy analyzes. The potential for this work to
improve the operations at the Swedish steelworks are identified by Göran Carlsson (2005) at SSAB, to be important parallel to the introduction of new technologies. Working with energy management should be continuously carried out as the system characteristics changes as the work proceeds. An example highlighting this, are heat systems that are often not redesigned as the system closure is improved and the use of excess heat can consequently be sub-optimized. Another very important aspect of improving existing equipment is a well-functioning maintenance scheme that guarantees regular maintenance and control of existing installations. This is effective to avoid old and malfunctioning equipment with low efficiencies. Energy management and process integration is a broad and the focus of intense research, and the range of measures is larger than can be explained here.

Purchasing new equipment on a smaller scale represents a large opportunity for improvements. The investments can often be initiated by the work explained above and mostly involve auxiliary equipment. To ensure that the equipment will be optimal from an economic and environmental perspective, the investment should be evaluated through LCA. The Government helps the business sector in this process by establishing labeling systems, which facilitates an easy overview of the efficiency of for example motors, pumps and fans (Chapter 4.6 and 9.1).

Large investments or new establishments provide the largest possibilities for emission reductions as these measures affect the main processes and combustion installations which are part of the production that are often most energy intensive. These large investments are in the basic industry and energy utilities very costly and often have a payback time and lifespan of 20-40 years. This hampers a rapid development of the efficiency work on this level and has strong implications for the policy framework. Another large energy management investment sector is to utilize industrial waste heat in district heating systems when the basis for such a development exists.
Area of Investment (Where)

There are three major areas to improve the energy efficiency and management of the operations. The heavy process and combustion installations are only affected when they are replaced at the end of their economic lifespan. The investments are, due to the long lifespan, very sensitive to changes in the framework that can affect the economic calculi during the operation. Long-term and well-designed policy instruments are consequently important to establish effective incitements for investments in superior technologies. This is important for the efficiency of the policy framework and is emphasized by the potentially heavy emitting nature of the basic industry operations.

As 80 % (SOU 2000:23) of the industrial emission originates from combustion, these installations can be considered to hold the largest potential for improvements. The most obvious way to reduce the emissions is to switch to RES but large improvements can often be made also through energy efficiency and management. The process conditions and potentials for improvements are specific for the different industries, and thus explained separately for each basic industry sector.

The auxiliary equipment is contrary to process installations affected in all investment categories, as large process and combustion investments inevitably also include this equipment. Birgitta Resvik (2005) at the CSE estimates that the potential for improvements in auxiliary equipment of the basic industry sectors are in the range of 1-1.5 %. The largest potential is identified as an improved utilization of waste heat. Policies targeting auxiliary equipment can potentially, due to the smaller investments, achievable improvements more rapidly. As the auxiliary equipment is similar in the industrial sectors as well as energy utilities the efficiency aspects thereof is jointly explained in Chapter 4.6.

---

81 While this must not be true for all industries, it is the case for the energy intensive basic industry.
4.5 Basic Industry Sectors

The basic industry sectors have, as mentioned above, varying possibilities to improve the production and process efficiency towards reduced energy consumption and carbon dioxide emissions. Due to this, the chapter provides an overview of the different sectors and their production with regards to processes and process emissions, energy consumption and the possibilities for fuel-switching to biofuels and improved energy efficiency. This is summed up in the possibilities to reduce carbon dioxide emissions.

4.5.1 Iron and Steel Industry

In 2004 the iron and steel sector encompassed about 452 companies with a turnover of 95,986 MSEK that represented 3.7 % of the Swedish GNP (SCB, 2005). The industry can be divided into the mining industry that produce crude iron by roasting and sintering iron ore and the steel industry that use crude iron as a raw-material. The only crude iron producer in Sweden is LKAB that during 1999 produced about 18 million tons of iron ore, which is about 2.2 % of the international production and 95 % of the EU production (LKAB, 2005). The Swedish steel industries, with SSAB being the major stakeholder, produce about 6,000 kton steel per year of which about 80 % is exported. The Swedish production has an increasing focus on alloy and high-carbon steels that meet certain strength and chemical requirements.

In 2000 the iron and steel industries contributed to 40 % of the Swedish industries carbon dioxide emissions and 13 % of the total Swedish net emissions. The major emission sources in the sector are the reduction processes at integrated steelworks.

\[82\] Calculations based on data excluding emissions from biofuels (SCB, 2005; SEA, 2004b).
There are 15 operations included in the current Swedish NAP1 (MIEC, 2004) under the EU-ETS category production and processing of ferrous metals and metal ore processing installations. An additional 3 operations are included as roasting and sintering operations. The sectors are excluded from the Renewable Energy Certificates (REC) scheme obligations. Metallurgic processes are furthermore excluded from both fuel and electricity energy taxes. The majority of the sector’s electricity consumption is thus excluded from the new electricity tax of 0.5 öre/kWh but operations can join the PFE with respect to auxiliary consumption. The operations are liable for a mandatory governmental permissibility consideration under the Environmental Code (SFS 1998:808).

Production

The production of crude iron and steel starts with the mining of iron ore, which is refined to fines and pellets through grinding and cleaning. These products plus metal scrap are used as the raw material in the steel production. If fines and pellets are used they are enriched through a blast furnace reduction process with temperatures of >1,000°C where the oxygen is removed by a chemical reaction with coke to produce crude iron.\textsuperscript{83,84} To supply coke to the blast furnace many steel works have their own coke oven plants that produce coke from coal as well as other internal fuels. The furnace steel is processed in an LD-converter which reduces the sulphur content and produces refined steel. Thereafter up to 25 % scrap metal is added together with alloys, which produce a steel melt with desired qualities.

The steelworks that produce their own crude steel from iron ore are called integrated steelworks but there are also a number of steelworks that produce crude steel mainly

\textsuperscript{83} The reduction process can also utilize small proportions of coal and gas.
\textsuperscript{84} The blast furnaces that are operated in Sweden are owned by SSAB and situated at the Luleå and Oxelösund integrated steelworks.
from metal scrap which is melted with electric arc furnaces. The steelworks that most commonly use this technique are alloy steel producers, due to alloy contents in the scrap.

When the steel melt has the desired composition it is cast into slabs of different shapes and left on cooling beds. The casting process may also include cooling the steel with water, which produces large steam volumes. The majority of the steel is further processed through forging or rolling to acquire certain characteristics that are requested on the steel market or in the internal production. These processes either occur as hot-working processes, often after reheating the steel in warm-up mills to temperatures of about 1,000-1,250°C, or in cold working processes.

**Energy Consumption**

The production in integrated steelworks is one of the most energy intensive industry sectors, representing about 15 % of the Swedish industries total consumption (SEA, 2005b). The largest energy consumer in an integrated steelwork is the blast furnace, which typically consumes 54 % of the total consumption, and the second largest is the hot working of the cast steel (SEA, 2001b). The main energy input is the large amount of coke that is used in the blast furnaces process to support the reduction of oxygen. The coke also fuel the furnace, which requires high temperatures of >1,000°C, and supply additional coal to the steel melt. The possibilities to switch to biofuels are limited due to their lower energy density as well as their ash contents and combustion characteristics. The consumption of coal and coke is consequently very large and the steel industry consumes about 50 % of the total Swedish industrial coal consumption and roughly 100 % of the coke consumption. The typical energy
consumption in an integrated steelwork is approximately 92% coal, 6% electricity and 2% other fossil fuels such as oil and LPG (Jernkontoret, 1997).³⁸⁵

The specific energy consumption for an integrated steelwork is 925 kWh/ton steel (SSAB, 2005) and in a scrap metal steelwork 630 kWh/ton (SEA, 2001b). The energy consumption in scrap metal steelworks is thus significantly lower but the processes require large amounts of electricity for operating the electric arc furnaces. The energy consumption in a scrap metal based steelwork is approximately 64% electricity, 23% oil and 14% LPG (Jernkontoret, 1997).

Figure 4.4 Energy consumption and sources in the Swedish steel and metal industry (1992-2001)

Source: Calculations based on SCB (2006) data (SNI 27, no later data available)

Other process steps with high energy consumption are the warm-up mills and the forging and rolling of the cast steel. These and other process steps also have a large electricity consumption in the main auxiliary systems – motors, pumps and fans as

³⁸⁵ Later data have not been found.
well as steam, high-temperature hot water, cooling water, compressed air – as the manufacturing processes are heavy, large-scale and requiring high temperatures. The heat treatment in rolling mills mainly utilizes electricity as well as oil and LPG.

The use of coal in the steel industry can be considered as a fuel or as a process material. If it is considered as a fuel, then coal supplies the majority of the energy. If is considered as a process material that also produce internal fuels, then the consumption pattern is different with a much smaller coal consumption and a more diversified energy supply. The main internal fuels are then, apart from coke, blast furnace, coke oven and LD gases.

Since the 1970s the energy consumption within the steel industry has developed towards a heavy reduction of oil consumption. This is a result of inter alia the use of coal injection in the blast furnaces, use of LPG as well as improvements in energy efficiency. Since 1980 a strong increase in the use of process coal is a result of a production increase. The increase in coal consumption is however limited by a lower specific consumption in the reduction process. The electricity consumption has during the same period been stable. The use of fossil fuels is however often difficult to replace – not only in the reduction process – as the energy intensity largely requires energy sources with high energy density.

The energy consumption of fossil fuels in the steel industries is incompatible with the governmental goal of not using fossil fuels in Sweden in 2020. Considering that the steel industry would then not be able to sustain their production and the important part that this sector plays in Sweden the 2020 goal stand out as a vision and not a target.
Carbon Dioxide Emissions

The iron and steel industry sector emissions of 6,756 kton in 2000 (SCB, 2005) represent the largest share of emissions within the basic industries.86 The emissions in SSAB’s integrated steel industries originate to 95% from the oxygen reduction process where carbon dioxide is formed (Carlsson, 2005). This large share is a result of viewing the coal as a process raw material that is necessary for the production, thus associating the emissions originating from the reduction and the use of internal fuels to coal. Other carbon dioxide emission sources are for example the use of fossil fuels for warm-up mills and hot-working processes. In an international comparison the specific emissions per produced ton of steel are today very low as the Swedish steel industries have worked to reduce the emissions (Sandberg et al, 2001).

SSAB’s daily work to reduce the emissions includes a focus on maintenance and even production loads (Carlsson, 2005). Reductions have been achieved through partially substituting coke with coal powder (ibid).

The EU-ETS establish that the NAPs shall consider the possibilities for the included stakeholders to reduce the emissions. The Swedish NAPs has responded to this and concludes that the emissions from the reduction processes and the use of internally originating fuels are non-replaceable (MIEC, 2004). The NAP2 (Ministry of Sustainable Development, 2006) have identified the steel industries competitive situation as being impaired by emissions trading. The NAP2 therefore basing the 2008-2012 allocations on a European benchmark to improve this situation.

Process and Energy Efficiency

Since the main emissions source is process emissions, simply analyzing the potential of energy efficiency does not provide an accurate picture of the total potential for

86 The data does not account for carbon dioxide emissions from biofuels.
emission reductions. As new technologies are required for a substantial reduction of the process emissions, substantial R&D efforts have focused on developing low carbon dioxide reduction processes through, for example, the use of other reduction agents such as natural gas. The R&D has been somewhat successful but has not resulted in any commercial alternatives. A theoretical option could be hydrogen, which would require that the hydrogen is produced with RES or there would be no net change in carbon dioxide emissions. The SEA has in cooperation with SSAB carried out research on a new blast furnace that would substantially reduce the utilization of coal (Levander, 2005). Birgitta Resvik (2005) at the CSE identifies that the Swedish steelworks are operating close to the BAT level established in the IPPC BREF on iron and steel production (EC, 2001a) and support that the potential for carbon dioxide emission reductions with present reduction techniques are limited. The main process improvement currently attainable is utilization of natural gas in the reduction process.

The potential for savings in terms of energy efficiency and management is large as a result of the high temperatures and internal fuels originating from the processes. While the Swedish steelworks are efficient, Göran Carlsson (2005) at SSAB identifies that there are still many production areas that can be improved and highlights utilizing the waste heat from cooling beds where the steel reduce the temperature by >500°C. Apart from maintenance and production load management, SSAB works to improve the energy efficiency through reducing the consumption of coal and coke, as this is a large cost in the production. A study (Nilsson, 2003) of heat recovery in connection to these beds has identified the potential for heating water can be as high as 55 kWh/ton. Nilsson further identifies a national technical and economic short-term potential of 200 GWh per year. In 2002 Swedish steelworks supplied 3.2 TWh of waste energy to CHP plants and district heating companies (Jernkontoret, 2005a). Another area where improvements can be made is to roll and forge the steel immediately after the casting to reduce the need for warming ovens. Further
potentials lie in an effective utilization of internally produced fuels, minimizing heat losses, effective utilization of waste heat for preheating when possible plus improved auxiliary equipment. An evaluation of several energy related projects within the steel industry found that the potential for savings are 1,200 GWh/year in a ten-year period and that the payback time could be about 2 years (Jernkontoret, 2005b). Since the evaluation the energy prices have risen, which consequently has increased the potential.

At the SSAB steelworks, many of the process optimizations that have improved the energy efficiency are a secondary effect of investments in improving the quality of the finished steel product (Carlsson, 2005). Historically improvements have for the most part been achieved through decommissioning old steelworks and recent efforts for example include installation of variable-speed control on electrical motors. Jernkontoret (2007) is now running an energy research programme (2006-2010) with a budget of 227 MSEK that aims to achieve 4.5-5 % energy consumption reduction. Through realizing this potential Jernkontoret have identified a potential to reduce carbon dioxide emissions of 275 kton per year.

The European integrated steelwork industries have initiated an EU research project against the background of future climate agreements called ULCOS – Ultra Low CO₂ Steelmaking. The project aims to develop a new integrated steelwork process that will reduce the carbon dioxide emissions per ton produced steel by 50 %. The project, which focuses more on the process emissions than on energy efficiency, was started in 2004 and will be concluded in 2008. Several emerging technologies will be evaluated, such as new blast furnace processes, use of natural gas in the reduction, use of biomass and hydrogen in the steel production as well as carbon capture and storage.
4.5.2 Mineral Industry

The mineral industry includes several sectors whose production entails the use of mineral products. In 2004 the mineral industry in total encompassed about 1,800 companies that represented 1.2 % of the Swedish GNP through a turnover of about 31,000 MSEK (SCB, 2005). The largest sector within the mineral industry and part of the basic industry is the cement production. The only Swedish cement producer is Cementa, which represents about 40 % of the mineral industries turnover and is the major emitter of the mineral industries carbon dioxide emissions. In 2004 Cementa produced 2.6 Mton of cement of which about 50 % is exported (Cementa, 2005).

In 2000 the mineral industries contributed to 17 % of the Swedish industries emissions and 5.6 % of the total Swedish net emissions. The major emissions in the mineral industry originate from calcination and combustion in the cement industry.

There are at present 18 production units that are included in the EU-ETS under the mineral industry category in the Swedish NAP1 (MIEC, 2004). The cement industry does not have any obligations under the REC scheme. The mineral industry is excluded from the new process related electricity tax of 0.5 öre/kWh for the process related consumption but Cementa participates in the PFE with regards to the auxiliary equipment. The industry utilizes a large share of waste fuels and is thus affected by the design of the waste incineration tax. Mineral industries receive a 79 % tax deduction of the energy taxes. The operations are liable for a mandatory governmental permissibility consideration under the Environmental Code (SFS 1998:808).

87 Calculations based on data excluding emissions from biofuels (SCB, 2005; SEA, 2004b).
Production

The first step in the production of cement is quarrying and crushing of primarily limestone. The roughly crushed stones are then further grinded to a fine powder which is mixed with additives to facilitate the production of cement with certain qualities. The condition under which the grinding and mixing occurs – wet, semi-wet, semi-dry or dry – categorizes the four principal ways to produce cement. The limestone powder is pre-calcined as it is preheated to 600-900°C and burnt in cyclones producing calcined lime (calcium oxide). The main process feeds the lime powder to an inclining rotary kiln that slowly moves the powder towards a combustion chamber at the bottom. The temperature is thus slowly increased to reach a temperature of 1,450°C, which is required to convert the calcined lime into cement clinker. The hot flue gases from the kiln are used for the preheating and calcination of the limestone. The clinker is left to cool in air and is thereafter grinded together with gypsum and other additives to produce the final blended cement product. The cement is finally used as the fixing and strengthening agent in concrete, where it makes up about 10-15 % of the weight.

Energy Consumption

The energy consumption in cement manufacturing is mainly related to the production method. Wet methods consume more energy through requiring drying, and as this is not required for the dry method, the latter is more energy efficient. Cementa has, due to this, switched to the dry method in the company’s three plants. The process that consumes the majority of the energy in the cement production is the rotary kilns that primarily use coal and pet coke from oil refineries as fuels. Cementa is working to replace these fuels, and in relation to this emphasizes a difference

---

88 This part of the cement production is shared by lime works that are also included in the EU-ETS as mineral industries.
between utilizing “virgin” fossil fuels (e.g. coal) and alternative fuels (e.g. waste products) (Lyberg, 2005). This standpoint is in accordance with the Swedish and EU waste hierarchies, which stipulate that utilizing wastes for energy production is prioritized over deposition (Bill 2002/03:117). Cementa currently utilizes a number of waste fractions as fuels, such as tires, plastics, paper, solvents plus meat and bone meal. Cementa’s goal to 2007 is to increase the use of biofuels from 2 % to 10 % (Lyberg, 2005) and the use of alternative fuels to 50 % (Cementa, 2005). In 1999, the fuel consumption in the cement production was 2.1 TWh and in lime works 870 GWh (Ds 2001:63).

**Figure 4.5 Energy consumption and sources in the Swedish mineral industry (1992-2001)**

![Energy consumption chart](image)

*Source: Calculations based on SCB (2006) data (SNI 26, no later data available)*

The cement production’s electricity consumption is mainly divided on the operation of crushers and grinders (60 %) plus kilns and fans (30 %) (Ds 2001:63). The consumption in the grinders is heavily depending on the hardness of the raw-
material and additives plus the desired fineness the final product. Cementa’s auxiliary consumption is 140 kWh per ton cement (Cementa, 2005), which means a yearly consumption of 336 GWh in 2004.

Cementa (2005) also produce electricity using secondary process heat with an annual production of approximately 20.5 GWh. The sites also deliver secondary heat to district heating systems of approximately 21.1 GWh per year (ibid). Anders Lyberg (2005) identifies that improving waste heat utilization could reduce the specific electricity consumption with 10 %, and the company has to date accomplished an 8 % reduction since 2001 through cogeneration.

**Carbon Dioxide Emissions**

The mineral industry is the second largest emitter of carbon dioxide in the basic industry with 2,931 kton in 2000 (SCB, 2005). The emissions from the production originate to 60 % from the calcination of limestone while 40 % originates from the combustion of fuels (Lyberg, 2005). The carbon dioxide that is naturally present in the limestone is released in the calcination process and the emissions are unavoidable as limestone is an essential raw material. The emissions originating from the combustion process are substantial due to the very high temperatures that are required in the rotary kilns to convert calcined lime to cement clinker.

A comparison of production emission rates between different companies in different countries are difficult as the emission volumes depends on the cement qualities produced. The Swedish NAPs establish that emissions originating from the burning of limestone and dolomite (magnesia limestone) are difficult to reduce as they are non-replaceable raw materials.

---

89 The data does not account for carbon dioxide emissions from biofuels.
While the carbon dioxide emissions have decreased, the mineral industry in general and the cement industry in specific could achieve further emission reductions through an increased utilization of biofuels. Cementa views alternative waste fuels as being carbon dioxide neutral as they consider that the primary energy was consumed in the production of the waste goods and that the waste would otherwise be deposited (Cementa, 2005). This view is however not shared by the EU-ETS Directive (2003/87/EC) and thus not used in the thesis.

Anders Lyberg (2005) at Cementa identifies that a potential for reducing the company’s carbon dioxide emissions exists both in a higher utilization of biofuels and improved energy efficiency. The maximum potential for biofuel utilization is limited by the different fuel characteristics compared to fossil fuels. The lower energy density mean that a kiln that exclusive utilize biofuels would have to be three times the size of current installations (Resvik, 2005). Full biofuel utilization would also include a larger environmental impact from transport due to a heavily increased transport requirement. Cementa also analyzes at the possibilities to introduce carbon capture and storage in their production (Lyberg, 2005). Rehan and Nehdi (2005) suggest that an effective governmental emission abatement policy agenda should promote cement additives and support low-carbon technology development and implementation. The potential to reduce the carbon dioxide emissions by increasing the amount of additives in the production is also emphasized by Worrel et al (2000).

**Process and Energy Efficiency**

The possibilities to reduce carbon dioxide emissions thorough improving efficiencies in the mineral industry lies mainly in improving energy efficiency. As established above, process emissions from the cement industry and lime works are unavoidable. It is however possible to reduce the process emissions and energy consumption in the cement industry through reducing the clinker content in the finished cement
product. While these reductions are easy to achieve they affect the finished cement product characteristics, and is therefore only possible within certain limits.

In general the main possibility to improve the energy efficiency in the largest energy consuming process – the rotary kiln – is to switch from a wet to a dry process. This is together with energy management, heat recovery and pre-heating established as BATs in the IPPC BREF document for the cement and lime manufacturing industries (EC, 2001c). These measures have been taken at the Cementa plants, which have roughly halved the specific energy consumption, and Cementa therefore regard their operations as being close to or in level with the BREF (Lyberg, 2005). As a result of these investments, the company identify that there are at present only minor potentials for further improvements (ibid). From an historic perspective large efficiency improvements have been achieved through decommissioning old plants (ibid). Further improvements in energy efficiency can be achieved through maximizing the waste heat for electricity production and heat deliveries to district heating systems. One of the most promising new technologies is a fluidized bed production process, which is still in a pilot phase, has a potential to reduce the emissions with 10-12 % (EC, 2000).

4.5.3 Pulp and Paper Industry

In 2004 the pulp and paper industry consisted of 469 companies of which Stora Enso is one of the largest. The sector’s turnover was approximately 110,000 MSEK which represented about 4.3 % of the Swedish GNP (SCB, 2005). The production in pulp mills has large differences depending on how the pulp is produced and this sector is therefore described with respect to the pulp production techniques.

In 2001 the pulp and paper industry was responsible for 12 % of the Swedish industries total carbon dioxide emissions and contributed to 3.8 % of the Swedish net
emissions.\textsuperscript{90} The carbon dioxide emissions from the pulp and paper industry almost exclusively originate from the combustion of fuels to produce process heat.

The Swedish NAPI (MIEC, 2004) includes 57 mills as trading parties under the EU-ETS. The sector is excluded from the obligation to purchase REC labeled electricity but is included with respect to internal electricity production with biofuels. The production is subject for the new process related electricity tax and the companies have the opportunity to participate in the PFE. The sector industries furthermore receive complete carbon dioxide and fuel tax deductions.\textsuperscript{91} The mills are large electricity and heat producers and are therefore affected by policy instruments targeting CHP production. Pulp and paper mills are required to undergo a mandatory governmental permissibility consideration under the Environmental Code (SFS 1998:808).

**Production**

The pulp and paper industry have production in mills that exclusively produce pulp or paper as well as in integrated mills, which include the whole production chain. Integrated mills are slightly more common in Sweden. The initial pulp and paper production processes is the production of pulp, which if produced in pulp mills are sold to paper mills as market pulp and if produced in integrated mills are referred to as pump pulp. Market pulps are dried before retailing as the transportation would otherwise be inefficient, this is not necessary for pump pulps. There are two principal pulp production processes, chemical and mechanical methods, which uncover and separate cellulose fibers and lignin from wood. A third alternative is to re-pulp recovered paper. The different production techniques have different production characteristics with respect to produced paper quality and energy consumption. The

\textsuperscript{90} Calculations based on data excluding emissions from biofuels (SCB, 2005; SEA, 2004b).

\textsuperscript{91} Except for pine oil (see Chapter 7.1).
paper production is however rather homogenous with respect to production techniques.

Table 4.3 Swedish pulp and paper mills and production (2002)

<table>
<thead>
<tr>
<th>Mill type</th>
<th>Number of mills</th>
<th>Capacity (kton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-integrated paper mills</td>
<td>13</td>
<td>1,090</td>
</tr>
<tr>
<td>Integrated paper mills</td>
<td>33</td>
<td>10,280</td>
</tr>
<tr>
<td>- with pulp manufacturing</td>
<td>18</td>
<td>5,860</td>
</tr>
<tr>
<td>- with pulp manufacturing and recovered paper</td>
<td>7</td>
<td>3,840</td>
</tr>
<tr>
<td>- with recovered paper</td>
<td>8</td>
<td>580</td>
</tr>
<tr>
<td>Pulp mills</td>
<td>13</td>
<td>3,850</td>
</tr>
</tbody>
</table>

Source: SFIF, 2004

The chemical pulps offer the best opportunities for producing papers with high quality but the production have a low yield, where the used wood produce pulp at a rate of approximately 50%. Chemical kraft pulps, also called sulphate pulps, represent about 67% of the total Swedish production of new pulps. The chemical processes separate cellulose fibers through dissolving the lignin in a cooking process with different aqueous chemical solutions. The production can include recovery systems with boilers that utilize spent cooking chemicals, black liquor, that contain organic compounds to produce heavy black liquor. The other main chemical production alternative is sulphite pulps that due to high energy consumption and low chemical recovery have decreased in volume over the last decades. R&D has however improved the process which potentially could strengthen the position of sulphite production in the future.

---

92 Pulp production data is calculated using data for 2004 from SFIF’s environmental database at http://miljodatabas.skogsindustrierna.org
Mechanical pulp processes have an approximately 100 % yield, but produce paper with lower qualities than the chemical methods. The advantages are that paper produced from mechanical pulps has a natural stiffness, which is useful in paperboard production and absorbing materials. The mechanical pulps in Sweden, mainly Thermo-Mechanical Pulps (TMP), represent about 20 % of the new pulp production (SFIF, 2001). TMP pulps are produced through mechanical treatment of the raw material, or lump, by means of grinding between disc refiners. The production is electricity intensive but about 70 % of the energy input can be recovered as steam in the refining process (IVA, 2002a). Some of this steam is used for preheating the lump before grinding, but the produced steam volume is higher than the consumption in the pulp manufacturing. Mechanical pulps are therefore almost exclusively produced at integrated mills, where the steam can be utilized in other processes, such as the paper drying stage. The loss of wood materials in the two TMP processes is low and recovery systems are therefore not used as in chemical production. Mechanical production can also include a chemical stage to soften the lignin prior to the grinding and is then called Chemi-Thermomechanical Pulps (CTMP).

Recovered paper is an increasingly important raw material for the industry and the repulping process depends on the type of paper that is recovered. All processes however consist of one or more pulpers that disintegrate the fibers in hot water and thereafter process the pulp by removing impurities to a required extent. Depending on the recovered paper used, de-inking may also be necessary. Recovered paper pulps are the least used pulp in paper production, representing about 13 % of the total amount of pulps used.

The paper production begins with a preparation stage where the dry or pump pulp is converted into a furnish that can be introduced into a paper machine. The initial process step press and dewater the furnish to form a paper web which is thereafter dried in several steps that for example use steam-heated cylinders. Further stages are
then added depending on what quality requirements that are put on the final paper product.

**Energy Consumption and Electricity Production**

The energy consumption in the pulp and paper industry is of large importance to the national energy system as the sector consumes 49% of the total industrial energy consumption of which 52% is supplied by RES (SEA, 2005b). According to a Swedish Forest Industries Federation (SFIF, 2001) report, integrated mills that produce paper with a mechanical pulp generally consumes double the amount of electricity compared to a chemical pulp. The mechanical pulp however only consumes one fifth of the fuel that is required when using a chemical pulp. Paper produced from repulped recovered paper is the most fossil fuel intensive, as the internal bio fuel resources are limited, with a consumption of about twice that of chemical production. The re-pulp process however consumes half of the electricity compared to production with chemical methods. In terms of total energy volumes the mechanical method consumes most energy, chemical methods less and re-pulping the least (EC, 2001d).

<table>
<thead>
<tr>
<th>Areas</th>
<th>Market pulp manufacturing</th>
<th>Integrated pulp and paper manufacturing</th>
<th>By-products</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production of pulp and paper</td>
<td>410</td>
<td>3,937</td>
<td>2,902</td>
<td>4,264</td>
</tr>
<tr>
<td>Backpressure power</td>
<td>10</td>
<td>2,030</td>
<td>10</td>
<td>800</td>
</tr>
<tr>
<td>Bought electricity</td>
<td>780</td>
<td>1,210</td>
<td>6,680</td>
<td>1,920</td>
</tr>
<tr>
<td>Total consumed electricity</td>
<td>790</td>
<td>3,240</td>
<td>6,700</td>
<td>2,720</td>
</tr>
</tbody>
</table>

*Source: SFIF, 2001*
The selection of production techniques consequently has a very large affect on the energy consumption within the industry but as papers produced from different pulps have different characteristics, optimizing the production from this perspective it is not always possible. From an energy efficiency perspective, Mikael Hannus (2005) at Stora Enso argues that which technique – chemical or mechanical – that is used in an integrated mill have minor effects due to their individual advantages from a raw material and product perspective. The energy consumption of the paper production is accordingly largely depending on the produced paper quality ranging from around 500 kWh/ton (e.g. newsprint) to 3,000 kWh/ton (e.g. tissue) (EC, 2001d).

Figure 4.6 Energy consumption and sources in the Swedish pulp and paper industry (1992-2001)

Source: Calculations based on SCB (2006) data (SNI 21-22, no later data available)

The process in chemical pulp factories that consumes the largest amount of energy is the boiling process but recovery boilers produce internal fuels that to a large extent supports this process. The mechanical pulp process largest energy consumption is
electricity used in the refiner grinding processes. The re-pulp process consumes most energy as electricity in the de-inking process. Roughly two-thirds of the energy required in the paper production is used in the last drying stage.

The industry’s CHP production is mostly related to the chemical pulp process that produces two internal fuels; black liquor and lime sludge. The former is burnt in soda pans that produce steam used in the process and for backpressure electricity production and the latter is burnt in limekilns. Other internal fuel sources that can be available at some mills are bark, wood refuse, pine oil and flammable gases. The pulp and paper industry is due to utilizing these fuels accountable for about half of the Swedish use of biofuels. Stora Enso aims to raise the utilization of biofuels in their Swedish mills from 80 % in 2005 to 85 % in 2006-2007 (Hannus, 2005). Further increase from that level is identified as difficult as it is regarded as the practical maximum. The pulp and paper industries production and backpressure generation are supplied to 77 % by internal fuels (SFIF, 2001). Fossil fuels are used to some extent but not as a primary mean of energy supply and rather as a compliment in the combustion of lime sludge and bark. In 2000 the pulp and paper industry generated 3,960 GWh of electricity from 35 turbines with an installed effect of 851 MW (SFIF, 2001). The production of electricity depends on various factors such as oil and electricity prices as well as the relationship between these two. It also depends on whether the steam can be used in the drying stages in integrated mills. Mikael Hannus (2005) at Stora Enso argues that the sector’s electricity production has been continuously developed and should consequently not be assigned to the REC system that has been in force for two years. The system is however identified as contributing to an increased electricity production within the sector at present. The pulp and paper industries furthermore contributed with 1.43 GWh (2000) of steam and secondary heat to district heating systems (ibid).
Even though the chemical pulp production has a much lower energy intensity it is responsible for 27.7 % of the electricity consumption due to its larger production (SFIF, 2001). The electricity consumption for the industry has risen due to a decrease in oil usage but also because of a raise in production and a shift towards mechanical pulp (ibid). The raise in electricity consumption is however much lower than the decrease of oil used for process steaming. This indicates the improvements in energy efficiency made through decommissioning several old plants with low efficiencies during this period. Since the industry is developing towards a larger share of mechanical pulps and that the potential of backpressure electricity is consequently reduced, the tendency in the pulp and paper industry sector as a whole is towards higher electricity intensity and lower availability of internal fuels.
Carbon Dioxide Emissions

The pulp and paper industry is the third largest emitter of carbon dioxide in the basic industry with 2,009 kton in 2000 (SCB, 2005). There are no process emissions in the pulp and paper industry which means that all emissions originate from the combustion of fossil fuels. The emissions from the industry are due to the internal CHP production capacity closely related to electricity price levels.

Figure 4.8 Production and specific emissions in the pulp and paper industry

Sources: Production of pulp and paper (National Board of Forestry, 2004), Total emissions (Swedish EPA, 2007). Specific emissions are calculated based on these data.

The reduction in specific emissions between 1997 and 2000 (Figure 4.8) was a result of extreme wet years when electric boilers were used instead of fossil boilers due to low electricity prices (Hannus, 2005). The rise in specific emissions at the end of the data series is a result of a strong rise in the electricity prices as well as a higher capacity usage where the mills had to support the processes with fossil boilers (ibid).

93 The data does not account for carbon dioxide emissions from biofuels.
current situation, where the electricity prices are likely to stabilize at higher levels, is however not likely to have these short-term effects in the long-term due to adaptation by the industry.

A study by Nyström and Cornland (2003) argue that the pulp and paper industry holds a major potential in achieving the national carbon dioxide emission targets through improved energy efficiency in terms of equipment, processes, CHP as well as an improved utilization of the black liquor resources. The study suggests that supplementary policy instrument support could possibly aid this development, albeit not specifying a specific design.

**Energy Efficiency**

There has been a natural development towards more modern and efficient mills as many older mills with low efficiencies have been shut down since the 1970s. As a result of the sector’s work to improve the energy efficiency, the specific consumption of electricity and fuels for both mechanical and chemical pulp production was reduced during the period 1994-2000 (SFIF, 2001). The consumption of oil decreased most but much of the accomplished reductions in specific energy consumption have been leveled out by higher quality requirements on the products. The SFIF (2001) report on the energy consumption in the Swedish pulp and paper industry identify several measures that have been implemented to improve the energy efficiency at pulp mills, such as efficient evaporation, heat recovery, refiners, water consumption and grinders as well as utilization of internal fuels. Some measures that aim to lower the environmental impact have had a negative effect on the energy efficiency, for example oxygen gas bleaching at kraft mills. Other installations, such as air pollution control equipment that reduces emissions of chemical organic compounds result in higher electricity consumption.
Mikael Hannus (2005) at Stora Enso identifies an increased back pressure production potential as one of the main areas where the industry’s total energy efficiency can be improved. There are also a potential for improvements by decommissioning old operations if the economic prerequisites exist for larger mills. Mikael Hannus however warns that a reorganization of the operations from this perspective can cause sub-optimizations if the development is driven by short-term climate and energy policies and not long-term business strategies. Hannus furthermore identifies that no major breakthroughs in the technology development that could have a large impact on the energy consumption or emission reductions is expected in the short-term.

Thomas Levander (2005) at the SEA identifies the pulp and paper industry to hold the largest potential for energy efficiency improvements in the basic industry. Levander however argues that the sector is conservative and therefore has been slow in implementing the latest technologies, such as black liquor gasification instead of recovery boilers. Levander further estimates, that the sector could be self-supporting or exporters of energy, if adopting a more proactive approach. The SEA has supplied funds for the construction of a state-of-the-art TMP mill which is estimated to have a future energy savings potential in Sweden of 2.25 TWh per year (SEA, 2006a).

As there are no process emissions of carbon dioxide in the pulp and paper industry, energy efficiency and management hold the potential for reductions of carbon dioxide emissions. A number of articles (Nyström and Cornland, 2003; Möllersten et al, 2003; Wising et al, 2005) discuss this issue from different perspectives and emphasize black liquor gasification, methanol production, lignin extraction and reduced water consumption as key technologies in improving mill operations.

In chemical pulp production there is a large potential for improvements through more efficient utilization of the internally produced fuels. The use of black liquor gasification with IGCC technique instead of recovery boilers can improve both the
energy efficiency of consumed energy and produced electricity. While the investment costs for these are usually higher than for traditional alternatives, they can nevertheless be favorable from an economic perspective due to a higher electricity production.

In the production of mechanical pulps two of the potential areas for efficiency improvements are better cleaning of process water as well as more effective refiners. The potential for improving the cleaning process lies in reducing the energy consumption through more effective cleaning equipment, leading to reduced water volumes and equipment sizes. New refiner techniques have been developed that optimize the operation of refiners with potential energy savings of 10-20 % (EC, 2001d).

The energy efficiency improvements in re-pulping of recovered paper differ depending on the paper quality that is recovered. There are techniques that reduce the energy consumption in wastewater treatment by using anaerobic processes and a technique is being developed which allows for recycling of carbon dioxide in the process.

The main potential for energy efficiency improvements in paper production is more efficient drying of the paper. One of the techniques that have been developed is pulse technologies that combine the pressing and drying of the paper into one single stage, resulting in higher quality paper and reduced energy consumption. Another technique increases the possibilities for energy recovery through improving the drying process while also improving the paper quality. Both these techniques are being tested in Sweden by STFI-Packforsk at the EuroFEX research facility.

Improving the efficiency in integrated mills logically includes the abovementioned technologies as well as an increased improvement potential through optimized operating conditions, aided by for example process integration. A MISTRA project
called KAM, focused on improvements in a theoretical integrated kraft pulp mill aims for a mill design with minimal energy consumption in the pulp process and a maximum energy surplus. The design used techniques that were available but not implemented all in one factory. The project resulted in a theoretical factory which was more efficient with lower oil consumption, a larger pine oil surplus, 10 % lower heat losses and a 550 kWh/ton electricity surplus (IVA, 2002a).94

4.5.4 Mineral Oil Refineries

Swedish mineral oil refineries are included in the EU-ETS under the category energy activities and the sector is homogenous with similar production methods. In 2004 the sector encompassed 53 companies representing 0.4 % of the Swedish GNP with a turnover of 8,800 MSEK (SCB, 2005).95 The major company and the largest carbon dioxide emitter in the sector is Preem, which hold three quarters of the Swedish refinery capacity and own Sweden’s largest refinery96 in Lysekil where the operations are presently expanded with a gas oil refinery operation.

In 2000 the mineral oil refineries emitted approximately 10 % of the Swedish industries emissions and approximately 3.4 % of the Swedish net emissions.97 The emissions will however rise due to the expansion of operations in Lysekil. The major

94 Analyzed techniques were more effective evaporation of black liquor as well as higher steam pressure and temperature for more effective backpressure generation.
95 The SCB data includes the production of nuclear fuel and coke oven products which may distort these data. It should however not have any major impacts on the emission data due to the larger production and high carbon dioxide intensity in the refineries.
96 Formerly owned by Scanraff Lysekil AB.
97 Calculations based on data including the nuclear fuel industry but excluding emissions from biofuels (SCB, 2005; SEA, 2004b).
emissions from oil refining originate from fuel combustion that is required to attain the required operating conditions in the fractioning column.

There are besides Preem only two other Swedish mineral oil refinery companies included in the EU-ETS under the national NAPI – Nynäshamn Refining AB and Shell Raffinerieer (MIEC, 2004). These refineries, six in total, are excluded from the requirement to purchase REC labeled electricity and are according to the Energy Tax Directive (2003/96/EC)\textsuperscript{98}, excluded from the carbon dioxide tax as well as the fuel and electricity taxes. The sector is consequently not included in the PFE. The operations are according to the Environmental Code (SFS 1998:808) liable for a governmental permissibility consideration and are not subject for any other subventions or subsidies.

**Production**

The oil refineries use crude oil as the raw material to produce different petrochemical products. The first step in the refinery process heats the crude oil in furnaces to 370-430°C after which it is introduced to a large pressurized fractioning column that separates the crude oil into different fractions suitable for various products, such as petrol, fuel oils and LPG. This is accomplished by varying chemical characteristics such as boiling points and viscosity of different hydrocarbons. The oil fractions can thereafter be further processed by supplying additives that enhance the characteristics of the product.

The produced heavy fuel oils can be further refined to higher grade products by upgrading the oil through thermal, catalytic or hydro cracking processes. Thermal cracking is accomplished by reducing the viscosity of the heavy oil at temperatures of >500°C and high pressures. Catalytic cracking is accomplished at temperatures of

\textsuperscript{98} Previously the Mineral Oil Directive (92/81/EEC) and amended through Directive 94/74/EC.
about 500-540°C and normal pressures through using a catalyst. Hydro cracking adds hydrogen at temperatures of <400°C and very high pressures. All these methods are used at Swedish refineries where upgrading has been favorable due to a reduced demand for fuel oils and an increased demand for petrol.

**Energy Consumption**

The main energy input to oil refineries is naturally the crude oil while light fuel gases are commonly utilized as internal fuels. The process that consumes the largest amount of energy in the oil refineries is the combustion of fuels utilized to attain the high temperatures that are required in the fractioning column and in the cracking processes. There are no single major electricity consumer but pumps are essential to transport the oil products and to provide the high pressures that are necessary in for example the thermal and hydro cracking processes. Using Preemraff Lysekil to exemplify the internal energy consumption in oil refineries, the energy input in 2003 was supplied to 84 % by combustible gases while coke supplied 13 % and fuel oil 3 % (Scanraff, 2004). The total energy input was during the same year was 5,272 GWh and the electricity consumption 398 GWh (ibid).

Catalytic crackers are soiled with large amounts of coke during the operation which has to be burnt off in order to continuously regenerate the cracker. The produced heat is necessary for the cracking process and the coke can thus be considered as replacing other fuels.

**Carbon Dioxide Emissions**

The mineral oil refining operations is the basic industries’ fourth largest emitter of carbon dioxide with 1,793 kton in 2000 (SCB, 2005). The emissions of carbon dioxide

---

99 The data does not account for carbon dioxide emissions from biofuels and includes pit-coal and nuclear fuel production.
in oil refineries originate almost exclusively from the combustion of fuels. The emission situation is therefore heavily depending on which fuels that are used in the processes and the IPPC BREF on mineral oil refineries (EC, 2003a) establishes that it is favorable to utilize gaseous fuels in the processes as these are less carbon dioxide intensive. This fuel utilization is, as described above, implemented at Preemraff Lysekil. The emissions from the combustion of coke at the regeneration of catalytic crackers are difficult to reduce and are considered non-replaceable by the Swedish NAPs. Birgitta Resvik (2005) at the CSE points out that the emissions from oil refineries are unavoidable as long as the transport sector is heavily reliant gasoline and diesel.

**Energy Efficiency**

Swedish refineries are among the most energy efficient in the world according to the Solomon Energy Intensity Index, which compares the energy consumption of over 300 international refineries on an annual basis (MIEC, 2004). This index can also be used for a relative comparison of carbon dioxide emissions due to the share of emissions originating from energy utilization.

Preemraff Lysekil has reduced its energy consumption by 60 % in 30 years in a process based on a benchmark process which studies the energy consumption every second year (Brinck, 2005). The improvements have been achieved by installing secondary heat boilers and by continuously improving auxiliary equipment such as heat exchangers, motors, piping insulations, furnaces and burners. This work has also included manual and automated supervision as well as maintenance. The major incentive has been to reduce the operational energy costs as these are the largest costs for the refinery. The target is to reduce the energy consumption with about 2-3 % per year (*ibid*). This work is supported by the IPPC BREF on refineries (EC, 2003a), which puts a focus on energy management, heat integration and CHP as measures to improve the energy system and reduce carbon dioxide emissions at refineries.
Leif Brinck (2005) at Preemraff Lysekil pointed out during the interview that the company operations are considered to be close to BAT as the prescribed measures by the BREF, that has been estimated as reasonable in their case, have been carried out. Leif Brinck identifies an improved utilization of waste heat in district heating systems as one of the major potentials for improved energy efficiency in the future. Brinck argues that politicians hold the key to unlocking this potential and states that Preem have met resistance at municipality levels in regards to such projects.

### 4.6 Auxiliary Systems

Most auxiliary systems, such as logic and automatic control, lighting, heating, cooling, drying, ventilation and compressed air are abundant in all industrial operations and energy utilities. If no efforts have been made in terms of improving the performance of these equipments, they usually hold a significant potential for improving the operational efficiency and thus also reducing operational carbon dioxide emission levels. The potential mainly lies in reducing the consumed energy in terms of fuels, electricity, heat and steam. This can be accomplished through different measures depending on the process and installed equipment. The first step is usually to carry out an energy audit to evaluate where measures needs to be taken and to establish a baseline from which the work to improve the efficiency can start and be measured against. Such energy audits are also the starting point for the work within the energy management system in the PFE. In this work the general rule is that the first investments are commonly the most cost effective, and as the work proceeds, further improvements are increasingly difficult and costly to attain.

Working to improve the systems can be approached in different ways but one rule of thumb is that there is often a large potential improvements in turning off unnecessary idling of auxiliary equipment. This measure might seem elementary but
has actually resulted in large savings for a number of companies. The potential for these improvements should be analyzed within an energy management scheme.

Educating personnel on how they can affect and reduce the energy utilization is another effort that can be effective. The education should be aimed at engaging all levels of the company in analyzing the consumption to increase the possibility to find additional areas where savings can be accomplished. An important success factor are persons dedicated to this work in as many positions as possible, as this have a major impact on how effective this process will be. Explaining the environmental implications of working with these issues is a vital part of an education programme, as this can engage the personnel in the efficiency improvement process. Personnel are likely to see environmental issues as something more important and tangible than the industries electricity bill. A reward system, which provides economic incentives, could further engage personnel in this work, but whether a company believes in such systems, or not, is a question of company policy.

Many investments are today evaluated exclusively with respect to their purchase price and payback time. The society’s increased attention to environmental concerns has however sparked the development of investment assessment tools that include environmental considerations. Two tools that are commonly used are Life Cycle Cost (LCC) and Life-Cycle Assessment (LCA). LCC focus on analyzing merchandize and services with respect to the lowest lifetime cost – i.e. purchase cost, operation, energy including efficiency losses, maintenance, down time, decommissioning and waste management costs. LCA has a larger environmental scope and also assess the environmental impact that occurs during the life cycle of different products. LCAs are regulated through international ISO standards, while LCCs are not. Both these tools can, from different perspectives, assist in evaluating the positive economic effects of energy efficient equipment and thus result in superior investments. A stakeholder group consisting of Stora Enso, ABB, Akzo Nobel and Chalmers University of Technology received EU LIFE programme funding for an
environmental assessment project called DANTES. The project aimed at creating win-win situations in the environmental work, through assessing and demonstrating environmental assessment tools such as LCC and LCA as well as Environmental Risk Assessment (ERA) and Eco-Efficiency. Case studies and calculations tools have been made available to the public through the project website.\textsuperscript{100}

The EU has adopted a Directive (2005/32/EC) on Energy Efficiency of Energy Using Products Setting Ecodesign Requirements, which includes auxiliary equipment commonly used in the basic industry and energy utilities (Chapter 5.4.2). In 2003 the EU launched the Motor Challenge Programme which aims to aid industries in improving the energy efficiency of their motor driven systems. The SEA also promotes efficient auxiliary products, for example, by issuing purchase guidelines for fans, pumps and compressors and cooling installations. Reducing the auxiliary electricity consumption is explained in Chapter 4.6 below, as the systems are basically the same in the different stakeholder sectors.

Technology procurement programmes are used to promote the development of energy efficient equipment that meets certain requirements that are specified by the programme stakeholders. The SEA and the Swedish Agency for Economic and Regional Growth (NUTEK) have initiated several programmes focusing on efficient auxiliary systems, such as industrial pumps, fans, compressed air, cooling compressors and lighting. The use of technology procurement programmes as a policy instrument is discussed in Chapter 7.4. Another project, including the SEA and the Association of Swedish Engineering Industries, which focuses on procurement of energy intensive equipment, has developed two LCC tools (LCCenergy and LCC Guidelines) that are aimed at the industry as well as public administrations.

\textsuperscript{100} http://www.dantes.info
Both Sweden and the EU have found that labeling systems that facilitates easy selections of efficient equipment can be an important tool in the work to promote energy efficiency. Electrical motors are one of the most important products to establish labels for, as these powers a wide range of other industrial auxiliary installations. The EU SAVE programme have in cooperation with the European Committee of Manufacturers of Electrical Machines and Power Electronics issued guidelines which classify motors in three categories – eff1, eff2 and eff3 – where the eff1 label represent the highest efficiency.\textsuperscript{101} The SEA estimates that the purchase cost of a motor is equivalent to the electricity costs of about 8-12 weeks of continuous operation and furthermore concludes that the additional investment in an efficient motor, being 10-30 % more expensive to purchase, in many cases has a payback time of under a year (SEA, 2006e\textsuperscript{102}).

**Electric motors**

Electrical motors in the industry – typically AC three phase induction motors – represent about 78 % of the electricity consumption (SEA, 2001b). Improving the efficiencies of these motors is consequently one of the most important areas for improving the electric energy efficiency. If the cost of a motor is assessed from a LCC perspective roughly 85 % of its LCC derives from the operational costs (SEA, 2001b), highlighting the potential economic gains of switching to a more efficient motor. As motors are not always bought separately but rather as part an application, such as pumps, fans, compressors and transport systems, it can be difficult to monitor the specific motor efficiency. Labeling schemes are however available for several applications.

\textsuperscript{101} Eff1 motors have about 3 % higher efficiency than eff3 motors.

\textsuperscript{102} This publication includes an updated (March 2006) list off eff1 labeled motors.
Controlling the output effect through variable-speed control, utilizing a frequency converter, can increase the efficiency of motors. Variable-speed control can be selected on new motors or be fitted to existing motors and offers a more efficient way to control the motor effect than for example the traditional way to control flow after a pump or fan with an upstream throttle – a system that is naturally associated with large inefficiencies. The speed control will however require correctly adjusted set points, or the potential savings will not be accomplished.

**Pumps and Fans**

Pumps and fans are frequently used in all basic industries but most notably in the paper and pulp industry where they consume roughly 50 % of the electricity (SEA, 2001b). According to an estimate about 75 % of all pump systems are oversized (Nolte, 2004) and if considering that the cost for energy during in a pump’s LCC is about 85 % (SEA, 2001b) it becomes apparent that there is a large potential for improvements and savings. Both pumps and fans are subject to programme requirements set by the SEA in 1996, which *inter alia* establish that upstream throttling must not exceed 15 % (SEA, 2001a). There are no energy efficiency labeling schemes of pumps and fans as the efficiency of moving or pressurizing a volume of mass is too much depending on the operation conditions and specific designs to be useful as a general label. The efficiency of the powering motor can however be used as a point of reference. The SEA has issued purchase guidelines aimed at promoting effective industrial installations for both appliances.103

**Compressed air**

The energy cost of a compressor’s LCC is typically 70 % (SEA, 1999b) which mean that substantial potential for savings. Compressors and appliances that use

103 These and other guidelines are available at the SEA homepage http://www.stem.se.
compressed air are not energy efficiency labeled and in order to promote efficient systems the SEA has issued purchasing guidelines that encompass the use, distribution and production of compressed air with a focus pressure loss. Specific suggestions for increasing the efficiency in compressed air systems are for example to reduce the leakage of air through minimizing the time that the system is pressurized, reducing the pressure and having smaller systems with shorter piping.

**Lighting**

Lighting systems are designed with respect to sight requirements and considered a health matter. Depending on the whether low-energy appliances are used or not the energy costs varies and energy is the largest cost from a LCC perspective only when using traditional appliances. The SEA is running an EU GreenLight programme that promotes energy efficient lighting systems in the business and public sectors. Many lighting systems are old and thus do not implement new efficient technologies such as high-frequency systems and T5 fluorescent tubes that have about 30-50% lower energy consumption during their lifecycle (SEA, 1999a). The SEA has also set up purchase guidelines to aid stakeholders on how to construct effective systems.

**Ventilation, Heating and Cooling**

Ventilation is a broad area which includes heating and cooling as well as other factors that affect the indoor climate. Efficiency improvements are possible through a wide range of measures such as variable speed-control of motors, monitoring, better air-condition systems, heat and cool recovery and effective filters. In many cases improving the efficiency of ventilation is a matter of improving fan efficiencies. SEA purchase guidelines have been issued for refrigeration compressors. Heat recovery, for example through using exchangers, is an important part of the work to improve the energy performance of the operations but as the equipment used for this largely varies depending on the processes it is not explained specifically here but rather included in the concept of energy management for each industry sector.
4.7 Summary

The potentials for reducing the carbon dioxide emissions from the basic industry sectors are limited. This is due to that the Swedish basic industries are energy efficient and have relatively low carbon dioxide emissions in an international comparison. A positive development in the basic industry has decoupled the energy consumption and carbon dioxide emissions from a production increase, which is found to be a result of the basic industries’ pursuit of lower production costs. This development is consequently strengthened by increasing energy prices, as a higher price motivates increasingly costly measures, and the high energy intensity of the basic industry operations. While the higher energy price is partly a result of implemented policy instruments, especially the EU-ETS and its effect on the electricity price, it is questionable if the increase in efficiency should be primarily assigned to the policy instruments. Pursuing reductions in the basic industry that exceeds the international emission commitments will inevitably have economic effects. Especially if accomplished in a non-harmonized policy environment that result in negative competitive effects for the industry.

The potential to reduce the basic industries’ operational emissions varies and the potential to limit the process emissions is currently very limited. This is mainly attributable to the necessity of coal and lime in the steel and cement industries. The main potential for emission reductions with present technologies essentially lies in increased utilization of biofuels and improvements in energy efficiency. The potential for the former is limited due to the energy intensity of the production process, where a full utilization of RES at some occasions is impracticable due to the lower energy density of biofuels and consequential higher transportation requirements.

There are large potentials for improvements in energy efficiency in all basic industry sectors. The development is however limited by the restricted possibilities and large
investments required to improve operations at the main process level. Improvements in energy efficiency are thus, in a shorter time perspective, more attributable to auxiliary equipment and energy management. Short-term policies reduce the development pace which is emphasized in relation to large investments that are more affected by an increased investment risk. Improving auxiliary equipments often have immediate economic effects and are initially easy to accomplish. Energy management includes energy optimization and the utilization of secondary heat in internal or external energy systems. The utilization of industrial secondary heat in district heating systems should be promoted.

The policy framework should include policies that aim at the implementation of energy efficient technologies that can realize emission reductions in the short term. The policy framework should also include R&D on low-carbon processes as to work for large-scale reductions in the longer term. Attention should be given to Municipal Energy Planning in order to highlight the potentials for utilizing the available surplus energy in the basic industry. While emission abatement and energy efficiency improvements are frequent to the larger basic industries, smaller companies can be involved at a higher rate through promoting ESCOs. Due to the generally efficient operations in the basic industry, most sectors would benefit from a benchmark allocation process. The problem lies in establishing a benchmark that appropriately takes varying raw-material and end-product characteristics into consideration. Most importantly, the policy framework should be stable as to provide efficient investment incentives.
5. The Political Climate

The Swedish Government has the responsibility to guide our society towards a sustainable development. Mitigating climate change will carry large costs and the development will thus inevitably be associated with certain inertia. To promote a positive development and to overcome this and other obstacles the Government can adopt a range of policy instruments into the policy framework. This is necessary to exercise control over Swedish institutions, business sectors and individuals. Utilizing the political system to steer this work efficiently – striving to achieve synergies while avoiding sub-optimizations – is a daunting task and depending on who asked, the success of the Government would be very differently perceived.

Thomas Levander (2005) at the SEA argues correctly, that the solution to the climate change issue is largely in the hands of the business sector and that climate and energy policies therefore should focus on long-term planning. The Government should thus work in cooperation with basic industry and energy utilities to achieve efficient progress. But the long-term and large-scale character of the climate issue
also call for political cooperation, in order to establish a broad political agreement on climate and energy policies, as this is essential for the stability of the policy framework.

Sweden has a history of being proactive on different environmental policies (Porter et al, 2000) and is now applying this mentality to climate change. An important policy step is the declaration of sustainable development as the overall goal for the work of the Swedish Government (Skr. 2003/04:129). The new Government has abandoned the positive initiative of the former Government to establish a Ministry of Sustainable Development. A Ministry that incorporates energy, climate and buildings issues consolidates the efforts on climate change mitigation, which potentially can improve the efficiency of this work.

The nature of a political agenda is changeable, predominantly due to elections and different political party agendas. In the Swedish case it can however be considered that the climate policy agenda is more stable than its energy counterpart. The reason for this is mainly twofold. Firstly, there is a political consensus that the climate issue must be prioritized and that international cooperation should guide this development. Secondly, the role of nuclear power in the Swedish energy system is a great divider. Consequently, governmental agendas on climate issues can be regarded as more long-term than is the case for energy issues. The policy framework described represents the former governmental composition, which essentially were consecutively in office for the last decades. The distinction above is thus important in light of the expected policy changes under the new government. Decisions that are essential for an effective climate change mitigation regime often include initial negative effects. The efficiency of the policy framework is therefore hampered by the short-term office periods, where important decisions are weighed against the support among voters. To stretch the truth one could argue that 20 year office periods or totalitarianism could be effective to improve this work. A cross-party agreement on
climate change and energy issues could however serve the same purpose albeit this has been proven difficult to achieve.

The Swedish climate and energy policies are affected by the development of the international agenda on climate change. The main example of this is the Kyoto Protocol (KP), aiming at mitigating climate change. Since Sweden joined the European Union in 1995 the EU agendas are of particular importance for the Swedish policy development. This most importantly includes the EU Emissions Trading Scheme (EU-ETS). The EU agendas are of large importance due to that Directives can force legislation into our national policy framework. This allows the EU to work more effectively on policy development than is the case for most international policy agreements. The EU climate and energy agendas concerning the Trading Sector is consequently of large importance within the scope of the thesis, seeing that it largely dictates future policy developments. The recent Climate Bill (2005/06:172) highlights the international influence, identifying global climate regimes as an essential issue on the international policy agenda. The most important aspect of this are currently the discussions on the design of an international climate change mitigation regime after Kyoto Protocol’s first commitment period ending in 2012.

This chapter firstly defines the main political stakeholders that concern the climate and energy policy framework, which is followed by an explanation of the Swedish general policy framework. The descriptions of policy instruments are kept short in this chapter, as a comprehensive analysis of them is the central subject of the following chapters. The Swedish overview is followed by a thorough description of the EU policies due to the strong interconnection to the Swedish policy development. The international agenda is outlined with the UNFCCC, while the KP is further

104 The focus of this and other chapters are on the former Government as the new Government has not been in office long enough to allow for any decisions to have an effect that allows for in-depth analyses. Some notes on decisions and declared policy decisions are however included.
described as a policy instrument. The analysis of the policy instruments in the following chapters is initiated by a description of different instrument characteristics.

5.1 Swedish Political Stakeholders

The Government Office, with the duty to execute the Government’s politics, heads the Government, assisted by twelve ministries and offices. The greater part of the Governments work is prepared by handling officers at each ministry. These officers generate both the foundation and suggestions for different governmental decisions along with analyzing national and international affairs. The officers normally do not carry out the decisions made by the Government as this is performed by numerous agencies, organized below the ministries, with more defined responsibilities. The Government can appoint committees to analyze and suggest action plans when an issue arises that is of special importance or complexity. These committees can consist of one or several persons and report to the ministry that initiated the inquiry. There are also other Governmental bodies such as companies, organizations and foundations, which can be part of a ministry’s area of responsibilities.

As sustainable development is incorporated into the entire governmental organization, strictly seen all governmental bodies are concerned with climate issues. The bodies explained here are however those of direct relevance to the climate and energy issues of the basic industry and energy utilities.

5.1.1 Parties of the Parliament

There are seven parties in the Parliament, which can be divided into a left and a rightwing bloc – or socialistic and non-socialistic bloc. The leftwing is formed by the Left Party (furthest left) and the Social Democratic Party. The rightwing consists of the Centre Party, the People’s Party, Christian Democrats and Moderate Party (in a
liberal to conservative fashion). There is also a Green Party, which have not taken a left/right position, but is usually associated with the left wing.

Figure 5.1 Swedish Parliamentary Party positions

In a general perspective the Swedish Parties have rather similar agendas on climate change and emissions of GHGs. All have acknowledged the scientific facts behind climate change and all are in favor of effective national and international GHG emission mitigation regimes.

The Party agendas on energy are also quite similar, albeit there are larger indifferences that are mostly assignable to nuclear energy, which is one of the main political dividers in Sweden. The fact that the Parties since the 1980 nuclear referendum have not been able to create a stable and long-term energy agenda, has often been criticized for having incurred large costs to the society. The Parties have at some occasions tried to reach a cross-boundary agreement regarding energy, which up until now have not been successful. In the absence of role in the balance of power that the Left and Green Party have played for a number of elections, it would have been more likely that a broader political agreement could have been adopted. Political turns on the energy agenda has meant that the nuclear system was installed within a short time period to thereafter be subject phase-out policies, and similar examples can historically be found for coal and oil related energy production. The recent shift towards a right-wing coalition has resulted in a more positive view on the contribution of nuclear energy. The new Government has however declared that
no decisions on permissions to operate nuclear facilities will be taken during the current term in office (Reinfeldt, 2006). All parties agree that the utilization of fossil fuels should be kept to a minimum and that policy efforts should be taken to increase the share of RES in the Swedish energy system. The 2006 National Budget (Bill 2005/06:1) acknowledges an IEA (OECD and IEA, 2004) recommendation on the necessity of a long-term agreement on nuclear energy as not delay investments in the national energy system.

Looking at the Party agendas (Table 5.1) it is obvious that some energy issues are relatively stable, despite the absence of a cross-boundary agreement. Renewable energy, cogeneration and energy efficiency are promoted by all Parties and should thus in one form or another be supported in a foreseeable future. The problem lies in the different opinions on how to design the climate and energy policies and policy instruments. This creates an unstable policy regime that does not effectively promote the common development goals. It is likely that emissions trading and the green tax-shift becomes a constant features in the policy framework. Decisions (Bill 2006/07:1) after the election, also indicates that the Renewable Energy Certificates (REC) scheme will be retained. The scheme has however earlier been identified as an unwanted subvention system by the right wing coalition and could consequently been considered to have a more uncertain future. The Moderate Party furthermore regard that political decisions should not decide which energy production that should be utilized but rather set a policy framework that promotes efficient and environmentally energy production at the utilities and let the market decide on the production characteristics. This indicates a development towards a more streamlined policy mix with a stronger focus on market based policy instruments.
Table 5.1 Main climate and energy policy agendas of Swedish Parliamentary Parties

<table>
<thead>
<tr>
<th>Party</th>
<th>Climate</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Left Party</strong></td>
<td>- In favour of a green tax-shift, emissions trading and REC system</td>
<td>- Rapid phase-out of nuclear energy</td>
</tr>
<tr>
<td></td>
<td>- Opposes taxes and subventions as policy instruments</td>
<td>- Promotes renewable energy, energy efficiency and cogeneration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Opposes a developed natural gas market</td>
</tr>
<tr>
<td><strong>Social Democratic Party</strong></td>
<td>- In favour of a green tax-shift and economic policy instruments in general such as emissions trading and REC system</td>
<td>- Responsible phase-out of nuclear energy</td>
</tr>
<tr>
<td></td>
<td>- Also in favour of support to climate investments</td>
<td>- Promotes renewable energy, energy efficiency, cogeneration, small-scale hydropower developments and a development of the natural gas market</td>
</tr>
<tr>
<td><strong>Centre Party(^i)</strong></td>
<td>- In favour of emissions trading and REC system</td>
<td>- In favour of continued utilization of the nuclear plants currently in operation</td>
</tr>
<tr>
<td><strong>People's Party(^i)</strong></td>
<td>- In favour of a green tax-shift (formerly opposed)</td>
<td>- Promotes increased hydropower utilization</td>
</tr>
<tr>
<td><strong>Christian Democrats(^i)</strong></td>
<td>- In favour of a deduction goal</td>
<td>- Supports natural gas during a transition period to non-fossil alternatives</td>
</tr>
<tr>
<td><strong>Moderate Party(^i)</strong></td>
<td>- Simplify the approval process in the Environmental Code</td>
<td>- Promotes renewable energy, energy efficiency and cogeneration</td>
</tr>
<tr>
<td><strong>Green Party</strong></td>
<td>- In favour of a green tax-shift</td>
<td>- Rapid phase-out of nuclear energy on a global level as well as a phase-out of fossil fuels</td>
</tr>
<tr>
<td></td>
<td>- Promotes economic policy instruments, a sector approach in emissions trading and support to energy efficiency measures</td>
<td>- Opposes new hydropower developments</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Promotes renewable energy and energy efficiency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Promotes hydrogen research</td>
</tr>
</tbody>
</table>

Source: Information available at Party websites. \(^i\) The right-wing coalition parties have a joint energy and climate programme and are thus explained jointly.
The political dominance of the Social Democratic Party has resulted in a direction of the Swedish climate and energy policies that generally corresponds to the political agenda of the Party. The fact the Social Democratic Party often has been in office as a minority Government has however resulted in that the agenda have occasionally diverged due to policy coalitions. This has meant that suggestions by the ministries have not always received approval by the Government, which has resulted in negative effects for how the business stakeholders perceive the dialogue between with the political stakeholders (Chapter 10.4).

Political decisions in other areas than climate and energy naturally also influence the basic industry and energy utilities with regards to their carbon dioxide emissions but this is not included within the scope of the thesis. This includes decisions that for example may have an impact on production volumes, new establishments and outsourcing.

5.1.2 Ministries

Due to Sweden’s declaration of sustainable development as the Government’s overall goal (Skr. 2003/04:129), most ministries have some kind of connection to the climate issue and energy utilization, albeit the Ministry of Sustainable Development has the general responsibility. The ministries also have other responsibilities and functions than those presented here, where only climate and energy policies are concerned. The presentation is based on the order of ministries under the former Government as their policy framework is in focus.105

105 Further information is available at http://www.regeringen.se/
The Prime Minister’s Office

The Prime Minister’s Office is responsible for coordinating the Swedish EU policies, which is accomplished through the work of an EU Policy Coordinating Unit plus the Swedish Institute for European Policy Studies (SIEPS). SIEPS also have a broader agenda with a focus on research and analyses of policy issues in the EU.

The Ministry of Sustainable Development (Ministry of the Environment)\(^{106}\)

The Ministry of Sustainable Development was formed 1 January 2005 when the Ministry of Environment was restructured and assumed the responsibilities for the energy and housing agendas. The reason for the reorganization was to collect sustainable development issues under one ministry with a more holistic view. The Ministry’s key task is to carry out the Government’s prioritized areas in the environment field and to realize what is referred to as “Det gröna folkhemmet” (eng. the green welfare state).

Since 2003 the Ministry hosts the Coordination Unit for Sustainable Development\(^{107}\) that coordinates issues regarding national sustainable development in the Prime Minister’s Office as well as to work as a think tank. The unit is appointed to lead the development of the national strategy on sustainable development and is responsible for Swedish sustainability affairs in a national context as well as in the EU and the UN Commission on Sustainable Development.

The Ministry also governs the Environmental Advisory Council\(^{108}\) that, since 1968, has aided the Government regarding environmental issues. The Council members

\(^{106}\) The Ministry has (as of 1 January 2007) under the new Government been reformed to the Ministry of Environment. The energy issues have been relocated to the Ministry of Industry, Employment and Communications, and housing issues to the Ministry of Finance.

\(^{107}\) Samordningskansliet för hållbar utveckling.

\(^{108}\) Miljövårdsberedningen
are primarily from the political arenas and academia with some involvement by the business sector. The current focus of the council is environmental policies for an ecological adaptation and a sustainable management of the national resources.

**The Ministry of Industry, Employment and Communications (MIEC)**

The Ministry is responsible for among other issues the basic industry, technical research, mining and mineral policies, business development, competitive issues and state owned companies. Its main goal is to create and uphold a market that allows for a well functioning business sector.

**The Ministry of Finance**

The responsibilities of the Ministry of Finance are, for example, international cooperation regarding economics, economic policies, taxes and the central Government budget. The Ministry governs the Swedish National Tax Board. The Ministry is also home for an expert committee for environmental studies that has been assigned the task to evaluate the economic efficiency and goal compliance of public funds and other policy instruments that has environmental consequences.\(^{110}\)

**The Ministry of Justice**

The Ministry work as governing body to the Swedish National Courts Administration that implements the Environmental Code and Planning and Building Code. The laws which governs the climate and energy policy instruments are however the responsibility of the Ministry of Sustainable Development.

---

\(^{109}\) Since 1 January 2007 renamed the Ministry of Industry, Energy and Communications by the new Government, thus reassuming the responsibility for energy policies.

\(^{110}\) Further information is available at http://www.expertgruppenformiljostudier.se.
The Ministry for Foreign Affairs

Foreign affairs are of essential importance to the climate problem but other ministries generally handle these issues. The Ministry is however responsible for the Swedish Partnership for Global Responsibility that promotes Corporate Social Responsibility. The partnership aims to support sustainable development and increase the knowledge about multilateral regulatory frameworks. The basis for the partnership is the OECD’s Guidelines for Multinational Enterprises and the principles of the Global Compact. The companies that join the Swedish partnership therefore becomes subject to responsibilities under these two accords.

5.1.3 Agencies

The different ministries administer agencies that are responsible for the continuous political work according Governmental policies. There are approximately 300 agencies of which 11 are described here due to their work within the policy framework. The Agencies are presented according to the organization under the former government.
Table 5.2 Organization of Swedish Agencies with climate and energy policy responsibilities

<table>
<thead>
<tr>
<th>Ministry</th>
<th>Agencies</th>
</tr>
</thead>
</table>
| Ministry of Sustainable Development | - Swedish EPA  
- Swedish Energy Agency  
- Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning  
- The Swedish Council for Sustainable Development  
- Swedish Meteorological and Hydrological Institute |
| ...of Industry, Employment and Communications | - Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning  
- Swedish Business Development Agency  
- Swedish Institute for Growth Policy Studies  
- Swedish Agency for Innovation Systems |
| ... of Finance | - Swedish National Tax Board  
- National Institute of Economic Research  
- County Administrations |

**Swedish Environmental Protection Agency**

*The Swedish EPA was explained in Chapter 3.1.*

**Swedish Energy Agency**

*The Swedish Energy Agency was explained in Chapter 4.1.*
The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (FORMAS)\textsuperscript{111}

Due to its holistic perspective, this agency reports to several ministries, such as the Ministry of Sustainable Development and the Ministry of Industry, Employment and Communications. FORMAS key task is to support research with the main objectives to:

- Promote an ecologically sustainable development
- Analyze required research areas and cooperate with other research funding agencies
- Distribute funds for research and to evaluate the research
- Promote and initiate interdisciplinary research
- Represent Sweden in various international environmental programmes

The Swedish Council for Sustainable Development\textsuperscript{112}

The Council, with the mission to focus on the role of individuals in realizing the Swedish strategy for sustainable development, resides mainly under the Ministry of Sustainable Development. The Council shall from this perspective:

- Work as a driver for local and regional implementation of the sustainable development agenda
- Stimulate cross-sectional collaboration between stakeholders on all levels
- Encourage debate
- Report results, experiences and good examples

\textsuperscript{111} Further information is available at http://www.formas.se

\textsuperscript{112} Further information is available at http://www.hallbarhetsradet.se. The council is being windup in 2007.
The Council originates from the Swedish Institute for Ecological Sustainability (IEH) that operated until the end of 2004.

**Swedish Meteorological and Hydrological Institute (SMHI)**[113]

SMHI is the central Governmental agency for meteorological, hydrological and oceanographic issues. SMHI is beside weather forecasts also responsible for providing a better scientific foundation for long-term climate policies by improving local climate scenarios. SMHI hosts the Rossby Centre, which was started as a climate modeling research institute within the Swedish Regional Climate Research Programme, or SWECLIM, that ran through 1996-2003 (also under SMHI). The Rossby Centre conducts research on different aspects of climate change and is co-funded by the Swedish EPA, the Swedish Energy Agency and MISTRA.

**Swedish Business Development Agency (NUTEK)**[114]

NUTEK is responsible for promoting business development through financing, information and counseling. One of its main tasks within this area is to promote sustainable growth and the institute tries to stimulate the business sector to seize the opportunities that lie in sustainability. NUTEK is together with SEA and the Swedish EPA member of the council that process the applications for issuance of emission rights by the stakeholders within the EU-ETS.

**Swedish Institute for Growth Policy Studies (ITPS)**[115]

The ITPS has the governmental mission to support growth policies through analyses of the Swedish and international development. Their work includes supporting a sustainable development and increased employment through promoting the

---

[113] Further information is available at http://www.smhi.se
[114] Further information is available at http://www.nutek.se
[115] Further information is available at http://www.itps.se
business sector and its competitiveness, for example by analyzing how climate policies affect the competitiveness of the basic industry.

**Swedish Agency for Innovation Systems (VINNOVA)**\(^{116}\)

VINNOVA has been commissioned to promote sustainable growth through the development of effective innovation systems within the technology, transport and communication and business sectors. The Agency has a specified task of contributing to a sustainable development of the energy systems and to report its findings to the Swedish Energy Agency. VINNOVA situated below to the Ministry of Industry, Employment and Communication.

**Swedish National Tax Board**\(^{117}\)

The Tax Board has the operative responsibility for claiming energy, fuel and environmental taxes (*for more information on taxes see Chapter 7.1*). The Tax Board also issue explanations of how the tax laws shall be interpreted. The tax board does however not establish the tax levels as this is the task of the Ministry that governs the tax area, which in the case of the thesis the Ministry of Sustainable Development.

**National Institute of Economic Research (NIER)**\(^{118}\)

NIER has the responsibility to produce prognoses too support decisions on economic policies. NIER conducts research in macroeconomics and environmental economics, where the environmental research aims to develop the existing monetary environmental accounting and environmental economic models. NIER also analyzes environmental control instruments from an array of perspectives, such as cost effectiveness, target compliance and flexibility.

116 Further information is available at http://www.vinnova.se
117 Further information is available at http://www.skatteverket.se
118 Further information is available at http://www.konj.se
Sweden’s County Administrations\textsuperscript{119}

The County Administration Boards have Environmental Inspection Committees that under the Environmental Code administer licenses for potentially environmentally hazardous businesses and monitor that the license conditions are followed. The boards are also responsible for providing information on how businesses can protect the environment.

5.2 International Political Stakeholders

As mentioned, the international influence over the Swedish policies has been strengthened. This is foremost a result of the membership the EU and the consequential influence of the work of various EU bodies. The bodies that are of specific concern to the climate and energy issues, with respect to the energy utilities and basic industries, are explained in the previous chapters. Much of the work within the EU is carried out within programmes of different natures which are not identified as stakeholders. The international influence also includes the work of the UN Framework Convention on Climate Change, which is explained in Chapter 5.5.\textsuperscript{120}

5.3 The Swedish Agenda

In 2004 the Swedish Government (Skr. 2003/04:129) declared sustainable development as the overall goal for the administration of the state affairs. This resulted in the development of a new Ministry of Sustainable Development that governed \textit{inter alia} climate and energy policies, environmental legislation as well as

\textsuperscript{119} Further information is available at http://www.lst.se
\textsuperscript{120} There are several other bodies within the UN system that concern the climate issue but defining all of the here would be superfluous. Further information is available at http://www.un.org.
EU and International cooperation in this area. The publication from 2004 was followed by a new declaration (Skr. 2005/06:126) on the Swedish position on building a sustainable society. This publication supported the previous declaration, emphasizing climate change as one of the main challenges of our time. Important from the thesis perspective is that this publication establishes that the entire set of policy instruments in the environmental area shall be reviewed by the SEA and Swedish EPA. The review results shall be utilized by an official inquiry on the design of the policy instruments. The publication also stipulates that the tax system shall be reviewed in 2006 from a sustainable development perspective.¹²¹

Through maintaining a progressive agenda on climate change the Government has the ambition to be a progressive international stakeholder on this issue. An official inquiry on the Swedish tax system (SOU 2003:38) identifies that the strategy on how to accomplish this is important. Working as a driving force in international discussions is deemed to be more effective than taking on climate policies that may lead to outsourcing of the GHG emission intensive industry. Internationally developed policies are also identified to incur considerably lower costs than isolated domestic policy measures. The measures carried out by the Government in promotion of environmental policy integration have received positive remarks in an EU report on environmental policy integration in Europe (EEA, 2005c).

One of the major environmental policy incentives is a “green tax-shift” that increases environmental taxes to facilitate a reduction of labor taxes (Chapter 7.1). The Government is in favor of market based policy instruments compared to non-market based instruments, such as subventions and subsidies, and is positive to multilateral

---

¹²¹ The declaration is not a legal document and the new government has not declared their position on the support thereof.
agreements on climate change and advocate a continuance after 2012 for both the KP and the EU-ETS.

While the climate and energy policies and instruments are in focus in this thesis. The reader should bear in mind, as Peet (1992) argues, that policies on energy cannot be seen as freestanding. The reason is that traditionally energy and today also climate policies, with sustainable development as an overall policy goal, are heavily depending on the general domestic policies. Energy is central to many social and environmental aspects in politics. Peet accordingly emphasize the importance of system thinking. Today’s climate and energy policy framework has grown substantially from yesterday’s regional energy issues.

**General Environmental Targets**

Sweden has, apart from the climate and energy issues, an environmental agenda that mainly consists of 16 guiding environmental goals with the expressed purpose to solve the major environmental problems during our generation (Bill 2004/05:150). The goals are not legally binding and cover a broad spectrum of the effects that our society has on the ecosystem. The goal that is of main interest here is Reduced Climate Impact, while for example Clean Air and A Safe Radiation Environment also can be related to activities within the basic industry and energy utilities. The use of these environmental goals has been identified by the European Environment Agency (EEA, 2005b) as both positive and negative. Positive aspect are easier understanding of environmental objectives, easier monitoring and development analysis plus the assignment of responsible authorities to each goal. Problems are the fact that the goals are different in their goal design and that county boards can set own goals.

**The 2006 National Budget**

The 2006 National Budget (Bill 2005/06:1) proposed a continuance of the green tax-shift, including an 85% raise of the nuclear tax and the introduction of a waste
incineration tax. Due to harmonization to EU rules the reduced tax rates (Chapter 7.1) on for example electricity, gas and heating will be removed. The Budget also proposed the exclusion of the carbon tax for the industry sectors included in the EU-ETS as well as for CHP plants with high efficiencies. Non-industry operations included in the EU-ETS was suggested to receive reductions on the carbon tax.

**EU Influence**

Due to the Swedish membership in the EU, the national agenda is linked to the Union’s. Several Swedish policy instruments, such as taxes and emissions trading, are subject EU harmonization. This situation has forced domestic policy decisions that have been both supported and disapproved of by the Swedish Government. Sweden has due to the progressive character of the national climate agenda occasionally pushed for stronger regulation than promoted by the EU. The EU-ETS makes it difficult for Sweden to set GHG emission targets that are different to that of the Trading Scheme as well as limiting the possibilities to introduce other carbon dioxide emission policy instruments on the Trading Sector (SEA and Swedish EPA, 2004c). Due to the link between the EU and Swedish policies, the EU agenda and different publications such as reports and position papers provide a strong indication of how the national climate and energy policies will be formed in the future.

**The New Government**

At the 2006 election the rightwing alliance consisting of the Moderate Party, Christian Democrats, People’s Party and Centre Party formed the Government. The new Government has declared climate change a main issue and highlights ambitious climate goals with clear action plans as central in the policy framework (Reinfeldt, 2006). The energy policies shall be guided by a long-term perspective and economic policy instruments are favored. The green tax-shift was initially declared to be removed (Bill 2006/07:01) but later statements (Veckans Affärer, 2006) are in favor of a continuation. It is concluded that the carbon dioxide tax has been effective but that
there is little room for further increases \textit{(ibid)}. The Government declares that no decisions on further phase-out of nuclear energy will be taken during the period in office (2006-2010), nor will the two recently phased-out reactors be given permission to resume production (Reinfeldt, 2006). The alliance promotes a broadening of the EU-ETS and a continuation of the Kyoto Protocol. The Government’s first budget (Bill 2006/07:01) stipulated changes in the policy framework:

- A new support to municipalities that actively plan for increased wind power developments
- Small-scale hydropower production will continuously receive RECs
- A review of energy efficiency policies

The Government will initiate a commission for sustainable development that will review how the organization and policy framework can be improved to streamline this work. An advisory scientific council is established to issue guidance on which climate goals that should be established. A parliamentary working committee invites all parliamentary parties to work on the preparation of a new Climate Bill that has been announced for release during 2008. The Government supports an EU goal for reduced GHG emissions of 30 % to 2020 (Ministry of the Environment, 2006).

5.3.1 The Swedish Climate Strategy

The climate strategy is essential to the Government’s work and affects many policy areas besides the energy policies. A goal was established in 1993 (Bill 1992/93:179) that the carbon dioxide emissions should stabilize at 1990 levels by 2000 and this goal was met. A 1998 report (SOU 1998:15) from the Swedish Environmental Advisory Council established that the emissions of carbon dioxide should not be increased in the future and that energy efficiency and alternatives to fossil fuels should be utilized. In 2002 the Government established a climate strategy (Bill 2001/02:55) that
established three climate goals that received support by the Parliament. The international goal is to stabilize the concentration of carbon dioxide equivalents on a level below 550 ppm. The national long-term goal is that the emission level in 2050 shall be lower than 4.5 ton carbon dioxide equivalents per inhabitant and year. The goal includes that the emissions should be further reduced thereafter. The short-term climate goal is to reduce the national emissions of GHGs with -4 % to 2012, instead of the allowed +4 % raise compared to a 1990 baseline, without the use of the KP flexible mechanisms or accounting for carbon sinks. This formulation creates erroneous effects and is consequently a main concern in the Swedish climate policies. *This issue is therefore is analyzed in the discussions in Chapter 10.1.*

The 2006 Climate Bill (2005/06:172), produced by the Social Democratic Party in collaboration with the Left Party, mainly establishes that the short-term goal should remain and be reviewed with respect of the flexible mechanisms at the 2008 control station. The Bill otherwise includes several suggestions for the future work within the climate and energy policies. The Bill suggests, as a long-term goal, that the emissions by 2020 shall be 25 % lower than the 1990 baseline and that this goal shall be monitored and reviewed no less than every five years starting in 2008. The goal is suggested against the EU agenda stipulating that the emissions in the industrialized countries should decrease with 15-30 % to 2020 (European Council, 2005a). The Bill identifies that an indication of the maximum allowed global temperature of +2°C increase shall be included in national environmental target of a limited climate change as this is established as an EU target (EC, 2002). The 2008 climate policy control station is given the mission to investigate what measures that these goals require in specific sectors. The Bill also mentions the vision to abolish fossil fuels to 2020.

From a policy instrument perspective the 2006 Climate Bill promotes improved coordination between the climate and energy policies as to gain from possible synergies arising from common policy goals, such as RES and energy efficiency. A
further analysis of this potential is planned in connection to the 2008 control station. The Bill also suggests a strengthening of the KLIMP programme (Chapter 7.2). The Bill furthermore establishes some of the essential design aspects of a future climate regime, such as cost-effectiveness and long-term efforts. The Government also establishes that it is important that Sweden maintains the high ambitions on climate issues and that this work should set an international example showing that strict climate policies can be combined with a positive economic development. The Government identifies that the strict policies can foster technology developments that can contribute to an increased environmental export. The identified potential for this development is however criticized by Kriström (2006), as the empirical evidence for this point in different directions.\(^\text{122}\)

The Swedish EU commitment corresponds to 75.3 Mton carbon dioxide equivalents, but can be recalculated to approximately 78 Mton if accounting for carbon sinks and governmental use of the KP project based mechanisms. It should be considered that the 2002 climate goal was adopted before the EU decisions to establish the EU-ETS and that the 2002 Climate Bill therefore included that Government should review the goal at climate policy control stations in 2004 and 2008. A first step in preparation for the 2008 control station is a large-scale investigation of the economic environmental policy instruments by several agencies, such as the SEA, Swedish EPA and National Tax Board. These stakeholders accordingly published a broad policy instrument analysis (SEA and Swedish EPA, 2006a) in 2006.

Many stakeholders, including the SEA, Swedish EPA at the 2004 control station and the official inquiry of the flexible mechanisms (FlexMex2), suggest the introduction of a new short-term climate goal formulation which aims to improve the goal design through integrating the emission commitments under the EU-ETS. The proposed

\(^{\text{122}}\) This issue is further discussed in Lundgren (2004).
goal, called a deduction goal, would deduct the emissions from the Trading Sector and thus not account these towards the national goal. The efforts to reduce emissions in the non-Trading Sector would consequently be strengthened. See discussion in Chapter 10.1 for further information.

5.3.2 The Swedish Energy Strategy

The present energy strategy partly originates from the 1991 energy agreement (Bill 1990/91:88) between the Social Democratic Party, the Centre Party and the Liberal Party, promoting secured energy supply in both the short and long term. The Bill suggested the introduction of policy instruments creating incentives for biofuels and cogeneration. The Bill received a broad political approval as the Moderate Party and the Christian Democrats decided to support it in connection with the 1991 election of a Liberal and Conservative coalition. In 1997 the Left Government in Office invited the Parties of the Parliament to a discussion on the future energy system in an attempt to establish a new foundation for a long-term energy policy. The talks rendered in a three-party energy agreement between the Social Democratic Party, the Centre Party and the Left Party, which that is outlined in the 1997 Energy Bill (1996/97:84). This Bill established that the 1991 guidelines would be adhered and initiated a short and long-term programme for the development of the energy system. The short-term programme (1998-2002) was aimed to meet the shortfall from the phase-out of Barsebäck 2, focusing on energy efficiency and renewable energy. The long-term programme, which ran until 2004, focused on research and development.

The Swedish Energy agenda was updated in the 2002 Energy Bill (2001/02:143), which was established by the same coalition as the 1997 agreement. The Bill aims to secure the short and long-term supply of environmentally friendly energy on competitive conditions and to aid the transition towards an ecologically sustainable
society. The electricity supply shall be secured through structuring the energy system on lasting energy sources that preferably should be domestic and renewable. The Bill therefore promoted a REC scheme, which was introduced in 2003 (Chapter 6.2). The Bill acknowledges that the internationalization of the energy market requires that the energy policies strive for harmonization for competitive reasons. The overall goal is to reduce the use of fossil and nuclear energy sources and to supply the entire society with renewable energy. This is manifested in the short-term target that 10 TWh of new renewable energy production shall be installed by 2010 and by the ambition that wind power shall supply 10 TWh by 2015.\textsuperscript{123} The Bill suggested that the renewable energy goal could be raised to 15 TWh if the conditions are favorable.\textsuperscript{124} The 2006 Bill (2005/06:154) on RECs recently amended the goal to 17 TWh of new renewable electricity production to 2016, compared to 2002 levels.

The earlier 2002 Energy Bill (2001/02:143) announces that Swedish policy efforts must be designed to reduce emissions as effectively as possible by taking competitiveness, employment and welfare issues into consideration. The Energy Bill states that cogeneration is preferable as it is effective from both an environmental and energy perspective, irrespectively of which fuel that is used. The Energy Bill also establishes that efficient energy utilization is central to the national electricity supply and forms the foundation for economic growth and a sustainable development. The Bill furthermore declares that the energy policies should be shaped in the light of the national environmental and climate goals. The industries electricity consumption shall, according to the Bill, not be limited by other policy instruments than the tax

\begin{footnotesize}
\begin{itemize}
\item \textsuperscript{123} The wind power goal is a planning target and not a projection target or part of the renewable energy target (Bill 2001/02:143). The policy support to wind power has been criticized, see Chapter 3.2.4.
\item \textsuperscript{124} The second assessment report about the REC system from 2005 considered that current conditions allow for an increased goal of 15 TWh new renewable production by 2012. The maximum potential is identified as 16 TWh from 2012 and 19 TWh from 2015 compared to the 2002 production (SEA, 2005h).
\end{itemize}
\end{footnotesize}
rules and the Environmental Code. In conclusion, the range of policy instruments in the energy field thus aims to fulfill a wide range of political aspirations.

In a nuclear energy context the Energy Bill supports the continuing phase-out that was initiated by the 1980 referendum and the 1997 energy policies (Bill 1996/97:84). The Energy Bill presented the intention to reach a long-term agreement with the industry on nuclear power production and the continuing development of the energy system. This effort was futile and in 2004 the special negotiator Bo Bylund unsuccessfully concluded the discussions. The Government has given permission for power uprating to Ringhals 1 and 3, which should be precedential for other operations. See Chapter 3.2.1 for more information on nuclear electricity production.

The energy agenda in different areas was updated in 2006 by a number of bills. These include:

- Environmentally friendly electricity production with wind power (Bill 2005/06:143)
- Research and new technology for the future energy system (Bill 2005/06:127)
- Renewable electricity with RECs (Bill 2005/06:154)
- Guaranteed origin of high-efficiency CHP production (Bill 2005/06:83)
- Taxation of incinerated waste (Bill 2005/06:125)

Another energy initiative is the 2005 goal to abolish the dependence on fossil fuels to 2020. The goal must be seen as a vision due to several reasons including, that the steel industry will not be able to maintain production without fossil fuels and that changing the transport sector is likely to take a longer period. This has also been admitted by Mona Sahlin, stating that she knows that this will not be met as she is
“...somewhat of a realist”\textsuperscript{125} (SvD, 2005b). The declaration nevertheless point out the long-term vision of the socialist Government’s energy policies – promoting renewable energy, renewable fuels for transport, R&D for a sustainable society and district heating. The declaration was followed by the work of a cross-sector Commission against the oil dependence with representatives from the Government, industry, utilities, agriculture and academia. The commission has published their final report (Kommissionen mot oljeberoendet, 2006) suggesting a number of goals and suggestions. They commission \textit{inter alia} suggest that the industry should reduce their oil consumption with 25-40\% to 2020 and a 20\% energy efficiency improvement in the society as a whole. The commission further suggests:

- Energy gases can play an essential role in the national energy system albeit the gas infrastructure should be kept at the current level and priority should be given to biogases.
- Strengthening of policy instruments that promotes a reduction of the oil consumption for heat and steam in the industry could be required.
- The PFE (\textit{Chapter 7.3}) should be widened to include oil.
- The Government should work for a strengthening of the EU-ETS, including auctioning of emission rights.

The Commission report has been referred to some 160 stakeholders for consideration.

\subsection{5.4 The European Agenda}

The overall environmental agenda in the EU is governed by the Environmental Action Programme which sets the long-term priorities for ten-year periods. The

\textsuperscript{125} Swe: “Jag är lite realistisk.”
current 6th Environmental Action Programme (2002-2012) stipulates the goals to reduce the EU Member States’ GHG emissions with -8% between 2008-2012, compared to 1990 levels and to keep the global temperature increase below +2°C, which supports EU’s commitment under the Kyoto Protocol (EC, 2002). The Action Plan also focuses on the sustainable use of natural resources which can have implications for the use of internal energy sources.

In a Commission communication (COM(2005) 218 final) sustainable development has been declared as a key principle of EU policies and actions establishing policy guiding principles to support this goal. The communication furthermore establishes that a proactive approach on sustainability can support the Lisbon agenda (see below) by creating win-win situations for both the environment and economic market. The EU has taken a vanguard position in the international climate work by establishing the multilateral EU-ETS before the KP entered into force. The Commission promotes harmonization of policy instruments to reduce negative competitive implications.

EU decisions that shall be implemented on Member State levels are adopted as directives by the European Council and/or European Parliament, based on the suggestions of the European Commission. The legislative power of the directives allows the EU to effectively promote and implement policies at Member State levels. The Commission publishes Green Papers that are discussion papers in specific policy areas as well as White Papers that include proposals for action within a certain area. White Papers are thus a “stronger” publication, as it is meant to promote a specific development. Other publications include Commission Communications, Parliament Resolutions, and Action Plans etc. The important and most recent reports and policy recommendations are outlined in this chapter.
Table 5.3 Goals and targets in EU climate and energy documents\textsuperscript{126}

<table>
<thead>
<tr>
<th>Climate</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keeping the atmospheric concentration of CO$_2$ equivalents below 550 ppm (EC, 2002)</td>
<td>22 % RES in electricity production by 2010 (Directive 2001/77/EC)</td>
</tr>
<tr>
<td>Reducing GHG emissions with -8 % to 2012 under the Kyoto Protocol (Directive 2003/87/EC)</td>
<td>12 % of energy and 21 % of electricity consumption should be met by RES by 2010 (European Council, 2006a)</td>
</tr>
<tr>
<td>Keeping global temperature rise below +2°C (EC, 2002)</td>
<td>20 % RES in the overall energy supply in 2020 (EC, 2007)</td>
</tr>
<tr>
<td>Reducing GHG emissions with 20 % to 2020 (European Council, 2007a)</td>
<td>40 GW wind power by 2010 (COM(97) 599 final)</td>
</tr>
<tr>
<td>Double the CHP production to 2010 by raising the CHP electricity production from 9 % to 18 % by 2010 (COM(97) 514 final)</td>
<td>Energy end-use savings of 1 % per year for 9 years (2008-2016) (Directive 2006/32/EC)</td>
</tr>
<tr>
<td>20 % improved energy efficiency in primary energy consumption by 2020 (COM(2006) 545 final)</td>
<td></td>
</tr>
</tbody>
</table>

The adoption of climate and energy targets has recently been highlighted by the discussions of the Commissions climate and energy package that was released in 2007 (see below).

**The Lisbon Process**

One of the cornerstones of the EU’s development is the Lisbon Strategy\textsuperscript{127} (EC, 2000), which was formed by the Council at the Lisbon Summit in 2000, aiming at making

\textsuperscript{126} Goals and targets are often mentioned in several documents, the references are examples of where the definitions can be found. Not all are binding.

\textsuperscript{127} Also called the Lisbon Agenda and Lisbon Process.
the EU “the most dynamic and competitive knowledge-based economy in the world” by 2010. The targets set to achieve this goal are not directly related to sustainable development and the climate issue – in fact environment is only referred in the Strategy as “business environment” – but it is a strong commitment that affect these areas. There has consequently been a discussion on which role that sustainability plays in the development and if environmental considerations have has harmed the competitiveness of the Union or if that eco-efficiency is central to fulfill the Strategy’s aim. The Strategy was re-launched in 2005 (COM(2005) 330 final), marking its half-way point, with a larger attention to environmental concerns through mentioning energy efficiency and renewable energy technologies as priorities. The revised Strategy does however not mention the climate issue and the need to reduce GHG emissions.

The Gothenburg Sustainable Development Strategy

The 2001 European Council summit in Gothenburg adopted a Sustainable Development Strategy (EU SDS) (COM(2001) 264 final) that had been brought forward by the Commission. The EU SDS incorporates all main pillars of sustainability and highlights climate change mitigation and increasing the use of clean energy as long-term objectives. The Strategy declares in this context that:

- An energy products tax directive shall be adopted
- A proposal on a EU emissions trading scheme starting 2005 shall be brought forward
- Subsidies to fossil fuel production and consumption shall be phased-out to 2010
- Strong efforts to reduce energy demand are to be taken through inter alia more efficient appliances
- Improved research, development and dissemination of clean and renewable energy resources as well as safe nuclear energy technologies
The EU SDS has been reviewed and the European Council (2006b) has declared the goal to establish a single and coherent sustainability strategy. The EU SDS in its new form builds on the policy aspects suggested in a Commission Declaration on Guiding Principles for Sustainable Development (COM(2005) 218 final)\textsuperscript{128}:

- Involvement of businesses and social partners through dialogue, corporate social responsibility and private-public partnership
- Coherence and governance between EU and International policies to promote sustainable development
- Policy integration to promote all areas of sustainable development
- Implementation of Best Available Technologies (BAT) and knowledge that are economically sound
- Use the Precautionary Principle to avoid damage to humans or the environment
- Use the Polluter Pays Principle (PPP) to promote that prices reflect the real costs of the production

The EU SDS affirms the EU’s long-term commitment to sustainable development as a main principle in all policies and actions. Climate change is one of the main topics of the new EU SDS and the strategy provides strong support for the EU-ETS and the KP. In an energy context the strategy promotes the recently published Action Plan on Energy Efficiency. Other energy considerations are how to promote CHP, achieve existing RES targets and set new targets.

\textsuperscript{128} Apart from COM(2005) 218 final the review was also supported by COM(2005) 658 final.
A European Energy Policy and the 2007 Climate and Energy Package

Through a 2006 Green Paper on a European Strategy for Sustainable, Competitive and Secure Energy, the Commission opened a discussion on the short and long-term energy and climate challenges for the EU. As an integrate part of this work, the Commission, in 2007, presented a package of climate and energy policy measures. This included suggestions on climate and energy targets and a ten-point Action Plan for achieving these targets (COM(2007) 1 final). While many of the earlier targets were set to 2010 or 2012, the new package mainly establishes targets to be met by 2020. These include that a post-2012 international emissions agreement should set the level of -30 % reductions to 2020. To support this, the Commissions suggested that the EU should commit to reduce GHG emissions by -20 % to the same year. The emission reductions should be reached by energy measures and the package *inter alia* also proposes binding national targets to increase the share of RES in the overall energy supply to 20 % by 2020. The Commission also recalled earlier energy efficiency goals as supporting the emission goal. The package furthermore proposed that the EU-ETS should be expanded to include other sectors and gases (COM(2007) 2 final). It also promotes that allocation periods should be longer than 5 years, albeit not defining a new period. Apart from these long-term goals the ten-point Action Plan includes discussions on *inter alia* energy technologies, including low-carbon fossil fuel utilization, and nuclear energy.

The Parliament has earlier taken a positive position towards similar targets (EP, 2006a) and consequently supports the suggestions in the energy package (EP, 2007). The Parliament however suggests a stronger RES target of 25 % of the overall energy supply by 2020 and suggests that Member States considers going beyond the 20 % energy efficiency target.

---

129 The package consisted of ten main documents. For more information on the package, see http://ec.europa.eu/energy/energy_policy/index_en.htm.
The European Council (2007b) did not provide the same support for the energy targets, rejecting the target of 20 % RES as binding. The Council however provided a strong support for a rapid implementation of the Energy Efficiency Action Plan. Council (2007a) decisions, in response to the climate targets, support the EU emissions goal of -20 % to 2020. This goal is strengthened to -30 % in case of a post-2012 global and comprehensive emissions agreement, with similar targets, is established. The decision also included decisions on developing differentiated approach to decide the contributions of the Member States contribution to reaching the EU KP commitment. This includes taking national circumstances at the base year into consideration.

**The EU Internal Market**

The EU has decided to create internal energy markets for electricity and gas with the goal that all customers shall have the opportunity to freely choose suppliers by July 2007. In 2003 the Electricity Directive (2003/54/EC) and Gas Directive (2003/55/EC) was adopted to govern this development. The Eurelectric (2005) has identified that the provisions in the Electricity Directive will benefit the market by increasing number of stakeholders and competition as well as promoting market based investments in new power generation facilities. The EU has also issued regulations on cross-border exchange of electricity (EC, 2003b). The development of internal markets can, inconsistently to its aim, hamper the competitiveness if mergers lead to a market development with a limited number of utility giants.

**Policy Instruments**

A key issue in the EU’s internal market is the need to harmonize certain policy instruments in the Member States in order to prevent market obstacles. This has in the Swedish case resulted in a restructuring of the energy tax and the implementation of a Programme for Energy Efficiency (Chapter 7.1 and 7.3). A Commission Green Paper on economic instruments is expected during 2007.
The main Swedish policy instrument that is governed on an EU level is the EU-ETS, albeit several directives, such as the IPPC Directive (96/61/EC) and Mineral Oil Directive (92/81/EEC), have an influence on the specific design of other instruments. A comprehensive overview of the directives that influence the design of national policy instruments is provided in connection to the analyses of the Swedish policy instruments. The number of instruments directly governed on an EU level could be increased, as EU is analyzing the possibility to promote a Union-wide introduction of an Energy Efficiency Certificates (EEC) scheme.

**EU Climate and Energy Programmes**

The EU climate and energy agendas include a number of programmes that influence the policy instruments and support their goals and targets. In 2000, the Commission launched the European Climate Change Programme (ECCP) with the goal to aid the development of an EU strategy on effective GHG emission reductions and the implementation of the KP. In end-2005, the Commission re-launched the programme as the ECCP II, focusing on opportunities for cost-effective GHG emission reduction after 2012 in synergy with the Lisbon Strategy (COM(2005) 35 final).

The Intelligent Energy for Europe (IEE) programme ending in 2006 has the target to sustain the EU agenda on sustainable development, energy security and competitiveness through supporting various policy documents in these areas, such as the Green Paper on Security of Energy Supply, the White Paper on Transport, the Renewable Energy Directive and the Directive on Biofuels. Actions supported by the IEE programme aim to remove market barriers hindering sustainable energy utilization. An example of this is the SAVE programme, promoting non-technological action on energy efficiency, which has supported the introduction of RECs and analyzed EECs. The IEE is proposed to be continued during 2007-2013 under a
Competitiveness and Innovation Framework Programme (CIP) that would focus on supporting the re-launch of the Lisbon Agenda.\textsuperscript{130} The IEE hosts the Sustainable Energy Europe campaign (2005-2008) which promotes renewable energy and energy efficiency by raising the awareness on these subjects across all societal levels.

The EU 6\textsuperscript{th} Framework Programme for Research and Technological Development (2002-2006) supported research within sustainable energy and climate change. This focus is shared by the current 7\textsuperscript{th} Framework Programme (2007-2013). The EU also runs several information campaigns in order to diffuse knowledge into the society.

5.4.1 Climate Change

The European Union’s short-term climate goals are dictated by the KP emission commitments. In 2005 the Commission proposed that post-2012 long-term goals should include the targets of a 15-30\% GHG emission reduction to 2020 and 60-80\% to 2050 (European Council, 2005a). The EU Summit diverged from these recommendations and decided that the 2020 flexible goal should be considered in the light of future work and cost-benefit aspects, while the longer-term target to 2050 was not specified at all (European Council, 2005b).

The EUCETS’s position as the main policy instrument to reach the climate goals makes the Emissions Trading and Linking Directives (2003/87/EC, 2004/101/EC), establishing the scheme, central to the climate change agenda. See Chapter 6.1 for more information on EU-ETS. The IPPC Directive also target GHG emissions but from a technological perspective and can been seen as a policy instrument promoting energy efficiency.

\textsuperscript{130} The Commission adopted the programme proposal (COM(2005) 121 final ) 6 April 2006 and it is now being negotiated on other EU institutional levels.
The Commission has released a Communication on Winning the Battle against Climate Change (COM(2005) 35 final) on post-2012 actions. The Communication outlines recommendations for future EU climate policies in five key areas:

- Rapid and effective implementation of suggested policy measures in, for example, the Green Paper on Security of Energy Supply (see below)
- Investment support for climate-friendly technologies and the launch of a new Energy Efficiency Initiative
- Informative campaigns for increased and sensitized public awareness on the climate change problem
- Increased and improved research
- Stronger cooperation with developing and third-world countries
- Introduction of a ECCP II programme focused on cost-effective measures to reduce GHG emissions

The EU has two bodies that work specifically with climate change and the emissions trading regimes. The Working Party on International Environmental Issues (WIPE) is a Council group that is responsible for the EU climate change negotiations, hosting a number of expert bodies on related issues. A Climate Change Committee supports the Commission as a managing and guiding body of the Directive establishing the EU-ETS (2003/87/EC). The Swedish EPA is the Swedish representative in both bodies.

**Integrated Pollution Prevention Control (IPPC)**

The IPPC Directive (96/61/EC) targets various pollutions, such as noise and substances, from specific point sources through controlling the issuance of operational permits based on BAT evaluations. The included operations roughly correlate to the stakeholders included in the scope of the thesis. The Directive stipulates that all new establishments must obtain a permit from responsible
authorities before they are allowed to operate.\footnote{In the Swedish case the permit is issued by different authorities depending on the type of operations.} Operations established before the Directive entered into force shall not be given continued operational permits if BAT has not been attained after an 8 year transition period.\footnote{The transition period is applied to prevent job loss and jeopardizing of business economies, as BAT investments can be costly.}

Due to the IPPC attention to BAT the Directive is accompanied by Best Available Technique Reference Documents (BREFs), which are non-legally binding, guiding the implementation of the Directive. BREFs has been published and approved on all basic industry and energy utility sectors and a new document on energy management and efficiency in auxiliary systems is under preparation. The work to develop the BREFs includes participants from many countries and the Swedish delegates report that Swedish operations are in the forefront with regard to implemented technologies (Resvik, 2005). This view is shared by many of the interviewees (Brinck, 2005; Carlsson, 2005; Lyberg, 2005; Resvik, 2005; Sunér Fleming, 2005) is that the Swedish operations already operate corresponding to, or close to, the BREFs’ BAT levels.

The IPPC is an administrative policy instrument and is implemented in Sweden through the Environmental Code (Chapter 8.1). The Emissions Trading Directive (2003/87/EC) allows for Member States to eliminate some of the IPPC regulations for the Trading Sector through the Article 26, which declares that Member States can choose whether to impose energy efficiency regulations on the Trading Sector or not. No such changes have however been included in the Swedish Environmental Code (SFS 1998:808). The BREFs also serves as a guide for the industry and energy utility stakeholders on BAT and can be used by policy makers for other purposes.
5.4.2 Energy

Green Papers and energy directives establish that increased utilization of renewable energy and energy efficiency improvements have potentials for substantial GHG emission reductions. A main issue is to harmonize the agendas of the Member States in order to achieve this potential. The main energy policy development in the EU is therefore currently to establish a Common European Energy Policy. The development of the policy area is thus closely related to the 2007 Climate and Energy Package and the upcoming legislative policy suggestions based on the Council and Parliament comments thereof. The main issues include the importance and safety of EU internal energy supply, RES, energy efficiency, environment and climate, CCS, harmonization of Member States energy policies and consumer behavior. Apart from the Electricity and Gas Directives already mentioned, the legal framework of focus here are four Directives:

- The Directive for the Taxation of Energy Products and Electricity (2003/96/EC)\(^{133}\)
- The Directive on the Promotion of End-Use Efficiency and Energy Services (2006/32/EC)

Several energy policies was reviewed in end-2005 and the Green Paper on A European Strategy for Sustainable, Competitive and Secure Energy (COM(2006) 105 final) was published in 2006. The Green Paper included six priority areas, which were later supported by the Council:

\(^{133}\) Since the Directive is directly relevant for the design of the national tax system it is presented in Chapter 7.1.
1. Competitiveness and the creation of the internal energy markets
2. Diversification of the energy sources
3. Sustainable development with a focus on tackling climate change – mainly energy efficiency, RES and CCS
4. Solidarity between Member States to increase security of energy supply
5. Joint R&D efforts on energy
6. Establishing an EU common comprehensive energy policy

The Green Paper suggests that the common energy policy should be long-term but flexible, being guided by regular Strategic EU Energy Reviews on the above priority areas. The focus of a common policy should be sustainability, competitiveness and security of supply. To aid this, the Green Paper promotes an increased integration of energy policies into other policy areas.

The issues of the Green Paper has due to recent high and volatile oil prices and with support from the Parliament resulted in a Commission five point plan that aims to further promote and accelerate actions and measures on renewable energy, energy security and energy efficiency (EP, 2005a). Against this background the Members of the Parliament has declared a vision that EU should be the most energy efficient and least fossil fuel dependant economy by 2020 and therefore gave the Commission the task of developing a European energy efficiency action plan to promote this (EP, 2005c).

A Large Combustion Plant Directive (2001/80/EC), mainly regulating emissions of sulphur dioxide and nitrogen oxides, also state that carbon dioxide emissions need to be reduced, use of natural gas for electricity production is likely to increase and that emission standards for biofuels are justified. The Directive on Energy Performance of Buildings is important in a climate context, due the large share of GHG emissions that derives from the built environment, but it does not apply to industrial sites.
Renewable Energy

The central goal on renewable energy is the RES-goal, which originates from the 1996 Green Paper on renewable energy sources (COM(96) 576 final). The Green Paper established a goal, called the RES-goal, to double the renewable energy utilization, meaning that renewable energy should supply 12% of the energy consumption in 2010. A study, initiated by the Commission, have identified that renewables could make a significant contribution in fulfilling the EU agenda on energy and sustainability, especially regarding the KP commitment (Ragwitz et al, 2005). The study highlights the importance of adopting EU directives into national policies and policy instruments. This is especially assigned to “the removal of economic barriers to the development of renewable energy sources by introducing financial support mechanisms and promotion schemes” and “the mitigation of non-economic barriers such as administrative barriers, market imperfections, technical obstacles and grid restrictions”.

The EU administration has at several occasions reaffirmed the RES-goal. The 1997 White Paper for a Community Strategy and Action Plan on Renewable Energy (COM(97) 599 final), introduces a number of Member State and EU-level actions that aims to fulfill the RES-goal. The White Paper also highlights that the goal depicts a political vision and thus not a binding commitment. In the Green Paper on Security of Energy Supply (COM(2000) 769 final), the Commission identify that fulfilling the goal will require “specific and targeted actions”, stressing financial incentives to promote renewables and removing market-distorting subsidies to conventional energy. Meeting the RES-goal is furthermore an important part of the Lisbon Strategy’s aim of pursuing a sustainable economic growth in the light of the developments on the international energy markets. The RES-goal is currently supported by the Campaign for Sustainable Energy (2004-2007) which focus on developing renewable energy sectors through stakeholder cooperation and energy efficiency.
The 2001 Renewable Energy Directive (2001/77/EC) establishes the framework for promoting RES as tool to reduce emissions and increase the Unions security of energy supply. The Directive takes a policy step towards the fulfillment of the RES-goal, by establishing the goal to increase electricity production with renewable energy from 14% in 1997 to 22% in 2010, called the RES-e goal. The Directive sets the indicative target for Sweden to 60%, while acknowledging that reaching this target may be difficult due to precipitation fluctuations and legal obstacles for new hydropower installations. As a response and to comply with the Directive, the Swedish Government introduced the REC scheme that shall increase the renewable production with 10 TWh to 2010 (Bill 2001/02:143). Ylva Rylander (2005) at the SSNC identifies this as a positive example of EU’s strong role as a stakeholder within the Swedish climate and energy policies. To strengthen the market for RES the Renewable Energy Directive also introduces guaranteed origin of electricity production with RES. Harmelink et al (2006) identify that the current policy instruments implemented by the Member States are not sufficient to reach the RES-e goal on an EU level and that additional instruments therefore are required. In the Swedish case the analysis identify that the Swedish indicative target of 60 % will be missed by 3 %.

A communication (COM(2004) 366 final) from the Commission on the share of renewable energy in Europe, established that additional efforts are necessary to fulfill the RES-goal. As a consequence a Biomass Action Plan (COM(2005) 628 final) was initiated to promote the target through a better coordination of EU policies, electricity and heat production as well as biofuels for transport. The Action Plan promotes a doubling of the share of RES in the EU’s energy consumption from 4 % to 8 % in 2010. The reasons for this are not only to reduce GHG emissions but also to strengthen the security of supply and to create new job opportunities. The Action Plan suggestions include the adoption of new legislation on RES and the adoption of national action plans in the Member States. The Commission (EC, 2005d) has
assessed the possibility to introduce a harmonized EU support scheme for RES but found that this is not currently recommended. The European stakeholder coalition European Renewable Energy Council (2005) supports strong EU initiatives and suggests a binding target of a minimum of 25% of heating and cooling being produced by renewable sources by 2020.

A Parliament statement by the Industry and Energy Committee on the share of renewable energy in the EU includes proposals for concrete actions (EP, 2005b). The statement promotes that the EU should aim for 25% energy contribution of RES by 2020 and points out a future energy policy agenda based on three pillars:

- Intelligent energy policies that promotes renewables on the supply side should be part of a policy mix together with demand side measures
- Energy density considerations, where low density sources (e.g. waste energy) supply low temperature needs (e.g. domestic cooling and heating)
- Local generation to reduce transport and enhance security of energy supply as well as strengthening local and regional economies

The report advocates that the EU electricity system shall aim for full (100%) utilization of RES in the future, and states that a 30% target for overall energy consumption for 2020 is possible. The technologies to support such a development are expected to be available and the Parliament sees political action as the major possible obstacle (ibid). The report points out four policy actions necessary for full-scale RES introduction:

- The most effective way to obtain carbon dioxide reductions are demand side policies
- Removing subsidies to non-renewable energy sources (non-RES)
- Fair grid access and fair pricing of balancing power
- Removal of complex authorization schemes
Energy Efficiency

The EU identifies energy efficiency improvements to hold a major potential for accomplishing large GHG emission reductions in the short-term. The Green Paper on Energy Efficiency (COM(2005) 265 final) promotes cost-effective energy savings of 20% to 2020 compared to a number of scenarios, which would mean returning to 1990 levels of an EU overall consumption. The Green Paper states that the industry has already undertaken measures for increased energy efficiency and that this development is likely to proceed. The Green Paper also sees a large potential for efficiency improvements in energy utilities and electricity generation. The Green Paper establishes that the EU has the opportunity to affect the development through promoting more efficient production in upcoming utility installations. The means to accomplish this is to promote more efficient electricity distribution, cogeneration to decrease heat losses and other efficient technologies such as combined-cycle gas turbines (CCGT). Policy instruments such as emissions trading, the IPPC Directive (96/61/EC) and voluntary agreements are deemed to further propel this development. Economic incentives are believed to contribute to further improvement of the energy performance of the industry sector’s processes and auxiliary equipment. The EU-ETS is identified as the most efficient policy instrument in accomplishing this but the possibility of introducing an EEC scheme (Chapter 6.3) is also mentioned.

In 2006 the Commission (COM(2006) 545 final) set out an Action Plan for Energy Efficiency. The Action Plan establishes 75 measures to reduce energy consumption. The measures are categorized under 10 action areas that are prioritized and should be “initiated immediately and implemented as soon as possible”. These include:

- Appliance and equipment labeling and minimum energy performance standards, including updated and dynamic labeling and minimum
energy performance standards for appliances and other energy-using equipment from 2007

- Improving efficiency of power generation and distribution more efficient, including minimum binding efficiency requirements for new electricity, heating and cooling capacity lower than 20 MW by 2009
- Facilitating appropriate financing of energy efficiency investments for small and medium enterprises and ESCOs
- A coherent use of taxation, including a review of the Energy Tax Directive in 2008 guided by a Green Paper on indirect taxation
- Raising energy efficiency awareness

The measures promoted by the Energy Efficiency Action Plan are identified to improve the energy efficiency by 1.5 %, which together with other EU legislation is expected to increase the ratio to 3.3 % per year. The Action Plan identifies a technologically and economically feasible savings potential of >20 % total primary energy to 2020. This savings potential is identified as 25 % for the manufacturing industry, mainly achievable in auxiliary equipment. The Action Plan and its proposed actions are fully supported by the EU ministers of Energy in the European Council (2006a).

Improved efficiency and the resulting reductions of carbon dioxide emissions is the subject of a Directive on the Promotion of Cogeneration (2004/8/EC). The Directive is strongly linked to the climate change issue through references to the UNFCCC and Kyoto Protocol as well as the Gothenburg Strategy. A goal for the EU to double the electricity production in CHP plants from 9 % in 1997 to 18 % in 2010 was set in the 1997 Cogeneration Strategy (COM(97) 514 final). This is through the Directive replaced by urging Member States to analyze their own individual potential.
The Directive on the Promotion of End-Use Efficiency and Energy Services\textsuperscript{134} (2006/32/EC) establishes a 9 \% savings target (1 \% per year) for the 9\textsuperscript{th} year after its implementation for each Member State. The Directive highlights the public sector’s role, and promotes energy audits, voluntary agreements and energy services by utilities and energy retailers. It also stipulates that the Member States may not use policy instruments that unnecessarily stimulate energy transfers or policies that impedes policy instruments that targets energy efficiency. The Directive furthermore stipulates that the Member States must adopt action plans on how to achieve the 1 \% indicative savings target. These plans are subject to review and approval by the Commission every three years. The Directive is thus a strong signal of the EU’s determination and focus on improving the energy efficiencies of the Member States. An important aspect is that the Directive also stipulates that the progress shall be evaluated after the first three years of implementation. It the review find it necessary it shall put forward a proposal for an EEC scheme. The regular control stations are positive as it has the potential to increase the policy efficiency through allowing for regular stakeholder participation and dialogue on the development.

A Directive establishing a Framework for the Setting of Ecodesign Requirements for Energy-Using Products (2005/32/EC) has been adopted that sets requirements on energy dependant products regarding for example their energy efficiency from a LCC perspective. As the Directive regulates the introduction and use of these products within the EU it has a strong influence on the acquisitions of auxiliary equipment for the industry and energy utilities. The Directive is however very flexible with regards to the industry, allowing for voluntary measures and agreements when they are deemed more efficient, as well as stating that its implementation must not have a significant negative impact on the industry’s competitiveness. The Directive is valid for all energy depending products (except

\textsuperscript{134} Often referred to as the Energy Service Directive.
vehicles) and all energy sources but products will only be included when implementing measures that specify the eco-design requirements have been set. The Directive is however unlikely to have an effect on the basic industry and energy utilities as it excludes these of any requirements sectors due to their inclusion in the EU-ETS and the IPPC.

5.5 The International Agenda

Dating back to the United Nations Conference on the Human Environment in Stockholm 1972 there has been a joint international agenda on environmental issues. Climate change is currently one of the issues that top this agenda. There is at present an international consensus that the climate is affected by anthropogenic emissions of GHGs and climate change has been the focus of several international forums. In 1992 the UN adopted the UN Framework Convention on Climate Change (UNFCCC) (UN, 1992), which was opened for signature at the Rio Summit later that year. In 1997 the UNFCCC was strengthened through the adoption of the Kyoto Protocol (UNFCCC, 1997), establishing an international emission trading scheme. The Kyoto Protocol is explained in detail in Chapter 6.1.5.

The UNFCCC, which entered into force in 1994, is governed by its signatories, called the Parties to the Convention, at regular meetings called the Conference of the Parties (COP). The Convention recognizes that the climate system can be affected by GHG emissions and aims to establish a framework to meet the threat of climate change through intergovernmental efforts. The objective is to stabilize the atmospheric concentration of GHGs at a level that will prevent dangerous changes to the climate system caused by anthropogenic interference. The main responsibility for this is put on the developed countries, stating that these should take the lead in this work, and that special attention shall be paid to the needs and conditions of developing nations. The UNFCCC includes the developed countries that are Parties to the Convention in
its Annex I. These countries are obliged to report the national emissions in a National Inventory Report (NIR) on a yearly basis. Parties included in the Annex II (Table 5.4) are Annex I countries, including Sweden, with additional responsibilities to provide developing countries with financial resources to support their provisions under the Convention and, if necessary, in their work to adapt to climate change effects.

Table 5.4 Annex II countries according to the UNFCCC

<table>
<thead>
<tr>
<th>Australia</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Luxembourg</td>
</tr>
<tr>
<td>Belgium</td>
<td>Netherlands</td>
</tr>
<tr>
<td>Canada</td>
<td>New Zealand</td>
</tr>
<tr>
<td>Denmark</td>
<td>Norway</td>
</tr>
<tr>
<td>European Economic Community</td>
<td>Portugal</td>
</tr>
<tr>
<td>Finland</td>
<td>Spain</td>
</tr>
<tr>
<td>France</td>
<td>Sweden</td>
</tr>
<tr>
<td>Germany</td>
<td>Switzerland</td>
</tr>
<tr>
<td>Greece</td>
<td>Turkey</td>
</tr>
<tr>
<td>Iceland</td>
<td>United Kingdom of Great Britain and Northern Ireland</td>
</tr>
<tr>
<td>Ireland</td>
<td>United States of America</td>
</tr>
</tbody>
</table>

Source: UN, 1992

The Convention had, as of 24th May 2004, been signed by 189 Parties\textsuperscript{135}, who are committed to cooperate and promote reduced climate system interference on most levels, including (UN, 1992):

- To “formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate

\textsuperscript{135} For continuous updates see http://www.unfccc.int

218
climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol\textsuperscript{136}, and measures to facilitate adequate adaptation to climate change”

- The “development, application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol in all relevant sectors, including the energy, transport, industry, agriculture, forestry and waste management sectors” (UN, 1992)

Annex I states shall also “adopt national policies and take corresponding measures on the mitigation of climate change, by limiting its anthropogenic emissions of GHGs and protecting and enhancing its GHG sinks and reservoirs”.

An additional international action to reduce GHG emissions is the recent Asia-Pacific Partnership on Clean Development, signed in July 2005, which promotes cooperation with a stronger focus on the development of clean technologies. This includes energy efficiency, clean coal, nuclear power and renewable energy utilization. The Partnership is signed by the United States, Australia, India, China, Japan and South Korea (United States, 2005b) and is identified by these countries as a compliment, and not a replacement, of the KP (United States, 2005c). Albeit the Partnership currently lacks in detail and concrete commitments it could, if strengthened, become an important channel for the United States to work with climate change mitigation on the international arena. This could prove to be essential as the present and other potential administrations have been reluctant to ratify the KP. It should however be noted that the United States have signed and ratified the UNFCCC and thus obliged

\textsuperscript{136} The Montreal Protocol (UNEP, 2000) includes Chlorofluorocarbons (CFC), Halons, other fully Halogenated CFCs, Carbon Tetrachloride, Methyl Chloroform, Hydro-chlorofluorocarbons (HCFCs) and Methyl Bromide.
to follow the provisions thereof. It is also noteworthy that the United States is investing $3 billion in a Climate Change Technology Program (United States, 2005a), which could contribute to future climate change mitigation. It should furthermore be noted that many US businesses as well as a number of states are positive to Emission Trading and that the position on the KP could change with a new administration.

International cooperation on energy is mainly carried out through the International Energy Agency (IEA) and the World Energy Council (WEC). The IEA was created in 1974 by OECD members to work as an energy policy advisor and promoting an effective reduction of the members’ oil dependence as a response to the oil crisis at the time. The current focus is wider and incorporates issues such as energy technology cooperation and reducing GHG emissions from the energy sector. The WEC promotes sustainable energy utilization by disseminating knowledge and to cooperate with other equivalent organizations.

5.6 Control Instruments

Control instruments can be divided into two groups where one is official policies and the other is governed by non-political groups such as NGOs or international associations. The absolute majority of instruments belongs to first group (1) and is referred to as policy instruments. These are administrated by the Government and used as tools to realize their political agenda. In the Swedish case, the second group (2) only includes environmental labeling of companies and electricity. Due to legislative reasons, control instruments in the second group are always informative. The emphasis is therefore on policy instruments as this group includes most instruments. Hence, the term policy instrument is used, except in those cases when green labeling or the difference between policy and other control instruments is discussed.
Policy instruments have in the past been developed on national levels but this situation has changed. The membership in the EU meant that Sweden was opened up for policy decisions taken on an EU level. The global nature of the climate problem has further internationalized the range of policy instrument targeting GHG emissions. All policy instruments must however be adopted in the Swedish juridical system to enter into force. This is preceded by an inquiry that publishes their findings in Official Reports, which are adopted by the Government and presented to the Parliament as bills. A policy instrument cannot be introduced in the legislation before the bill has received approval.

**Figure 5.2 Structure of control instruments in Sweden**

The Swedish policy framework is subject to international influence through the KP (UNFCCC, 1997) that establishes a GHG emission commitment for Sweden as a Member State of the EU. This EU commitment of reducing the GHG emissions with -
8 %\textsuperscript{137} however does not affect Sweden directly as the EU have been assigned a joint KP commitment that the Member States have agreed to meet in cooperation according to a burden sharing agreement (European Council, 2002). Under this agreement Sweden is allowed to increase the emissions with +4 %. Sweden consequently has legally binding commitments both under the KP and the EU-ETS, where both are to be met through the latter.

Table 5.5 Classification of Swedish policy instruments\textsuperscript{138}

<table>
<thead>
<tr>
<th>Market Based</th>
<th>Non-market Based</th>
<th>Administrative</th>
<th>Informative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissions Trading</td>
<td>Taxes</td>
<td>Environmental Code</td>
<td>Labeling</td>
</tr>
<tr>
<td>Renewable Energy Certificates</td>
<td>Subsidies and Subventions</td>
<td>Municipal Energy Planning</td>
<td>Information Campaigns</td>
</tr>
<tr>
<td>Energy Efficiency Certificates</td>
<td>Voluntary Agreements</td>
<td></td>
<td>Research Funding</td>
</tr>
<tr>
<td></td>
<td>Investment Programmes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Technology Procurement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Policy instruments are divided into three groups; economic, administrative and informative. The first (1) group can be either market based or non-market based. The former group is favored in Sweden as considered more cost and control effective. Examples of market based instruments are emission trading and RECs. Non-market

\textsuperscript{137} All commitments refer to carbon dioxide equivalents and are due to be met during 2008-2012 compared to a 1990 baseline.

\textsuperscript{138} Energy Efficiency Certificates is the only policy instrument not yet implemented but included in the thesis. This is due to that the instrument is considered on an EU level.
based instruments are taxes, subventions, subsidies etc. The second (2) group are juridical instruments such as the Environmental Code. Policy instruments can be associated with more than one of these groups. The Programme for Energy Efficiency, for example, is administrative as well as economic. RECs are both market based as well as non-market based subvention. The last (3) group usually takes the form of information campaigns.

5.6.1 Control Instrument Characteristics

Instruments used to control the development of the Swedish energy system and emissions of carbon dioxide have different design characteristics. Those made above are quite general and this chapter aims to illuminate other characteristics that can vary between different instruments. These characteristics are not only important from a design perspective but also for how stakeholders view the instruments. It is by no means meant as the only way to categorize policies, as there are other characteristics and ways of combining them, to match different political and social sciences. As a consequence of the interview results, the focus in the thesis is on the time perspective, interaction, acceptance, dialogue and predictability characteristics.

![Figure 5.3 Control instrument design characteristics](image-url)
Goal

The goal, or aim, of an instrument is its general feature that governs many of the following characteristics. An instrument can have different goals, such as the carbon dioxide tax with the main goal to reduce emissions while also supporting the green tax-shift. This shows that policy instruments can have primary or secondary goals. This is also evident in the case of policy instruments promoting energy efficiency, with the aim to reduce carbon dioxide emissions and to improve the security of supply while at the same time reducing carbon dioxide emissions. Control instruments also differ regarding whether the goal is static or dynamic. Trading schemes are for example dynamic as they are designed to be strengthened over time by setting increasingly stringent goals.

The goal formulation in policies is also vital, which has become evident in the interviews where the Swedish national climate goal has received much critique. See Chapter 10.1 for a discussion on this subject.

Target Areas

Policy instruments have different target areas, or scopes, meaning that they can target one several areas in the society. The scopes that are focused on here are policy instruments targeting:

- Emissions of carbon dioxide
- Choice of energy carrier (e.g. wind, hydro, fossil fuels)
- Energy efficiency

Target Groups

Which target groups, or stakeholders, that a policy instrument is directed towards, is an essential part of the instrument design. In today’s global market, nations must combine the governing force of policy instruments – in this case targeting carbon
dioxide emissions and energy efficiency – with safeguarding the competitiveness of the domestic business sector and thus the national economy. The Swedish basic industry has been subjected to this set of problems for decades, but as a result of the Nordic and developing European energy markets it has also become an increasingly important issue also for the energy utilities. The energy utilities nevertheless have larger possibilities to transfer higher costs to the customers than is the case for the basic industry. This characteristic is consequently, due to harmonizing aspects, also a question of whether the policy instrument is implemented on a national or international level.

Instrument design can also differ, not only regarding what stakeholders it includes, but also in how they are included. An example of this is the allocation of emission rights in Sweden where, based on the 1990 baseline, the basic industry received emission rights for 100 % of their emissions compared to the energy utilities that received allocations for 80 % of the emissions during 2005-2007.

**Time Perspective**

This is one of the main topics of this thesis, as it is one of the most important characteristics in the design of a well-functioning policy framework. The reason for this is that companies in the basic industry and energy utilities have long payback times for plants and key investments and thus need long-term instruments for economic stability.

The time perspective of policy instruments can be viewed from different perspectives. Instruments such as taxes and laws are usually in force for longer periods than other instruments but this does not mean that the instruments are long-term if its design and rates are not. It can thus be argued that a policy instrument is not more long-term, or stable, than its amendment rate.
An important policy instrument characteristic for the business sector is the predictability of the instrument design, as this is essential for the business sector stakeholder’s possibility to adapt to changes in the design. The predictability is mostly discussed as relating to the long-term design perspective in the instrument designs. The characteristic however also relate strongly to the dialogue between the Government and the business sector, as an effective dialogue can help improving the instruments from this perspective.

The time perspective and predictability characteristics have been found to be of large concern to the interviewees and are consequently thoroughly analyzed in the summary of this chapter and in the end chapters, where also suggestions are given on how to improve instrument designs with regard to this issue.

Fiscal Effects

A policy instrument can, from a financial perspective, be internal or external to the Treasury. An internal instrument can be of two types, where one results in an income or expenditure to the Treasury, such as taxes and subsidies. Other internal instruments do not impose any monetary flows for the national budget, as the net flow is zero. External instruments such as the Environmental Code do not cause any other monetary flows than for its administration, which is the case for all administrative instruments. It should however be noted that the administration of all policy instruments incur some costs for the Government.

---

139 A Swedish example is of this type is the NO\textsubscript{x} fee that all energy utilities pay. The sum is then reimbursed to the utilities in relation to their emissions – a large production with small emissions result in large reimbursement creating a financial incitement to reduce emissions. As all fees are reimbursed the net sum for the Treasury is zero. No instruments analyzed in the thesis are of this type.
Administration

The administration of a policy instrument can be observed from a Governmental or corporate perspective. The administration can be divided into characteristics such as cost-effectiveness, time consumption and comprehensibility, all of which interrelate to how easy or difficult an instrument is to administer. Policy instruments differ largely in this aspect and Hillring (1998) have identified economic instruments as having positive administrational characteristics while the opposite is regarded for administrational instruments.

The cost-effectiveness of policy instruments is an important factor in its design and it is influenced by the other administrational factors.\textsuperscript{140} The cost-effectiveness can be viewed as how much of the financial flow of an instrument that supports its goal, for example how much of the REC value that is invested in new renewable energy production. It can also be seen as how much carbon dioxide emissions that are mitigated per economic entity, such as expenditure in the national budget or in companies’ turnovers. It should also be noticed that some instruments, such as RECs and emission trading, are meant to reduce the specific cost for emission reductions. Policy instruments promoting energy efficiency can have direct positive turnover effects for companies due to reducing the cost for energy. The cost-efficiency is also associated with the administrational time rate. New market based policy instruments generally have larger administrational requirements. This is however challenged by Crals and Vereeck (2005) who argue that emissions trading under specific conditions\textsuperscript{141} incur lower operational costs than environmental taxes.

\textsuperscript{140} For a discussion on the cost-effectiveness of Swedish climate policy instruments, see Swedish EPA (2003).

\textsuperscript{141} Specifying this as a large-scale, upstream monitored scheme with a brokered market and free allocations (Crals and Vereeck, 2005) – i.e. the conditions under which the EU-ETS work.
The *administrational time rate* of different instruments can be very different. Taxes require monitoring and submitting the emission data to the supervising authority. The Environmental Code and its approval process have received much critique for being too time-consuming incurring large costs as a consequence. Thomas Levander (2005) at the SEA identifies the submission of reports under various policy instruments as a significant problem for many stakeholders.

A characteristic that influences the above is the *comprehensibility* of an instrument. If it is too complex it reduces it effectiveness by requiring more work to administer, thus reducing its cost-effectiveness. In this perspective informative instruments are important in connection to the introduction of new non-informative policy instruments, as they can potentially increase the understanding and thus effectiveness of these instruments.

These three characteristics amount to the *administrative effectiveness* of an instrument, which includes the characteristics of the characteristics above. This aspect should be carefully analyzed as it has considerable implications for the stakeholder acceptance. One way of accomplishing this, is to analyze how much time that is expected to be required for the administration of the policy instrument in contrast to how much time that will be spent on actually improving the performance and reach compliance with the instrument goals.

**Interaction with other Instruments**

All policy instruments which are analyzed in this thesis include the aim to reduce carbon dioxide emissions, albeit some more directly than others. The fact that the instruments aim towards the same goal, place the issue of how they affect each other at the top of the design criterions. How different policy instruments interact and what synergies and/or sub-optimizations that occur as a result of this are one that further influences their effectiveness.
Goal Efficiency

Most characteristics sum up to the main issue of how effective the instruments are in reaching the desired goals and/or targets, such as reducing the utilization of fossil fuels, promoting renewable energy or energy efficiency. Due to the scope of the thesis this characteristic ultimately focuses on the efficiency of reducing carbon dioxide emissions.

Harmonization

An important aspect that determines the acceptance of a policy instrument is its harmonization level. This is for example highlighted by Göran Carlsson (2005) at SSAB, who identifies this as one of the most important issues in the policy instrument designs. As Thomas Levander (2005) at the SEA discusses, the business sectors are generally not reluctant to work with the climate change issue – risk management is part of their daily business – but they will criticize decisions that put them in a negative competitive situation. The business sector thus promotes instruments that are harmonized with regards to target and steering levels, stakeholder and sector groups as well as markets and countries.

This is an important aspect, highlighted by the interviewees, and discussed in relation to inter alia the allocation of emission rights.

Acceptance

The characteristics above all interact with each other and this forms the basis for stakeholder acceptance. Well-functioning and long-term instruments with a high level of efficiency are essential to achieve stakeholder acceptance. This, in turn, is essential to effectively steer the basic industry and energy utility sectors towards the established policy goals. No Swedish companies oppose the goal to mitigate climate change, but many are critical to the design of the different policy instruments and other elements of the policy framework.
This issue, being in the focus of the basic industries and energy utilities efforts to reduce carbon dioxide emissions, is consequently further discussed in the final chapters.

**Regulatory Strength**

Different policy instrument have varying compliance characteristics – some are guiding and some controlling. This is an important aspect of their design and also one that have large effects on the stakeholder acceptance of the implementation of the instrument. The business sector is naturally prone to be in favor of instruments that offer a larger element of flexibility than instruments that, for example, stipulate direct economic interventions or technology implementation. The reason for this being that the businesses then can allocate their efforts according to an individual agenda.

**Figure 5.4 Regulatory strength of policy instruments**

![Diagram showing the degree of compulsoriness with informative instruments on the left and financial disincentives on the right.](figure)

*Source: Based on Jaccard et al (2002)*

Informative instruments are associated with a minimal regulatory aspect and thus belong to the left side of the continuum in Figure 5.4. Somewhat stronger are voluntary agreements, such as the PFE, and financial incentives that may or may not have to be applied for. The ETSs and the REC scheme are found in the mid-range in the continuum, as these strongly stipulate quotas and commitments but not directly
how these shall be achieved. From this aspect the REC scheme can be argued to be stronger than the ETSs, due to the possibility to utilize the flexible mechanisms is the emissions trading. Taxes are argued as stronger than these two instruments as they are non-market based. Administrative instruments, also called control-and-command instruments, such as the Environmental Code is situated to the far right, as they strongly regulate conditions under which the businesses are allowed to operate, including strong compliance mechanism.

**Dialogue**

A final feature that is important for optimizing the above characteristics is the subject of stakeholder consultation in the design and reviews of policy instruments. The legislative procedure includes stakeholder consultation where the stakeholders can express their opinions on proposed legislative measures. This includes a wide range of stakeholders and, as discussed, the basic industry and energy utilities often rely on the sector organizations in this process. The effort to accumulate stakeholder opinions can increase policy instrument efficiency by improving stakeholder acceptance and reduce the need for future amendments.

*This subject was one of the topics in the stakeholder interviews and is considered to be of importance for the long-term perspective that is considered essential in the thesis.*

### 5.7 Summary

Both Sweden and the EU have declared sustainable development as the overall policy and have established ambitions climate and energy policy goals. The main purposes of these goals are to increase the security of energy supply, reduce environmental impact and to reduce the GHG emissions of in order to mitigate climate change. The Swedish Government has decided not to adopt the commitments under the KP, according to the EU burden sharing agreement, as the short-term
climate goal to 2012. The goal is instead of +4 %, established as -4 %. In the longer term the Swedish climate goals may be guided by the EU agenda that is promoting GHG emission reductions of -20 % by 2020. In an energy context, a number of national and EU goals on energy efficiency and RES – overall and specifically for wind power – has been established. This establishes a comprehensive agenda on the climate and energy policy areas. As many of the goals are indicative and not associated with compliance mechanisms, the agenda must however to a large extent be seen as a vision.

The set of policy instruments that is used to accomplish the political agenda are associated with a number of design characteristics. These characteristics, in combination, decide the efficiency of the individual policy instruments and the policy framework overall. Two of the most important aspects in the designs are that the instruments are harmonized and associated with a time perspective that is similar to the timeframes used in the business sectors investment calculi. The time perspective should also pay attention the policy goals in the overall framework. This is, for example, emphasized by EU decisions, where a stronger climate goal is justified only if associated with a long-term and international climate regime. The following chapters argue that short-term policies are inefficient in providing incentives for large-scale investments and technology development.

As a result of the continuous development of EU policies, the EU agenda has increasingly stronger influence on the Swedish policy framework. The agenda point to a development in the medium-term future where the EU-ETS will be a constant feature in the climate policies. This will include a broadening of the scheme, with respect to both included gases and activities. Subsidies to non-RES will be phased-out and additional support for RES will be implemented if the RES-goal is not reached. An EEC scheme is likely to be introduced if the promoted energy efficiency development is not accomplished.
The possibility to move forward with a progressive climate agenda is undermined by uncertainties on the development of a post-2012 international GHG emissions regime. This limitation does not exist in an energy context, where the security of supply provides sufficient support for both strong RES and energy efficiency targets.

The effectiveness of the current climate and energy framework is limited, as the Government has failed to provide a stable framework with clear and reasonable policy goals and instruments that provide stable economic incentives. The following analysis of the individual policy instruments will point to a number of problems and possibilities in the design characteristics that affects the efficiency of the implemented policy framework.
6. Market Based Economic Instruments

Market based economic policy instruments targeting GHG emissions are currently in the international limelight of policy makers. The reasons are that the international emissions right trading has put them in the centre of attention and that they are regarded as effective from an economic perspective. Instruments of this group are favorable when implementing policy schemes on multinational levels, as their characteristics makes them relatively easy to harmonize to national differences. One characteristic that differ them from non-market based economic instruments is that they are designed to allow for the market to allocate the emission mitigation resources to the areas where it will be most effective. Another characteristic is that they are subject to market fluctuations as they use tradable entities. A difficulty is that they require the establishment of new markets that due to their novelty may be difficult to predict, making the effects of the instrument unclear. Another issue is that they, due to the market aspects are susceptible to interaction with other instruments. An example is that the price of Renewable Energy Certificates (RECs) can be
expected to decrease when the electricity price rises due to emissions trading, resulting from reduced support requirements. Similar unpredicted effects can in the short term reduce investments in environmental projects and other climate efforts due to uncertainty of the emission rights and REC market. This implies that it is favorable to adopt a “one-goal-one-instrument” approach to reduce these effects. It also implies that expanded systems, with larger markets, are more predictable which increases policy stability.

The market based economic policy instruments that is currently in use in Sweden are the EU-ETS and the REC scheme. Sweden has ratified the KP and will consequently be a Party to the Protocol during its first commitment period 2008-2012. The EU is also analyzing the possibilities of introducing an EU-wide Energy Efficiency Certificates (EEC) scheme to support the EU energy efficiency goals.

This chapter starts by outlining different important aspects of general emissions trading systems, which is followed by analyses of the two main schemes, i.e. the KP and EU-ETS. Thereafter follows analyses of REC and EEC scheme characteristics.

### 6.1 Emission Trading Schemes

The concept of emission trading was brought to the top of the international climate agenda by the UN Framework Convention on Climate Change (UNFCCC) in 1992 and by the adoption of its subsequent Kyoto Protocol (KP) in 1997. The central parts of the ETSs are flexible mechanisms that aim to improve the cost-effectiveness of emission reductions, based on the fact that GHG emission is a global issue. Stakeholders included in the ETSs can utilize the mechanisms to trade emission rights and perform emission reduction projects in developed and developing nations in exchange for additional emission rights.
The EU negotiated a common cap for all Member States under the KP and therefore designed an EU Emission Trading Scheme (EU-ETS) that is aimed to meet the EU commitments. The EU-ETS is currently undergoing a first commitment and test period (2005-2007) and both schemes will operate with a common commitment period in 2008-2012. While the emission reductions targeted by the initial commitments under the KP and EU-ETS are not nearly as substantial as required in a longer perspective, both schemes are designed with the intention that the commitments shall be continuously strengthened.

In the Swedish case, the EU-ETS and its design is of closer importance than the KP, since it is under the EU scheme that Sweden need to comply with their KP emission commitments. The KP is of interest as it works as a framework for the EU-ETS, and largely dictates the future of emissions trading. The EU-ETS also have a clearer future after 2012 The European Parliament for example promotes that the EU-ETS should run for 20 years (EP, 2006a). The EU Member States has also shown a much greater will to cooperate and reconcile on the details of the ETS design than has been the case in the negotiations on the KP and related post-2012 agreements.

The two large schemes are very similar in design, as a consequence of the EU designing the EU-ETS to comply with the KP if and when it entered into force. Both schemes are cap-and-trade systems, meaning that a total emission volume for the participating parties – for the overall system and for every nation – is agreed on. The national volume, or cap, is the base for the governmental allocation of emissions rights to national stakeholders. At the end of annual commitment periods the stakeholders and nations included in the ETS are forced to hold and surrender emission rights that correspond to their emission volume.

Since the KP and EU-ETS are similar in designs, some aspects of the schemes – stakeholders, different emission rights and flexible mechanisms – are explained before the two schemes are presented in detail separately. The EU-ETS is analyzed
more in detail as it is under this scheme that Swedish basic industries and energy utilities primarily will act to meet their commitments.

Apart from the KP and EU-ETS a number of smaller trading schemes that focus on different emissions exists in different institutional settings for example countries, regions/states and companies. Corporate trading can be implemented at different levels to meet the obligations according to larger scale schemes at a lower cost. This method is for example put into practice at the interviewed stakeholders Fortum Värme (Käck, 2005) and SSAB (Carlsson, 2005).

The scientific analyses of emissions trading are abundant and the general consensus is that the instrument holds a key importance in a successful abatement of climate change and GHG emissions. Economic theory also indicates that ETSs have near perfect cost-efficiency characteristics. The main difficulty of the instrument is however to design a scheme with a high level of equity between sectors and regions. This issue is in many aspects related to the allocation procedure, as this sets the individual targets and strongly affects the economic implications for the included countries and stakeholders.

The analysis of the ETSs includes minor repetitions of information. The reasons are that the schemes are complex and interact. The repetitions are an attempt to clarify these relationships and provide an easier understanding of the scheme designs.

6.1.1 Stakeholders under the KP and EU-ETS

The UNFCCC categorize countries based on its Annex I, where Annex I countries have binding emission commitments under the KP and can utilize the flexible mechanisms to meet these commitments. The categorization also defines between which countries that the project-based flexible mechanisms (Chapter 6.1.3) can be
realized. The KP defines the UNFCCC Annex I countries together with their emission commitments in the protocol’s Annex B.

The EU-25 Member States, which are parties under the EU-ETS, are all Annex I countries. All EU Member States thus have commitments under the KP. The commitments are however based on internal emission commitments under the EU-ETS, resulting from EU negotiations on behalf of all Member States at the Kyoto proceedings. Thus, Sweden is an Annex I country under the UNFCCC and obliged to fulfill its commitments under the KP, as established in the Annex B, through the EU-ETS.

A difference between the two schemes is that the EU Emissions Trading Directive (2003/87/EC) clearly defines a Trading Sector. The KP (UNFCCC, 1997) only exemplifies sectors that emits GHGs, but does not mention that those have special commitments under the protocol.

6.1.2 Emission Rights

The KP and EU-ETS have established five different emission rights (Table 6.1). The main emission rights are the KP’s Assigned Amount Units (AAUs). As the KP is not fully operational until 2008, the main emission right commodity at present is the EU Emissions Allowances (EUAs), which are used for compliance under the EU-ETS. During 2008-2012 when both schemes operate the EU will exchange the AAUs rights to EUAs. The common value for all these commodities is one (1) ton of carbon dioxide equivalents.

All emission rights are associated with a specific year, since the emission quotas and verified emission levels are validated and surrendered per year. Emission rights can be banked as to enhance the flexibility of the ETSs, but different rules apply to the different emission rights. The EU Linking Directive (2004/101/EC) allows for the use
of ERUs and CERs within the EU-ETS, but also includes that the Member States can limit how these are accounted for towards the emission target.

Table 6.1 Different emission rights units in KP and EU-ETS

<table>
<thead>
<tr>
<th>Emission Rights</th>
<th>Characteristics</th>
<th>Banking regulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAU <strong>Assigned Amount Unit</strong></td>
<td>Allocated to the KP Annex B countries corresponding to the individual commitments</td>
<td>No regulation</td>
</tr>
<tr>
<td><strong>ERU Emission Reduction Unit</strong></td>
<td>Emission rights originating from JI projects</td>
<td>Up to 2.5% of total AAUs together with CERs according to KP</td>
</tr>
<tr>
<td><strong>CER Certified Emission Reduction</strong></td>
<td>Emission rights originating from CDM projects</td>
<td>Up to 2.5% of total AAUs together with ERUs according to KP. Bankable between EU commitment periods.</td>
</tr>
<tr>
<td><strong>RMU Removal Unit</strong></td>
<td>Created through carbon sinks in agricultural management in Annex B countries</td>
<td>Not saveable</td>
</tr>
<tr>
<td><strong>EUA EU Emissions Allowance</strong></td>
<td>Allocated emission allowances within the EU-ETS (converted from AAUs allocated to the EU)</td>
<td>Bankable between 2005-2007 and 2008-2012 only if allowed according to national rules</td>
</tr>
</tbody>
</table>

Source: SEA and Swedish EPA, 2004c

Applying banking rules on the project-based mechanisms are meant to enforce a rule, adopted through the KP Marrakesh Accords (UNFCCC, 2001a, 2001b), that utilizing the schemes shall be supplementary to domestic measures to reduce emissions. The EU does not allow for emission rights, except for CERs, to be banked between the 2005-2007 and 2008-2012 period (EC, 2004b). In later commitment

---

142 Except for ERUs and CERs originating from land use, land-use change and forestry activities (LULUCF).
143 According to decisions 16/CP.7 (UNFCCC, 2001b) and 17/CP.7 (UNFCCC, 2001a).
periods banking is however allowed according to Commission regulations on Trading Directive registries (ibid). In the case of allowed banking, the cost-efficiency of the ETS is increased due to a higher rate of flexibility, and consequently the absence thereof reduces the efficiency due to inefficient allocations of abatement measures (Schleich et al, 2006). This effect is increased in respect of the amount of countries that allow banking or not. Stephan and Müller-Fürstenberger (2004) identifies that countries with a tighter carbon budget may gain from increased banking flexibility, while negative effects may arise in countries with high initial allocations. The effects of increased banking possibilities should in the Swedish Trading Sector case mean that the compliance costs would decrease, while potentially also alleviating the effects of the national climate goal.

There have been discussions on the influence of the large amounts of surplus AAUs that are available in Eastern Europe a result of an economic recession since the 1990 baseline. The purchase and use of these AAUs are referred to as “hot-air reductions”, as they do not include any real emission reductions in present time. This discussion is however not of importance under the scope of the thesis as the qualities of different emission rights are analyzed.

6.1.3 Flexible Mechanisms

The three flexible mechanisms in Table 6.2 form the backbone of the trading schemes, where trading with emission allowances is the main mechanism. The use of the project-based mechanisms may be a more feasible solution – a situation that is strengthened as the price and scarcity of emission rights is increased – but is limited.

---

144 According to Section 7, Article 61.
Table 6.2 The Kyoto Protocol flexible mechanisms

<table>
<thead>
<tr>
<th>Flexible Mechanism</th>
<th>Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissions Trading</td>
<td>Emissions Trading allows for Parties to use trading with emission rights to comply with the KP emission commitments. The trading must be supplemental to domestic measures aimed at reaching these commitments.</td>
</tr>
<tr>
<td>Joint Implementation (JI)</td>
<td>The JI mechanism allows for Annex I Parties under the KP to perform emission reducing projects in other Annex I Parties, in return for Emission Reduction Units (ERUs).</td>
</tr>
<tr>
<td>Clean Development Mechanism (CDM)</td>
<td>The CDM is designed to assist Annex I Parties under the KP to comply with their emission commitments and non-Annex I Parties with sustainable development through performing emission reducing projects in non-Annex I countries, for which they will receive Certified Emission Rights (CERs).</td>
</tr>
</tbody>
</table>

Source: UNFCCC, 1997

In the utilization of the JI, AAUs are subtracted from the Party where the project is carried out, and transferred to the acquiring Party as ERUs. The JI consequently does not affect the net volume of emission rights within the system. The CDM can be utilized by both Annex I stakeholders that wish to acquire emission rights, as well as by non-Annex I stakeholders to improve the feasibility of projects resulting in emission reductions. In the case of the CDM, no AAUs can be subtracted from the non-Annex I Party and CERs are issued to the host Party. The CERs and ERUs are divided among the project participants according to project agreements. The CDM thus increases the total amount of emission rights within the schemes.

Through amending the EU Emissions Trading Directive, the Linking Directive (2004/101/EC) establishes that all ERUs and CERs that are issued may be used in
The EU-ETS exchange ERUs and CERs for EUAs by the national registry supervisor. The exchange of emission rights helps avoiding double accounting of emission reductions resulting from the flexible mechanisms.

The Linking Directive also establishes that the Member States shall define in their NAPs to what extent the use of the project-based flexible mechanisms is allowed considering the supplementary principle. No limitations for the Trading Sector were however mentioned in the Swedish NAP1 (MIEC, 2004) or the laws governing the emissions trading (SFS 2004:1199, 2004:1205). In the later Commission guidelines (COM(2005) 703 final) for the 2008-2012 NAPs, the issue was highlighted. The 2006 Emissions Trading Bill (2005/06:184), outlining the Swedish NAP2, responded to this and set the limitation of the ERUs and CERs use to 20 % of the total allocation. In the Commission review of the NAPs for the second commitment period however demanded that the allowed 20 % use of CDM and JI is cut back to 10 % (EC, 2006b). This should establish a precedential case, declaring 10 % as the maximum allowed level. The SEA and Swedish EPA (2006b) promotes the possibility for a high utilization of CDM and JI, as this can reduce the price of emission rights in the EU-ETS and consequently also the EUA impact on the electricity price.

The 2006 Emissions Trading Bill supports that the national target of reducing the GHG emissions with -4 % to 2012 shall be met without the use of flexible mechanisms. The Government nevertheless supports the use of the project based mechanisms for several reasons, as exemplified by the SEA and Swedish EPA (2004a):

- Well functioning flexible mechanisms are essential for the continuing international climate change mitigation regimes, as they are important for
  
  _inter alia_ long-term international commitments after 2012

- They achieve emission reductions at low costs
- They generate relations with host countries
- They induce environmental awareness in host countries

The Government has however not been effective in promoting their utilization which is foremost due to the design of the national short-term GHG emissions target and that the Linking Directive and that the legislation on the allowed use of the project-based mechanisms was postponed.

On an EU level there have been fears that a too large utilization of the project-based flexible mechanisms could mean that the supplementary requirements stipulated by the KP Marrakech Accords (UNFCCC, 2001a, 2001b) are not met and that additional environmental benefits from carbon dioxide emission reductions, such as lower sulphur emissions, are not realized. Due to this and that the CDM could flood the carbon market with CERs and disrupt the market conditions the Commission has suggested that a review of the situation should be triggered as the EU use of ERUs and CERs reaches 6 % (COM(2003) 403 final).

The Government has funded a Swedish International Climate Investment Programme (SICLIP), which is aimed at generating know-how on the use of the project-based mechanisms and to contribute with this knowledge on the international arena. Within the programme both CDM and JI projects have been selected for realization.

### 6.1.4 Allocation of Emission Rights

The allocation of emission rights can be carried out according to different procedures. The goal of all procedures is to provide a fair and uncomplicated allocation, but this is difficult to accomplish. Several aspects make the allocation procedure one of the main issues in the ETSs, while also having strong implications for other instruments. One of the main aspects of the allocation procedure is that
stakeholders within the scheme are affected differently. It is thus difficult to accommodate a procedure that is both fair and uncomplicated. The 2006 Emissions Trading Bill (2005/06:184) therefore supports that the allocation procedure could be adapted for different sectors, through a sector approach.

An important aspect of the allocation process is whether the emission rights should be allocated for free or through auctioning. Which of the two that is used, has very large impact for how the ETS works as well as how the policy instrument is viewed from a macro-economic perspective. If auctioning is used, the ETS can result in very large fiscal incomes and potentially adding to competitive disadvantages for the included operations. The EU-ETS (2003/87/EC) regulates the allocations from this aspect by stipulating that a minimum of 95 % of the allocations shall be free in the NAP1 and minimum 90 % in the NAP2. The European Council (2007b) acknowledges these issues and has consequently declared that the EU-ETS should be improved in light of these aspects.

The allocation methods are briefly described below for the understanding of the chapter. The issue is discussed in detail in Chapter 10.3 as an essential issue in the policy framework.

**Grandfathering**

Allocation procedures that base the allocation volume and quota on historical emissions during a chosen base year are called grandfathering. In a country, such as Sweden, with a large share of electricity production from hydropower, yearly emission volumes fluctuate from dry to wet years depending on corresponding fluctuations in hydropower production and carbon dioxide emissions (Chapter 3.7). Grandfathering allocations are also sensitive to the temperature profiles of the selected base years as well as during the commitment periods. These characteristics must be taken into account throughout the allocation process – EU in relation to Sweden as well as Sweden in relation to the national Trading Sector.
Benchmarking

Benchmarking establishes the allocations with respect to included operation’s emissions compared to an established point of reference. How the benchmark is established allows for a larger degree of flexibility than with grandfathering, as it can include various sector characteristics, such as mean emissions of carbon dioxide. Benchmarking has the potential to benefit operations that have low specific emissions as well as to provide a more just treatment of operations that has taken early actions in reducing emissions. A difficulty is how to establish a fair benchmark, making the procedure suitable only for some sectors.

6.1.5 Kyoto Protocol

The Kyoto Protocol\textsuperscript{145} (KP) establish that the emissions of the Annex I countries shall be reduced with at least 5\% below 1990 levels, calculated as carbon dioxide equivalents, during the first commitment period 2008-2012. To enter into force, the KP required the ratification of 55 Parties of the Convention, accounting for at least 55 \% of the 1990 carbon dioxide emissions of the Parties in the Convention’s Annex I. After a period of uncertainty whether the Protocol would be ratified, it entered into force in 2005, following the Russian ratification. The KP currently has 169 Parties, of which 31 Parties have emission commitments that account for 61.6\% of the total carbon dioxide emission volume that is subject to reduction targets.\textsuperscript{146}

The KP’s governing body, the Conference of the Parties serving as the Meeting of the Parties (COP/MOP), is made up of the countries that have ratified the Protocol. In the COP/MOP the EU-25 have private sessions where common negotiating positions

\textsuperscript{145} The full name is the Kyoto Protocol to the United Nations Framework Convention on Climate Change.

\textsuperscript{146} Data as of 13 December 2006. For continuously updated information see http://unfccc.int.
are agreed on, which are presented to the larger assembly by the country that holds the EU Presidency.

Table 6.3 Sectors and sources included in the Kyoto Protocol’s Annex A

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>Fuel combustion</td>
</tr>
<tr>
<td></td>
<td>- Energy industries</td>
</tr>
<tr>
<td></td>
<td>- Manufacturing industries and construction</td>
</tr>
<tr>
<td></td>
<td>- Transport</td>
</tr>
<tr>
<td></td>
<td>- Other sectors</td>
</tr>
<tr>
<td></td>
<td>- Other</td>
</tr>
<tr>
<td></td>
<td>Fugitive emissions from fuels</td>
</tr>
<tr>
<td></td>
<td>- Solid fuels</td>
</tr>
<tr>
<td></td>
<td>- Oil and natural gas</td>
</tr>
<tr>
<td></td>
<td>- Other</td>
</tr>
<tr>
<td>Industrial processes</td>
<td>Mineral products</td>
</tr>
<tr>
<td></td>
<td>Chemical industry</td>
</tr>
<tr>
<td></td>
<td>Metal production</td>
</tr>
<tr>
<td></td>
<td>Other production</td>
</tr>
<tr>
<td></td>
<td>Production of halocarbons and sulphur hexafluoride</td>
</tr>
<tr>
<td></td>
<td>Consumption of halocarbons and sulphur hexafluoride</td>
</tr>
<tr>
<td></td>
<td>Other</td>
</tr>
<tr>
<td>Agriculture</td>
<td>Enteric fermentation</td>
</tr>
<tr>
<td></td>
<td>Manure management</td>
</tr>
<tr>
<td></td>
<td>Rice cultivation</td>
</tr>
<tr>
<td></td>
<td>Agricultural soils</td>
</tr>
<tr>
<td></td>
<td>Prescribed burning of savannas</td>
</tr>
<tr>
<td></td>
<td>Field burning of agricultural residues</td>
</tr>
<tr>
<td></td>
<td>Other</td>
</tr>
<tr>
<td>Waste</td>
<td>Solid waste disposal on land</td>
</tr>
<tr>
<td></td>
<td>Wastewater handling</td>
</tr>
<tr>
<td></td>
<td>Waste incineration</td>
</tr>
<tr>
<td></td>
<td>Other</td>
</tr>
<tr>
<td>Solvent and other product use</td>
<td></td>
</tr>
</tbody>
</table>

*Source: UN, 1992*

Annex A of the KP includes a number of sectors (Table 6.3) which are mentioned as *example areas* where efforts to mitigate climate change shall be taken. It should however be noticed that these sectors and sources are not referred to in the protocol.
text as prioritized due to their inclusion in the Annex A. The Annex A also states which GHGs (Table 6.4) that are included in the emissions cap.

Table 6.4 Greenhouse gases included in the Kyoto Protocol’s Annex A

<table>
<thead>
<tr>
<th>Carbon dioxide (CO$_2$)</th>
<th>Hydrofluorocarbons (HFCs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane (CH$_4$)</td>
<td>Perfluorocarbons (PFCs)</td>
</tr>
<tr>
<td>Nitrous oxide (N$_2$O)</td>
<td>Sulphur hexafluoride (SF)</td>
</tr>
</tbody>
</table>

*Source: UN, 1992*

The Article 2 of the KP state that all parties included in the Annex I shall perform a number of activities in order to promote sustainable development and in achieving the quantified emission limitations and reduction commitments. The Article enumerates examples of policies and measures that shall be implemented and/or further elaborated by the Parties in accordance with national circumstances (Table 6.5).
Table 6.5 Policy measures promoted by the Kyoto Protocol

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhancement of energy efficiency in relevant sectors of the national economy</td>
<td>Progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the UNFCCC and application of market instruments</td>
</tr>
<tr>
<td>Protection and enhancement of sinks and reservoirs of greenhouse gases not controlled by the Montreal Protocol, taking into account its commitments under relevant international environmental agreements; promotion of sustainable forest management practices, afforestation and reforestation</td>
<td>Encouragement of appropriate reforms in relevant sectors aimed at promoting policies and measures which limit or reduce emissions of greenhouse gases not controlled by the Montreal Protocol</td>
</tr>
<tr>
<td>Promotion of sustainable forms of agriculture in light of climate change considerations</td>
<td>Measures to limit and/or reduce emissions of GHGs not controlled by the Montreal Protocol in the transport sector</td>
</tr>
<tr>
<td>Research on, and promotion, development and increased use of, new and renewable forms of energy, of carbon dioxide sequestration technologies and of advanced and innovative environmentally sound technologies</td>
<td>Limitation and/or reduction of methane emissions through recovery and use in waste management, as well as in the production, transport and distribution of energy</td>
</tr>
</tbody>
</table>

Source: UN, 1992 (Article 2)

The KP includes compliance rules, adopted at the COP/MOP 1, where countries that do not meet their commitments under the protocol can be excluded from the use of the three flexible mechanisms. In a case where a country does not meet their emission commitments, the compliance committee can subtract allocations for the next commitment period with a value of 1.3 times the additional emission volume.

The KP has been criticized for having set too low emission reduction targets and thus not being an effective instrument in attaining the required reductions of global GHG emissions that is called for by the IPCC. A major issue for the KP is the reluctance of the United States to ratify the Protocol in its current design. Among others, these two issues pose a serious problem for the KP to achieve continuing emission reductions and strengthen the international community’s efforts to mitigate climate change. The KP system has also failed in installing and operating important functions for the
operation of the scheme. The International Transaction Log that shall monitor the movement of emission rights has not been installed, meaning that issued CERs cannot be delivered to the project participants – a strong impediment for an effective use and promotion of the CDM.

The negotiations on the continuance of the KP were officially initiated in conjunction with the first COP/MOP in Montreal, Canada, in end-2005. In connection to the COP/MOP 1 the public debate on climate change was intense and some expressed confidence in the KP while others doubted a continuance after 2012. Some Swedish voices were Anders Wijkman (2005), who called for a pragmatic approach in the upcoming meeting about the future of the UNFCCC and KP, and Sweden’s Chief negotiator on climate issues Anders Turesson (2005) that considered that the cost of establishing the KP is too great to surrender. The future of the KP is however unclear and it remains to be seen if further commitment periods are realized, and in that case, if the Protocol is amended. The conference also formally adopted the Marrakesh Accords (UNFCCC, 2001a, 2001b), installed a compliance body and agreed on the rules for the Joint Implementation mechanism.

In November 2006 the COP/MOP 2 was held in Nairobi, Kenya. The main issue at hand was to continue COP/MOP 1 discussions on a post-2012 regime. Other issues were third countries’ adaptation to climate change, how additional countries could self-assume emission targets under the KP, the geographical distribution of CDM projects and the importance of avoided deforestation. The main outcome, to conclude a review of the KP by 2008, makes the success of the conference very modest. Prompt and firm decisions on post-2012 commitments and targets are required to promote action on combating climate change through facilitating and upholding a well-functioning and long-term carbon market that can enable large-scale emission reductions.
6.1.6 EU-ETS

The EU Emission Trading Scheme (EU-ETS) entered into force in January 2005, as the world’s first operational multilateral and multi-sectoral ETS, including some 7,300 companies and 12,000 installations in the first phase. The Emissions Trading Directive (2003/87/EC) was adopted to implement the EU-ETS as an internal tool to meet the KP commitments of reduced GHG emissions by -8 % to 2012. The EU-10 countries are linked to the scheme but have individual emission commitments. The EU-ETS is for harmonizing reasons designed to be compatible with the KP and observe changes thereof. The second commitment period is the same as for the KP but the EU decided to start the internal ETS with a first test phase 2005-2007. This decision was taken to promote emission trading, through taking on a progressive position in the international climate work, as well as to prepare authorities and businesses on the functionality of the schemes. This was considered important by the EU, as the ETS concept had not been tried on such large scale before. The first phase is also meant to show if the planned design of the EU-ETS is sufficient to reach the EU emissions commitment. The scheme is considered by the EU to have the potential to approximately halve the cost for the Member States to reach the KP commitments at around 0.1% of the total GDP (EC, 2005a).\textsuperscript{147}

The KP negotiating body within the EU is the Working Group on International Environmental Issues Climate Change (WPIE/CC)\textsuperscript{148}, which works under the Environment Council. The WPIE/CC is represented by all Member States and the Swedish representative is been the chief climate negotiator Anders Turesson. The WPIE/CC hosts a number of expert groups on \textit{inter alia} reporting, flexible mechanisms, carbon sinks, future development, legal aspects and research. These \textsuperscript{147} 2.9-3.7 Billion Euro annually instead of 6.8 billion Euro with the scheme (EC, 2005a).
\textsuperscript{148} The WPIE/CC is referred to as the EU Working Unit at the COPs and COP/MOPs.
groups are represented by concerned institutions in the Member States, which in the Swedish case are the SEA, Swedish EPA and ministries.

The EU commitment under the KP is allocated to the Member States as EU Emissions Allowances (EUAs) through a burden sharing agreement (European Council, 2002). The Member States are obliged to comply with the conditions in this agreement through transferring their EUAs to the Trading Sector (Table 6.6).

Table 6.6 Operations included in the EU-ETS

<table>
<thead>
<tr>
<th>Operations</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy activities</td>
<td>Combustion installations with a rated thermal input exceeding 20 MW (except hazardous or municipal waste installations)</td>
</tr>
<tr>
<td></td>
<td>Mineral oil refineries</td>
</tr>
<tr>
<td></td>
<td>Coke oven installations</td>
</tr>
<tr>
<td>Production and processing of ferrous metals</td>
<td>Metal ore (including sulphide ore) roasting or sintering installations</td>
</tr>
<tr>
<td></td>
<td>Installations for the production of pig iron or steel (primary or secondary fusion) including continuous casting, with a capacity exceeding 2.5 tonnes per hour</td>
</tr>
<tr>
<td>Mineral industry</td>
<td>Installations for the production of cement clinker in rotary kilns with a production capacity exceeding 500 tonnes per day or lime in rotary kilns with a production capacity exceeding 50 tonnes per day or in other furnaces with a production capacity exceeding 50 tonnes per day</td>
</tr>
<tr>
<td></td>
<td>Installations for the manufacture of glass including glass fibre with a melting capacity exceeding 20 tonnes per day</td>
</tr>
<tr>
<td></td>
<td>Installations for the manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain, with a production capacity exceeding 75 tonnes per day, and/or with a kiln capacity</td>
</tr>
<tr>
<td>Other activities</td>
<td>Industrial plants for the production of pulp from timber or other fibrous materials and paper and board with a production capacity exceeding 20 tonnes per day</td>
</tr>
</tbody>
</table>

Source: Directive 2003/87/EC
In its first phase, the EU-ETS only includes carbon dioxide emissions from the included operations.\textsuperscript{149} The Directive however includes all six major GHGs, which are mentioned in the KP, and upcoming decisions will decide whether these will be included in post-2012 commitment periods (see below).

**The Emissions Trading Directive**

The Emissions Trading Directive (2003/87/EC) does not regulate how the EUAs shall be traded or who that can participate in the trading and therefore all persons and stakeholders can participate in the trading. National authorities are responsible for supplying emission rights accounts to the Trading Sector and other actors that wish to trade. In the Swedish case, this responsibility is put on the SEA. The SEA shall report all transactions to a Central Administrator, responsible for the Community Independent Transaction Log (CITL) that keeps records of the transactions of EUAs within the EU. The CITL will also work towards the KP’s ITL when it becomes operational. All registries will be electronic, meaning that no allowances will be printed.

The Emissions Trading Directive’s Article 25 includes the possibility of linking the EU-ETS to other ETSs and discussions have been held with, for example, Norway, Canada and some individual states in the United States, on participation in the scheme. Countries included in the EEA are free to accede to the Trading Scheme. An IEA report (Blyth and Bosi, 2004), analyzing the connection of EU-ETS to other schemes and countries, has found that such a development would increase the economic efficiency of the scheme if the marginal abatement costs for GHG emission reductions is increased. The report highlights that this would require negotiations for

\textsuperscript{149} All UNFCCC GHGs (Table 6.4) are however indirectly included through the Linking Directive (2004/101/EC) supporting the utilization of the two project based flexible mechanisms CDM and JI that target all GHGs.
harmonizing for example scope, trading units, target definitions, allocation, banking and compliance. This is however no different than is the case under the KP or any other multilateral agreement.

**Allocation Procedure**

Member States shall submit NAPs that corresponds to the respective state’s emission commitments under the Burden Sharing Agreement (European Council, 2002). The allocation of the EUAs is governed by Article 9-11 and Annex III in the Emissions Trading Directive. According to Article 9 future NAPs shall be submitted to the Commission no later than 18 months before the commitment period begins, that is 30 June 2006 for the second commitment period, with due consideration taken to public comments. Article 10 settles that a minimum of 95% of the emission rights shall be allocated free of charge in the first phase and a minimum of 90% in second phase 2008-2012. Article 11 establishes that the NAPs shall be adopted in the Member States, 12 months prior to the commitment period start and that new entrants shall be considered in this process. A just and harmonized allocation procedure is one of the most complicated aspects of an ETS and the difficulties are therefore discussed in Chapter 10.3.

The Swedish NAP1 (MIEC, 2004) was submitted to the EU based on the decree about emissions of carbon dioxide (SFS 2004:657)\(^{150}\), which governs the Swedish allocation of emission rights. Sweden decided to allocate 100% of the emission rights 2005-2007 at no cost, as not to cause allocation difficulties. The allocations are based on the mean emission during 1998-2001. Decisions on the allocation of Swedish emission rights are prepared by a council consisting of the Swedish EPA, the SEA and NUTEK. The NAP was unconditionally accepted.

\(^{150}\) Replaced with SFS 2004:1205 but was valid for applications submitted before 31 December 2004.
Table 6.7 Number of Swedish operations included in the NAP2 (2008-2012)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustion installations</td>
<td>611</td>
</tr>
<tr>
<td>– electricity and heat utilities</td>
<td>507</td>
</tr>
<tr>
<td>– industry</td>
<td>104</td>
</tr>
<tr>
<td>Mineral oil refineries</td>
<td>5</td>
</tr>
<tr>
<td>Iron and steel industry</td>
<td>18</td>
</tr>
<tr>
<td>– roasting and sintering of iron ore</td>
<td>3</td>
</tr>
<tr>
<td>– production of iron and steel</td>
<td>15</td>
</tr>
<tr>
<td>Mineral industry</td>
<td>20</td>
</tr>
<tr>
<td>Pulp and paper industry</td>
<td>58</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td><strong>712</strong></td>
</tr>
</tbody>
</table>

Source: Bill 2005/06:184 (As of 31 December 2005)

The allocation to the energy utilities are reduced to 80% while the other industries have received 100% coverage (SFS 2004:1205). The reason for scaling down the allocation of emission rights to the utilities is that the Swedish NAP1 (MIEC, 2004) establishes that the potential for reducing the emissions is larger in the utility sector than in the basic industries. Sweden has through the Law on Emissions Trading (SFS 2004:1199) chosen to utilize the opportunity within the EU-ETS to opt-in small combustion installations. This applies to installations smaller than 20 MW if they are included in a district heating system that exceeds this effect. This was chosen as not to create different conditions for the operations in a common system or investments in installations below the 20 MW limit (Bill 2005/06:184).
The guidelines from the Commission (COM(2005) 703 final) on the new NAPs included the possibility to use national benchmarking allocations. The Government has chosen to utilize this opportunity during the 2008-2012 period for the ore-based steel production and new entrants (Ministry of Sustainable Development, 2006b). The other Trading Sectors will be allocated emission rights on the same criteria as the previous NAP1. The majority of the Swedish allocations for the second period will be free of charge (Bill 2005/06:184).

The European Commission has indicated that the EU emissions cap may be tightened with 6%, compared to the 2005-2007 period, through tighter allocations in Member States that are distant from achieving their national targets (EC, 2006c). Together with several other Member States, Sweden has been issued a request for cutting the allocated volume of emission rights by the European Commission (EC, 2006b). As the EU-ETS is undergoing a review focusing on inter alia harmonized allocations it is possible that the allocation processes may be amended for upcoming commitment periods.

Energy Utilities and Windfall Profits within ETSs

An issue related to the allocation process is the critique towards the energy utilities and how they are presently included in the EU-ETS. When the energy utilities are included on the same conditions as other stakeholders, it results in a marginal electricity tariff, due to the marginal price setting that is currently praxis on the EU deregulated electricity markets. This occurs even if some Member States, such as Sweden, allocate a reduced share of EUAs. The resulting higher marginal electricity tariff – where the cost of emissions rights are levied on all production – results in a large windfall profits for the utilities while the electricity cost for all consumers is

---

151 The EU has also published guidelines on how the allocation rules shall be implemented and how the NAP should be designed also for the first commitment period (COM(2003) 830 final).
raised. This situation has been accused of being erroneous, as the absolute majority of the electricity is produced with hydropower, nuclear and RES that are not included in the ETS.

The increase in electricity price has occasionally also been explained with the fact that the utilities have received a smaller allocation than their emissions and that they therefore has to purchase emission rights at the cost of higher electricity prices. The need to fund these purchases with an increase in electricity price could however be challenged inter alia based on the all-time record profits that the large utility companies are currently making.

The SEA (2005c) acknowledge this criticism by agreeing that production not included in the EU-ETS benefit from by higher pricing but does not see this as a system flaw but rather as an expression of a marginal pricing system. Peter Chudi (2005) at E.ON Sverige identifies that wind fall profits is a natural effect within a marginal priced energy system and this system is deemed most cost-effective to society by economists. Maria Sunér Fleming (2005) at Swedenergy however concluded that the future of the EU-ETS is probably depending on a redesign where this situation is amended, as the current design will not be accepted by the electricity consumers in general and basic industry in specific. The Swedish Government has responded to the situations through introducing a tax on all categories of emission rights – EUAs, ERUs and CERs – through the Bill 2004/05:33.152

In the Finnish case, Fortum has chosen not to operate some of the coal-fired plants and have due to a 93% carbon dioxide free production from hydro and nuclear power been able to sell emission rights for 25 MEuro (Hufvudstadsbladet, 2006). Fortum’s CEO, Mikael Lillius, defend this by saying that he identifies this as an

152 This also includes REC's.
opportunity during wet-years while the company during dry-years may be forced to purchase emission rights (*ibid*).

**Price Developments of Emission Rights**

During the existing trading of the EUAs the price level has lacked stability. This was not unexpected as the commodity of an emission right has not previously been set in a system of such size as the EU-ETS. The fluctuations can be associated with the immaturity and low rate of trade on the EU-ETS market. The major effect has however been related to the allocations within the Member States. The price of EUAs has is attributable to the price of primary energy and especially the difference between coal and natural gas. The reason is that it corresponds to a technologically viable opportunity for GHG emission abatement in energy utilization. The link can be seen as negative as it negatively influences the industries with both higher energy prices and costs for emission rights. A positive factor is that the link allows for some predictability of the price of EUAs. As the market develops further links will be established, such as the possibilities and price of utilizing the JI and the CDM. These are included in the ETSs to reduce the overall cost of emission reductions and while both mechanisms accomplish this, the CDM also increases the availability of emission rights in the schemes. The start-up of the ITL will thus affect the price level. Other factors that influence the price are the NAPs in the large Member States and the possible inclusion of non-EU states.

During the first 4 months of trading the price of the EUA were relatively stable around 21-24 Euro/EUA (European Energy Exchange, 2007). The following increase took many analysts by surprise as a price level of >20 Euro/EUA was not expected. Most stakeholders estimated that the prices would be substantially lower. One of the reasons that has contributed to high EUA price levels is that the EU-10 were late in installing their national registries and could as a consequence not make their surplus
EUAs available on the EU carbon market, which was included in many EUA price scenarios.

Figure 6.1 Price development and trade of EU emission allowances

The publishing of the 2005 emission reports resulted in a plunge of the EUA price as many countries had allocated EUAs in a greater volume than the emissions. In the Swedish case roughly 2.5 Mton less carbon dioxide was emitted than the 22.4 Mton that had been allocated (SEA and Swedish EPA, 2006c). This situation sparked discussions on whether Member States emissions should be reported more frequently and whether allocation periods should be longer as well as raising requests for a larger transparency in the allocations. The likelihood of similar events will decrease over time as the carbon market matures and the rules thereof are
improved. This is important as a reasonable and relatively stable EUA price – what price level that is reasonable is however difficult specify – is necessary for the long-term acceptance and survival of the scheme.

The current low price level poses a serious problem for the EU-ETS as the steering efficiency of the emissions cap is reduced. Estimates on the price level that the EUA will stabilize vary, but estimates somewhere of approximately 10-15 Euros are frequent. All estimates in this area are however very sensitive to the development of the international emission agreements, namely the KP. As a step to reduce these effects the Commission has declared that they will not allow generous NAPs and aim for (EC, 2006c).

**Linking Directive**

The EU initially did not intend to allow the use of JI and CDM but amended this through the Linking Directive (2004/101/EC), which establishes rules for how credits gained by the project based flexible mechanisms in the KP can be used within the EU-ETS. The Linking Directive was created as it was considered to increase the cost-effectiveness of the scheme. Member States are free to allow operations to use these credits up to nationally established maximum share of the allocated amount. The maximum allowed level has been set at 10 %, as a result of complaints on NAPs exceeding this level (EC, 2006b). The Linking Directive excludes the use of CERs and ERUs originating from land use, land use change and forestry (LULUCF) activities. CDM projects credits can be accredited towards the EU-ETS commitments from 2005 and JI credits from 2008 (2004/101/EC). The Linking Directive was introduced into Swedish legislation through the Emissions Trading Bill (2005/06:184).

**Compliance**

A general difficulty in the allocation procedures is the need for accurate emission data. The schemes declare that no emission permits shall be allocated to operations
that are not capable of accurately monitoring and reporting their emissions. To ensure this, the EU-ETS state that the operational emission reports must be reviewed by accredited bodies according to European Accreditation guidance (EA, 2005). In the Swedish case this means that the reviewing bodies have to be accredited by the Swedish Board for Accreditation and Conformity Assessment (SWEDAC).

The EU-ETS levies penalties for operations that do not hold emission allowances corresponding to their emission volume after each annual period. The responsibility for supervising emission volumes lies at national authorities, in Sweden represented by the Swedish EPA. Besides the penalty, operations are obliged to attain and surrender the EUAs missing. The penalties are under the first period 40 Euro per ton and will rise to 80 Euro per ton under the second commitment period. It is thus essential that the EUA price do not exceed these levels, as this would drastically impair the scheme’s functionality. It is highly unlikely that this would occur with the higher penalty level but the current penalty level has been close to previous EUA price levels (Figure 6.1). The EU has issued guidelines to the Trading Sector on how to monitor and report emissions under the EU-ETS (EC, 2004a).

**Swedish Perspective**

The Government has published four bills (2003/04:31, 2003/04:132, 2004:62, 2004/05:18), based on the work of the FlexMex2 committee (SOU 2003:60, 2003:120, 2004:62 and 2005:10), on the introduction of the EU-ETS in Sweden. A fifth Emissions Trading Bill (2005/06:184) was issued in 2006 suggesting legal amendments that were considered essential in relation to the second commitment period. The Bill establishes the foundation for the allowed use of the JI and CDM in Sweden and suggested the limit to 20 % of the allocated EUAs to each operation. The European Commission has later declared that Sweden must lower this limit to 10 % (EC, 2006b).
The Emissions Trading Bill further establishes that the opportunity within the EU-ETS to include other GHGs and sectors in the national emissions trading, should not be used due to insufficient decision support and time to carry out such changes, which is supported by the majority of the bodies that considered the legislative proposal.\textsuperscript{153} This means that the operations included in the NAP2 did not change much. Due to considerations of the Commission guidelines (COM(2005) 703 final) on the inclusion of combustion installations in the upcoming NAPs, approximately 38 operations (of which 24 was earlier partly included) in the industry will be new entrants into the system.

The majority of the allocations for the second commitment period (2008-2012) are free of charge. The NAP2 (Ministry of Sustainable Development, 2006b) stipulates that new entrants from energy utilities must be highly efficient, according to Directive 2004/8/EC promoting CHP, to receive free allocations. The total average planned allocated amount for the second period was 25.2 million EUAs per year compared to 22.9 million EUAs per year allocated during the first period. The European Commission has however announced that Sweden together with 9 other Member States must lower the planned allocations and in the Swedish case it is a question of a cutback of 2.4 million EUAs, or 9.5\% (EC, 2006b). A problem with the decision is that it is based evaluations of emissions in 2005 which was a relatively cold year with high Nordic hydropower production, while the planned allocations must be based on normal-year characteristics.

The NAP2 the allocations to the ore-based steel industry sectors will be carried out through benchmarking based on European production and emission statistics. New entrants from the industry sectors will receive allocations based on BAT

\textsuperscript{153} See the five bills (2003/04:31, 2003/04:132, 2004:62, 2004/05:18, 2005/06:184) for brief views by a broad range of stakeholders on specific issues related to the development of the Swedish emission trading policies.
benchmarking and in utilities in view of allocations in countries to which Sweden have grid connections. The allocations for the energy utilities will be continuously be more stringent than for the industrial operations, and more stringent than the first period, with an average downscaling of 60-70 %\(^\text{154}\) (Ministry of the Environment, 2006b). The reasons for this reduction are declared as differences in the sectors’ possibilities to reduce emissions as well as industry sectors facing international competition.

The 2006 Emissions Trading Bill (2005/06:184) suggested that if additional measures are necessary to reach the EU-ETS emission commitment, the allocations to the utility sector may be downscaled, while protecting the industries’ competitiveness through full allocations. What is noteworthy is that the allocations shall also consider the national short-term climate goal, which is more stringent than the EU-ETS commitments. It is not specified exactly what this means for the allocations. It is nevertheless extraordinary that the Government, being aware of the characteristics of a cap-and-trade scheme, discusses to allocate emission rights at a volume below the commitments under the KP and EU-ETS. Such measures will be balanced out within the schemes, consequently not resulting in any real reductions. Such an allocation procedure would result in reduced cost-efficiency of the EU-ETS implementation in the Swedish case. This supports an amendment of the climate goal to exclude the Trading Sector, in order to avoid this and similar effects of decisions on emissions trading (Chapter 10.1). The Bill also establishes that, when a more long-term allocation procedure has been developed, the allocation procedures for the utilities need to be amended.\(^\text{155}\)

\(^{154}\) The downscaling during the first period was 80 % (MIEC, 2004).

\(^{155}\) For example removing the free allocations to biofuel CHP operations as they have no fossil carbon dioxide emissions and have a profitable production.
Stakeholder Perspectives

The business community is mainly positive to emissions trading as it is a market based policy instrument but some concerns of the design was raised during the interviews. These were primarily associated with the competitive disadvantages with an isolated EU system, the allocation procedures as well as the windfall profits by the energy utilities.

The CSE is positive to ETSs in principle, as it is a market based policy approach which has a higher level of international harmonization than national policy instruments in general (Resvik, 2005). The CSE however identifies that the EU-ETS and KP must also include China, India and the USA, in order to establish more confidence in the climate policies and reduce the competitive risk for the industry. Birgitta Resvik (2005) at the organization argues that an ETS within the EU will not be acceptable without a larger international harmonization and that such a system will lack stability. The CSE identifies that the short-term development of the ETSs must include a strong focus on cost-efficiency in order to avoid increased costs, as a result of reviews and amendments. The identified problems related to the allocation procedure is mostly associated with how new entrants are dealt with, as this is seen as creating problems for investments in natural gas utilization and the development of the gas infrastructure. Resvik emphasizes that the allocation procedures must be harmonized within the EU-ETS.

The Swedish utility sector organization, Swedenergy (Sunér Fleming, 2005), are positive towards ETSs and other market based policy instruments. The EU-ETS is identified as particularly positive in view of the development of an internal EU electricity market. Maria Sunér Fleming (2005) at the organization however views that the harmonization within the system should be improved on an EU level, for example with respect to allocations, new entrants and closing of operations. The current differences in allocations are identified as creating imperfect market
conditions for the Swedish energy utilities, especially for new entrants. Sunér Fleming argues that the stability of the system is only partially a result of its long-term perspective as it is also very depending on developments on the carbon markets. Sunér Fleming identifies that the long-term perspective could be improved through longer allocation periods and more clearly defined midway targets. The stability of ETSs as policy instruments are regarded as drastically reduced due the international discussions that dictate the future presence and design of the systems. Sunér Fleming further identifies that the high electricity prices that the EU-ETS have resulted in, should mean that the EU must amend the scheme to reduce this effect which could be achieved though auctioning of allocations to utilities. Within the current design Sunér Fleming identifies that the rate of industry investments outside of the scheme will rise as the situation in Sweden includes both purchasing EUAs as new entrants as well as being subjected to elevated electricity prices.

E.ON Sverige (Chudi, 2005) is positive towards the EU-ETS as it improves the harmonization of carbon dioxide emission policies on an EU level. E.ON Sverige nevertheless identifies that an international widening of the system, as will be the case in 2008-2012, is necessary due to competitive reasons. This is consequently a demand also for the energy utilities and not exclusively for the basic industry that is subject to competitiveness on a larger international arena. Peter Chudi at the company has confidence in the politicians’ ability to solve the climate change issue and believes in a continuation of the ETSs after 2012, due to the importance of the climate change issue. Chudi identifies that energy utilities are disadvantaged in the allocations due to the smaller allocation that utility operations receive. He also identifies that the allocation disadvantages the operations that have carried out early measures to reduce carbon dioxide emissions prior to the 1998-2001 baseline. As the chosen allocation base years were wet-years, Chudi furthermore argues that the energy utilities do not receive allocations based on a normal year. E.ON Sverige promotes a full auctioning in the allocation process. Chudi identifies that the EU-ETS
must be amended with respect to increased transparency in the allocation process as well as harmonization of the national NAPs.

Gunnar Käck (2005) at Fortum Värme is also positive towards emissions trading but identifies the indefinite post-2012 future as a problem, reducing the policy stability. Käck however finds the EU position on a continuance of the EU-ETS after 2012 as reassuring. The international extent of the ETSs is not identified as being a major issue for the energy utilities. The allocation process is however argued to create a problem as the utilities receive a smaller allocation than the basic industries. This is an issue as a large share of Fortum’s production is sold to the basic industries – thus being secondarily subjected to the international competitiveness.

Raine Harju (2005) at Vattenfall identifies the basis of ETSs as a very positive policy instrument, but argues that the current schemes lack in global participation and harmonization. The allocation on historical emissions is seen as working well with the exception that it does not account for dry years.

Göran Carlsson (2005) at SSAB is critical towards the design of the EU-ETS and the KP as the schemes does not include many of the countries that have competing steel producers. This is identified as a harmonization issue which causes competitive disadvantages. Carlsson warns that this situation could lead to outsourcing of production outside of the schemes, which could have negative consequence for the global emission levels if the emission legislation is less stringent in the countries not included in the schemes.\textsuperscript{156} The development of the EUA price is identified as problematic as it would be difficult for SSAB to buy emission rights at high prices. Carlsson further identifies that if emission rights would have to be purchased for the marginal production, the cost for these would be equal to the labor costs, making the

\textsuperscript{156}This possibility is also highlighted in the EU-ETS review (McKinsey & Company and Ecofys, 2006).
production thus would be unfeasible. Carlsson further identifies that the decisions on
the allocation procedure was taken too quickly, causing confusion among the
Member States on how to interpret the rules. The EU-ETS is regarded as lacking a
long-term perspective in view of that the company’s investments have a 25 years
depreciation time.

The principles of ETSs are regarded as positive by Anders Lyberg (2005) at Cementa.
Anders Lyberg however identifies that the effects that the emission rights have had
on the electricity prices is a strong contribution to a projected increase of Cementa’s
electricity costs with 50 % on a 10-15 year perspective. Therefore an international
harmonization of the EU-ETS is seen as essential due to competitive considerations.
Cementa’s allocation of emission rights are seen as sufficient and Lyberg states that
the production, due to the increase in production costs, would shut down if the
company would not receive any allocations. Cementa aims to alleviate this situation
by increasing the share of biofuels in the production. If this is not fully possible, the
production increase will be limited accordingly. Lyberg shares the opinion that the
company prefers a smaller allocation with lower electricity prices over a situation
with full allocations and high prices. An auctioning of the allocations is regarded as a
catastrophe for the company, as it would drastically reduce the feasibility of the
production due to the high carbon dioxide intensity.

Mikael Hannus (2005) at Stora Enso argues that most stakeholders have not realized
how strong ETSs are as policy instruments. This is identified as a problem in
reference to the review of the EU-ETS, as the dates for the review are included in the
Emissions Trading Directive, and that the scheme consequently cannot be promptly
revised if unwanted negative effects occur that need to be promptly amended.
Hannus also identifies that the review is erroneously conducted, as the stakeholder
opinions were to be sent in to the commission only a few months after the scheme
was launched. This is considered to be too soon while also disregarding the
experience from the business sector, as the review is regarded to only have tended to
political opinions. Mikael Hannus furthermore argue that the electricity price increase resulting from the EU-ETS is harmful for the Swedish business sector’s competitiveness.

Leif Brinck (2005) at Preemraff Lysekil argues that the scheme should not be prolonged after 2012 as it has resulted in a 10 % increase in energy costs. Brinck argues that policy makers do not to fully understand the implications of the scheme, which has caused erroneous allocation procedures. One of the main issues is identified as the national climate goal of -4 % GHG reductions without the use of the flexible mechanisms. The goals should thus, according to Brinck, be amended so that it removes the national goal alternatively allows for the use of the flexible mechanisms. Brinck further identifies that the scheme, in its current design, makes operations that are more efficient pay more, while operations with low efficiencies need to pay less, which is seen as an obvious design flaw.

Thomas Levander (2005) identifies the lack of long-term stability of the EU-ETS and KP as a problem and argues that a more stable ETS with a long-term perspective of 20-30 years would substantially improve the scheme’s efficiency in promoting technology development and investments as well as improving the cost-efficiency characteristics. Levander promotes a sector approach within the EU-ETS, as this would increase the harmonization of the system and facilitate improved allocation processes. This is further discussed in Chapter 10.3. Levander identifies that the system is too weak in promoting electricity production with RES and that the support thereof by the REC system is positive. Levander also emphasizes that the inclusion of the transport sector, resulting in higher costs within the EU-ETS, could be complicated for industries facing international competition outside the EU-ETS.

Ylva Rylander (2005) at the SSNC identifies that a problem with the ETSs is that the cap is set too high, meaning that the substantial emission reductions that are necessary will not be achieved. Therefore the cap should be set lower so that the
allocations become more stringent and the price of emission rights higher. Rylander further criticize that the operations are allowed to predict their future production and emission levels, albeit under scrutiny of the Swedish EPA, which has led to that operations with skilled negotiators have received large allocations. The SSNC is furthermore negative to the flexible mechanisms as they are neglecting the fundamental Polluter Pays Principle. A positive development of the introduction of ETSs, as identified by Rylander, is that they have elevated and popularized the dialogue on climate change. The organization is hopeful for a post-2012 international ETS regime and considers that Sweden should be a strong catalyst in this development.

EU-ETS Review and Future Developments

An external review of the EU-ETS by a wide-range consultation of stakeholders with knowledge of emissions trading was initiated in June 2005. The results was published by the Commission (COM(2006) 676 final), according to the Emissions Trading Directive (2003/87/EC). In conjunction with earlier signs, the Commission clearly states the opinion that any EU-ETS amendments should not enter into effect until 2013. The reasons given are the “regulatory stability and predictability” of the scheme. The communication outlines four priority areas in the review where the first (1) is the scope of the EU-ETS, including clarity on the inclusion of small combustion installations and expanding the scheme to other sectors and gases such as N₂O from the production of ammonia and CH₄ from coal mines. The review will also consider how carbon capture and sequestration should be regarded from an EU-ETS perspective. The second (2) area focuses on increased harmonization and predictability of the scheme, recognizing that the system should provide a longer-term planning than 5 years. This review area will also include analyzing the possibility of a single EU-wide cap, looking in to allocation issues such as auctioning and benchmarking as well as increase the transparency within the scheme. It furthermore includes issues on new entrants and closures. The third (3) area puts an
emphasis on compliance and enforcement and the fourth (4) on third countries and the possibility to link the EU-ETS to schemes in these countries and to utilize this to promote a stronger attention to a sustainable development.

There have been discussions on including transportation in the scheme and the possible inclusion of aviation was found feasible in a Commission study (Wit et al, 2005). The inclusion of aviation is also supported by the Parliament (EP, 2006b) and European Council (2007b). According to a LETS Update\textsuperscript{157} report (AEA Technology Environment and Ecofys UK, 2006), other sectors that may be included from 2013 an forward are the aluminum, coal-mining and parts of the chemicals sector, potentially increasing the included carbon dioxide emissions by 9 %. The Commission has declared that the inclusion of transportation or any other amendments will not enter into force until a possible third commitment period from 2013 and forward (COM(2006) 676 final). A later legislation proposal (EC, 2006a) however suggests an inclusion of air transport into the scheme as early as 2011.

A problem in the inclusion of transportation is the transport customers’ higher willingness to accept higher costs for fuels and transports, than is the case for the basic industries customers. This can result in higher costs associated with the EU-ETS, and the inclusion of the transport sector would consequently have to be associated with mechanisms that alleviate this effect. This is recognized by the European Parliament (EP, 2006b) who identify that applying specific rules, such as maximum allowed purchased EUAs, could alleviate this effect. The inclusion of transportation could otherwise, in the absence of such measures, have negative effects for the basic industry in light of the international competition outside the scheme. The energy utilities have larger possibilities to transfer an increased ETS cost

\textsuperscript{157} The EU funded LETS Update project is made up by the environmental protection agencies in Austria, Denmark, Germany, Italy and UK (England and Wales).
to the customers, due to smaller markets and the necessary nature of their produced commodity. If the inclusion of the transport sector would coincide with free allocations of emission rights in the Member States, the States are likely protect their industries with higher allocations. This situation would, as identified by Thomas Levander (2005) at the SEA, drastically reduce the efficiency of the system, which would probably receive acceptability issues as a result. Anders Lyberg (2005) at Cementa adds, in addition to the above, that the inclusion of the transport sector would not result in any additional reductions.

The SEA and Swedish EPA (2006b) has published a report in relation to the review of the scheme which outlines the agencies’ opinions on the development of the EU-ETS. The report supports an EU-wide cap and allocations system and promotes auctioning. The report however state that industry sectors that are subjected to EU external competition should receive their allocations free, if the competitors are not subjected to any carbon dioxide emission costs. This means that the energy utilities should receive allocations through auctioning. The agencies furthermore suggest that Sweden should support the inclusion of the aluminum industry and coal mines as well as parts of the chemicals industry.

### 6.2 Renewable Energy Certificates

Renewable Energy Certificate (REC) schemes – internationally also referred to as green electricity certificate schemes – is essentially a subvention scheme albeit considered a market based policy instrument due to the market influence of certificates trading. The decision to introduce a REC scheme was taken by the Government in 2000 by setting up a committee that would guide the introduction. By way of an official report (SOU 2001:77) a Bill (2002/03:40), the instrument was introduced into the Swedish policy mix in May 2003. The scheme works as a replacement for investment and operational support programmes, such as small-
scale renewable electricity production and the investment support for wind power. The main goal is to increase the economic stability for investments in renewable electricity production and to support the national RES policy targets. The specific target was initially to support the target of 10 TWh new renewable electricity production from 2010 declared in the 2002 Energy Bill as a result of the EU Directive (2001/77/EC) promoting increased renewable electricity production in support of the RES-e goal. Recent changes have increased the ambition level setting the goal to 17 TWh of new renewable electricity production to 2016, compared to 2002 levels (Bill 2005/06:154). The scheme is governed by the law (SFS 2003:113) on electricity certificates.

The scheme includes all electricity consumers but have special rules for the electricity intensive industry. The definition of these industries was previously based on SNI-codes but has recently been amended. The reason for this was to harmonize the scheme with the EU Energy Tax Directive (2003/96/EC), and consequently also the PFE and changes in the tax system. The new definition targets each operation’s electricity intensity in reference to the sales value. The new definition excludes a specified share of the electricity consumption as follows:

- 50 %, if the electricity consumption per year amounts to a minimum of 40 MWh, but less than 50 MWh, for each million of the company’s sales value
- 75 %, if more than 50 MWh, but less than 60 MWh, for each million of the company’s sales value
- 100 %, if more than 60 MWh, for each million of the company’s sales value

The supervising authorities are the SEA and Svenska Kraftnät, where the SEA is responsible for approving plants, annulling certificates plus supervising and deciding on sanctions. Svenska Kraftnät is responsible for the issuing and accounting of certificates. The trading place for certificates is the Nord Pool exchange.
As the scheme provides subventions, the system is likely to incur larger costs within the electricity system, due to the promotion of more expensive production alternatives. This is supported by a Profu (2003) analysis, identifying that the system consequently is not the most cost-effective policy to accomplish carbon dioxide emission reductions. The policy instrument is nevertheless justified as part of the policy framework, as it is introduced to support specific RES policy goals. The REC system results in end-customers paying for the increase renewable electricity production, making it vital that the Government safeguard that the costs are kept to a minimum (Verbruggen, 2004). REC systems have been criticized for causing unjust competition between RES technologies at various stages of maturity, as the system favors the most mature technologies, such as wind power (Meyer, 2003). Peat is qualified for certificates when used as fuel in approved CHP plants (SFS 2004:98). The reason for including peat is that it could otherwise be replaced with coal at CHP plants, leading to a higher carbon dioxide emissions and environmental impact (Bill 2003/04:42).

Table 6.8 Renewable energy sources permitted under the REC scheme

<table>
<thead>
<tr>
<th>Wind power</th>
<th>Biofuels (including peat utilization at CHP plants)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar energy</td>
<td>Hydropower</td>
</tr>
<tr>
<td>Wave energy</td>
<td></td>
</tr>
<tr>
<td>Geothermal energy</td>
<td></td>
</tr>
</tbody>
</table>

Source: SFS 2003:120. Several conditions apply, see decree for full information.

The operations utilizing the RES in Table 6.8 for electricity production are liable for receiving RECs for a period of 15 years (but no later than 2030, Table 6.9). Installations that were operational before the introduction of the scheme are however only issued RECs until 2012 and operations that received governmental support during the
construction or reconstruction of the installation receive RECs until 2014 (SFS 2003:113). This rule is introduced to promote a continuing development of the electricity system and achieves the goal of increasing new renewable electricity utilities. These limitations also reduce the costs of the scheme for the electricity end-users.

Figure 6.2 Number of approved installations under REC scheme with reference to RES (2006)

![Pie chart showing number of approved installations by energy type.]


While hydropower installations represent the largest share of approved installations (Figure 6.2), the biofuel operations are larger and represent the largest share in terms of issued RECs (Figure 6.3).
There are four stakeholder groups that are involved in the rotation of certificates, which takes place during one accounting period (1\textsuperscript{st} April – 31\textsuperscript{st} March). Electricity producers apply for an approval of their operations at the SEA. These utilities will upon receiving approval be issued one REC from Svenska Kraftnät for every MWh that is produced at that plant, using the RES in Table 6.8. The electricity producers can sell the certificates on Nord Pool, directly to electricity retailers that purchase certified electricity or use them in their internal retailing of electricity. Electricity intensive industries, stakeholders with internal production of electricity and stakeholders purchasing electricity from Nord Pool are obliged to acquire RECs that correspond to a quota of their consumption. The quota liability for other customers is put on the electricity retailers where the retailers reports the amount of electricity sold and hand in the corresponding certificates to the SEA. The quota liability is changed over time to increase the scheme’s steering efficiency (Table 6.9). The surrendered REC amounts are verified and the certificates annulled per year. The scheme thus allows for utilities with a larger share of renewable energy production than the quota to sell surplus certificates on the marketplace – this option has however been used very sparsely.
Table 6.9 Quota liabilities per consumed MWh under the REC scheme

<table>
<thead>
<tr>
<th>Year</th>
<th>Quota Liability</th>
<th>Year</th>
<th>Quota Liability</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>0.074(^i)</td>
<td>2017</td>
<td>0.111</td>
</tr>
<tr>
<td>2004</td>
<td>0.081(^i)</td>
<td>2018</td>
<td>0.111</td>
</tr>
<tr>
<td>2005</td>
<td>0.104(^i)</td>
<td>2019</td>
<td>0.112</td>
</tr>
<tr>
<td>2006</td>
<td>0.126(^i)</td>
<td>2020</td>
<td>0.112</td>
</tr>
<tr>
<td>2007</td>
<td>0.151</td>
<td>2021</td>
<td>0.113</td>
</tr>
<tr>
<td>2008</td>
<td>0.163</td>
<td>2022</td>
<td>0.106</td>
</tr>
<tr>
<td>2009</td>
<td>0.170</td>
<td>2023</td>
<td>0.094</td>
</tr>
<tr>
<td>2010</td>
<td>0.179</td>
<td>2024</td>
<td>0.090</td>
</tr>
<tr>
<td>2011</td>
<td>0.179</td>
<td>2025</td>
<td>0.083</td>
</tr>
<tr>
<td>2012</td>
<td>0.179</td>
<td>2026</td>
<td>0.075</td>
</tr>
<tr>
<td>2013</td>
<td>0.089</td>
<td>2027</td>
<td>0.067</td>
</tr>
<tr>
<td>2014</td>
<td>0.094</td>
<td>2028</td>
<td>0.059</td>
</tr>
<tr>
<td>2015</td>
<td>0.097</td>
<td>2029</td>
<td>0.050</td>
</tr>
<tr>
<td>2016</td>
<td>0.111</td>
<td>2030</td>
<td>0.042</td>
</tr>
</tbody>
</table>

Source: Bill 2006/07:1. \(^i\) According to SFS 2003:113 before amendments resulting from the approval of Bill 2005/06:154.

To increase the financial stability of the scheme the state has guaranteed a minimum price of the certificates that is paid by the SEA if the actual certificate price would be lower. This price level is reduced with 10 SEK per year (from 60 SEK in 2003 to 20 SEK in 2007 and 0 SEK in 2008). The Government has however not yet been forced to interact as the price have stayed well above this level, with an average price of approximately 220 SEK during the first period (Figure 6.4). The certificates have an unlimited shelf life as long as the retailers or consumers use them to fill their quota. The scheme also includes a penalty mechanism, where quota obligated persons or companies that do not have sufficient certificates have to fill their quota by paying 150% of the average certificate price during the last accounting period. Due to the novelty and price uncertainty of the scheme the maximum average price level was
set at 175 SEK for 2004 and 240 SEK for 2005. During the first operational period some stakeholders paid the quota penalties instead of surrendering and annulling certificates. The reasons for this could, according to Svenska Kraftnät (2004), be that this was cheaper, since the price of certificates during the first period was above to the quota penalty price. But Svenska Kraftnät also offers the possibility that stakeholders expect higher certificate prices in the future, as the quota penalty levels are increased, and that keeping the RECs consequently was economically motivated. As the penalty behaves as a tax if it is lower than the certificate cost, this must be carefully avoided by using a flexible level such as will be the case from the third accounting period. If not, it could act as an electricity retailing tax that targets renewable electricity, which would be counteractive to the scheme’s goal. The scheme is however now running with a high level of compliance and for the 2005 period 99.9 % of the RECs were surrendered to the SEA (SEA, 2006b).

The price level of RECs has been relatively stable, but has during 2006 dipped slightly, to thereafter increase again (Figure 6.4). The reason for this development is that there is a surplus of RECs on the market, and the SEA identifies the development as reasonable considering this situation (SEA, 2006c). The price is also affected by the electricity market where higher electricity prices result in lower REC prices, as the utilities during this situation can sell the certificates at a lower price with a maintained revenue. The future price level will be affected by the realization of larger RES projects, due to the impact of available RECs (ibid). The pricing will stabilized in more stakeholders take part in the trading through the participation of other countries. The same improvements could also be achieved through higher quota levels, resulting in higher trade volumes.
By a request from the Government, the REC scheme design was reviewed in 2005, by the SEA, in two reports. The first (1) report (SEA, 2005g) established that the inclusion of peat is problematic as it creates a credibility problem plus, in a longer perspective, a need for changed quotas. SEA thus suggested that an alternative subvention instrument should replace the REC scheme. The report furthermore discuss the opportunity keep the quota penalties to the scheme and that the penalty could be annulled if the electricity retailer fills the quota gap within three years. The second (2) report (SEA, 2005h) identified that the 10 TWh new renewable electricity target would be at risk if the scheme did not have a longer time perspective. The

---

158 The support to the working of peat is offered in order to uphold job opportunities and local infrastructures (SEA, 2005g)
The report also established that if the scheme is made permanent, that the potential for increased renewable electricity production is sufficient to support a higher ambition level, setting the goal to 15 TWh to the same year. The SEA thus suggested that the REC scheme should provide longer-term incentives, with clear quota levels up to 2025, which should be increased up to 2015 to thereafter stabilize. The report also suggested a further analysis of whether a utility operation should be allowed to receive certificates under a limited period in order to increase the level of new operations.\textsuperscript{159} The report furthermore established that the certificate scheme up until then had not led to any new wind power production and that wind power would be more efficiently promoted if the certificate scheme were made permanent. The report also established that the schemeotherwise has functioned well during its initial phase and suggesting that the cost for certificates should be included in the electricity price to safeguard the consumers’ interests. The SEA furthermore established in the report that only 49% of the REC scheme incomes has been used for new RES production while the other share has ended up in the national treasury, as VAT and penalties, as well as at the energy utilities as administrative costs. This bears a risk that the acceptance of the scheme is reduced albeit the situation will improve when the maximum penalty levels are removed in 2006.

These report recommendations were largely heeded by the Government in the REC Bill (2005/06:154). The Bill declared that the scheme should be prolonged to 2030 with new quota liability levels (\textit{Table 6.9}). The Bill also moved the quota liability that formerly lay on the electricity customers to the electricity distributors, albeit this does not apply for electricity intensive industries, in-house produced electricity and electricity that is purchased from or imported through Nord Pool. A positive element

\textsuperscript{159} This is analyzed in the report (SEA, 2005d) on the effects of an expanded certificates market, finding that a time limit should be included if the system is made permanent, that this is supported by Norway and that the issue should be “seriously discussed” further.
in the REC Bill is that it establishes that the scheme shall be reviewed in regular intervals, every fifth year beginning in 2012. This could potentially increase the efficiency of the policy instrument, if an effective dialogue between all stakeholder parties can be established, as this can increase the perceived stability of the scheme. *The issue of dialogue is further elaborated in the discussions in Chapter 10.2.*

A memorandum (Ministry of Sustainable Development, 2005) suggested that small-scale hydropower production should only be issued RECs until 31 December 2010. This was suggested against the background of the environmental goal to protect unaffected waterways from exploitation. The REC Bill (2005/06:154) included and highlighted this memorandum but postponed the decision on this subject to a later date. The actual decision was taken through the 2006 spring budget (Bill 2005/06:100) but the new Government has declared (Bill 2006/07:1) that this decision will be revoked.

The Norwegian Stortinget\(^\text{160}\) has shown a large interest in initiating a joint Swedish-Norwegian REC scheme and expanding the REC scheme is supported in the Energy Bill (2001/02:143) for harmonizing and stabilizing reasons. The expansion of the REC scheme would be beneficial for both countries as the positive effects and function of a REC trading scheme – lowering the costs for introduction of renewables, reducing carbon dioxide emissions plus stabilizing the REC price – is continuously strengthened by an increasing number of participants. Among the problems that need to be solved are that the national subvention systems need to be harmonized, as these would otherwise impair the allocation effectiveness of the scheme. Another important issue is the national level of new renewable energy that is to be produced under this common scheme. The price development would be erroneous if one country adopts a more modest goal than the other. The SEA (2005d) suggests that the

\(^{160}\) The Norwegian Government
countries should have separate goals that are both reasonable and related to the respective potential for new renewable production. Concerns have been raised that the initial added uncertainty of the REC price in a joint scheme could lead to a temporary halt in investments until the scheme has been tested (SEA, 2005d). Earlier discussions between the Ministers of Energy in both countries established that a joint scheme could be started in 2007 (Hedström, 2005) but Norway has postponed this to an undefined date.

The EU analyzed the implementation of RECs within a project (2000-2001) called RECeT – the European Renewable Electricity Certificate Trading Project. The project focus was to see if, and how, tradable RECs could help EU to reach the RESe-goal. The conclusion was that a Europe-wide scheme with RECs could have a substantial contribution to reduce the cost for achieving the goal compared to other policy instruments, such as feed laws (Energie, 2001). Other Member States, for example UK, Netherlands and Italy, have implemented REC schemes and a platform for accomplishing EU intentions for a future harmonization of REC schemes could be the European voluntary Renewable Energy Certificates System (RECS, see below for more information). An EU system, that sets a cap based on the RES targets, would imply the same difficulties for proactive Member States as in the EU-ETS, where States that take on strict targets only serve less proactive countries with the possibility to reduce their efforts.

From a climate policy perspective, a report prepared by NERA (Harrison et al, 2005) carried out on behalf of the EU Commission finds that REC schemes are likely to increase the costs for compliance with EU-ETS emission commitments. Morthorst (2003) has an opposite position, identifying that an ETS and REC scheme working

---

161 Most of these issues are discussed in the memorandum DS 2005:29 where measures to overcome them are suggested.
alongside each other can constitute an effective national emission abatement regime. The finding that the REC system has large implications for the EU-ETS is supported by Unger and Ahlgren (2005), who however identifies that the introduction of a REC system may reduce the price of emission rights. This would consequently imply that the cost for complying with the EU-ETS would be reduced. Unger and Ahlgren also identifies that the reverse effects of stronger carbon dioxide emission quotas, only have limited effects on the price of RECs.

From an energy policy perspective, Unger and Ahlgren further identifies that a REC scheme probably cannot effectively promote offshore wind power and new power technologies, and that this consequently requires supplementary support programmes. This finding would thus support the continuous policy support that is offered to wind power (Chapter 7.2). The need for production specific support is also supported by Vergbruggen (2004), who identifies that this can be accomplished by supplementary policy instruments or by assigning RECs to specific technologies or segmenting the REC market. The latter suggestion would however inheritably reduce the flexibility that the system offers and as such reduce the acceptance and possibly also the cost-efficiency of the scheme. This could nevertheless be justified, depending on the priority of the wind development goal. Verbruggen also argues that an REC scheme, which is effective in promoting its aim, is associated with high REC prices and a reduced consumption of electricity. Voogt and Uyterlinde (2006) identifies that a REC scheme implemented on an EU level could be a cost-effective way to promote renewable electricity production and thus support the RES-e goal of the Renewable Energy Directive (2001/77/EC).

**Stakeholder Perspectives**

Energy producers, mainly utilities and pulp and paper industries, are positive to the REC scheme but have the unanimous position that it prior to the decision to prolong the scheme lacked a long-term perspective that reduced the policy efficiency.
Birgitta Resvik (2005) at the CSE identifies that a REC scheme in theory should be superfluous parallel to a correctly designed and well-functioning ETS. An ETS is also argued to have the potential to increase the cost of fossil fuel utilization at lower overall costs than is possible within a REC scheme. Birgitta Resvik however states that the current REC scheme works as supposed but that the CSE is worried that the costs of the scheme may become too high for electricity consumers. Birgitta Resvik identifies that the new utility production that the scheme will promote will increase the electricity price when the subvention to this production is removed, as this production is more expensive than the mean produced kWh. This suggests that the time-limit for the issuance of RECs can prove difficult in view of the already increased price due to the EU-ETS. Whether or not this will be the case is a result of many factors, such as the ETSs and energy price developments, and remains to be seen. The potential influence of the interaction between the two policy instruments should however not be neglected. Resvik also express doubts about the increased ambition level, which is argued to incur large costs to the society. The cost issue identified by Resvik can be summed up by stating that the Government should not introduce policy instruments that sub-optimize the commonweal due to too strong and problematic instrument designs. A long-term perspective and a balanced ambition level, that take the higher cost of the RES production into account, are essential elements in the policy instrument design. Resvik is thus positive to the extended time-period of the scheme as it strengthens the support for capital-intensive investment. Birgitta Resvik concludes by stating that the CSE is positive towards an expansion of the scheme to for example Norway.

Swedenergy (Sunér Fleming, 2005) are positive to the REC scheme and identifies that the scheme has market based characteristics, albeit at a market that has a politically constructed demand for certificates. One of the major positive elements identified, is that the scheme is technology neutral, meaning that it does not dictate which RES that should be utilized to achieve the goal. This creates competitiveness between the
different alternatives, which is beneficial for the cost-efficiency of the scheme. The inclusion of peat is therefore argued as negative, as it reduces the technique neutrality. Maria Sunér Fleming (2005) at the organization argues that the REC scheme could become superfluous parallel to a long-term ETS that causes the cost of non-RES utilization to rise. Sunér Fleming furthermore argues that the long-term perspective of the scheme was previously too short to create a stable investment basis for the utilities, especially in view of that the approval process called for by the Environmental Code could take up to 10 years and more. The recent changes are thus considered positive. Sunér Fleming identifies that the dialogue on the introduction of the REC scheme worked well, seeing that a business representative headed the official inquiry on its implementation.¹⁶²

Peter Chudi (2005) at E.ON Sverige is positive to the REC scheme as it is market based. The scheme has supported company investments in wind energy projects that would not have been realized without the instrument. The scheme is identified as being long-term and predictable, even before the prolongation, but having a political stability risk in the possible amendments of the scheme. An expansion of the scheme to other countries is seen as positive as it increases the cost-effectiveness and harmonizes policy instruments. Expanding the scheme is however seen as requiring strong efforts on harmonizing the goals with the scheme. Chudi identifies that peat should be removed from the scheme, considering that it aims to promote RES. Chudi furthermore identifies initial surplus of RECs is seen as a result of a faster transition to RES in the pulp and paper industry and CHP production.

Gunnar Käck (2005) at the energy utility Fortum Värme is positive to the use of the REC scheme as a market based policy support of RES. The REC scheme is identified as being a better option than feed-in tariffs or construction investment support. The

¹⁶² This was done by Nils Andersson, employed at Vattenfall.
scheme has supported a 30% increase in the production at some CHP plants that would not have been realized without the scheme (ibid). Käck is negative towards amendments of the scheme that would limit the eligibility of operations to receive REC}s and views the current design as more efficient in achieving the objectives. Käck regards that incineration plants should receive REC}s for the fraction of waste that are composed of RES and identifies that this is supported in the EU Directive on Incineration of Waste (2000/76/EC).

Vattenfall are positive towards the REC scheme but identifies that the scheme in its initial design lacked a long-term perspective and that a prolongation of the scheme therefore was required (Tollin, 2005). The amendments to the scheme are thus considered an improvement. Johan Tollin (ibid) at Vattenfall regards that the scheme will be continuously strengthened, as the REC trading volumes rises and that this will support the stability of the market.

Anders Lyberg (2005) at Cementa regards that the REC scheme disadvantages the utilization of secondary heat, arguing that electricity production with secondary heat should receive certificates. Lyberg also argues that a fixed feed-in tariff of approximately 20 öre/kWh would have induced less risk into investment calculi compared to the current market based system with a heavily fluctuating market.

Mikael Hannus (2005) at Stora Enso argues that the REC scheme should be promptly removed, as it is identified to distort the cost-perspective on the electricity market. The scheme is regarded to cause increased costs for the pulp and paper industry with regards to both raw materials and investment costs for mill equipment. The latter as the equipment costs has been raised by, for example, boiler manufacturers that have identified an opportunity to increase the profits due to higher end-prices. Hannus further argues that the scheme is superfluous due to the EU-ETS, as a result of the increased support for RES that the trading scheme provides due to increased fossil fuel and electricity prices. The scheme is nevertheless identified as contributing to a
higher level of electricity production in the pulp and paper industry. The prolongation of the scheme is regarded as positive for wind power developments but otherwise not mitigating the above negative effects.

Thomas Levander (2005) at the SEA identifies that the time-perspective of the REC scheme initially was too short and that it did not establish the stability that is necessary for accurate investment calculi in the companies. The prolongation of the scheme is thus identified as a positive amendment. Levander further identifies that the problems that have occurred on the REC market, with high prices in line with the penalty level, could be reduced through participation in the scheme by other countries. Levander furthermore argues that the REC scheme is important as the EU-ETS is identified not to promote RES in the electricity utilities effectively. This was one of the reasons why the SEA suggested that the scheme should be made permanent with a recommended timeline of 30 years. Levander identifies a future possibility to create an exchange scheme between RECs, emission rights and EECs could increase the effectiveness of all schemes. This view is shared by Bertoli and Huld (2006) who identify that such a scheme that removes the risk for double accounting. Bertoli and Huld however conclude that this is not possible within the current design of the EU-ETS, as it allocates emission rights to specific industrial operations while the other two schemes have a larger scope of included stakeholders. Levander furthermore highlight that the scheme result in large incomes to the Government due to that VAT is levied on the certificates and that these funds should be returned to support the REC scheme’s goal at a higher rate. The REC scheme is also identified as possibly postponing investments in natural gas in Sweden as well as in our neighboring countries.

Ylva Rylander (2005) at the SSNC highlights that it is important that the funds generated by the scheme are utilized to support RES production and not allocated to other purposes. The sanctioning system is identified as one of the most important aspects in the scheme as it is essential for the scheme’s goal to be reached. The SSNC
supports a continuation of the REC scheme, as a short-term perspective could have negative impacts on the introduction of RES.

**Renewable Energy Certificates System – RECS**

RECs can also be traded on an EU level through a voluntary system called Renewable Energy Certificates System, or RECS. The organization is open for all stakeholders and Swedish members companies include E.ON and Vattenfall. Other countries that take part in the RECS through member companies and Issuing Bodies are, for example, Denmark, Finland, Norway, France and the U.K.

Within RECS, countries have agreed on a common set of rules on what electricity production that shall be considered as renewable. Electricity producers can apply at the national Issuing Bodies for a RECS certificate, which can be traded on a market place. The system thus works in a similar fashion as the Swedish national REC system.

Nord Pool was initially engaged in creating a marketplace for RECS certificates but the RECS framework did not provide enough support for this. A problem was that the certificates are organized according to the production type, which resulted in too low trading volumes. There is currently no marketplace for RECS certificates and all trade is therefore bilateral.

While it is presently possible to exchange Swedish RECs to RECS certificates this is suggested to be prohibited in the memorandum DS 2005:29. The reason is that the Government identifies a risk in reduced stability of the REC scheme if certificates can be removed from the national market. This could be the case if the RECS value is higher than on the national market, making it feasible for Swedish stakeholders to

\[\text{\underline{\text{\textsuperscript{163} For more information on details and members see http://www.recs.org.}}]}\]
exchange national RECs to EU RECS. As no further guidance on this subject was included in the recent Bill (2005/06:154) on RECs, it is presently uncertain whether the above suggestion will be adopted in legislation.

6.3 Energy EfficiencyCertificates

The possibility to introduce an Energy Efficiency Certificates (EECs) scheme, also known as White Certificates, as an incentive for energy conservation on an EU-wide level has been raised by the EU Commission. This was done in relation to the proposal for a Directive on Energy End-Use Efficiency and Energy Services (COM(2003) 739 final). An EEC scheme would thus aim to support energy savings target of 1 % per year as declared in the Directive (2006/32/EC). The Directive establishes that the Commission shall evaluate the progress on energy efficiency, based on the Member States reporting under the Directive in 2012, and if deemed appropriate put forward a proposal for an EEC scheme. The preparation for a European system with EECs is also supported in the Green Paper on Energy Efficiency (COM(2005) 265 final) as well as being promoted in the newly released 2006 Energy Green Paper (COM(2006) 105 final). A measurement system for the purpose of a possible EEC system introduction is also prepared under the Directive on Ecodesign and Energy Using Products (2005/32/EC). The probability of an EU wide introduction of an EEC system must consequently be regarded as relatively high. The implementation on an EU level is favorable due to competitive, policy harmonizing and increased cost-efficiency reasons.

An EEC scheme is suggested to work in a similar fashion to a REC scheme and will correspondingly work as a subvention system for energy efficiency measures, with market based policy instrument characteristics. An EEC scheme will similarly create a market for, and thus promote, energy efficient products and energy conservation services. An EEC scheme would be designed so that a defined group of stakeholders
within the energy system will have the accountability to hold certificates according to a quota commitment after a certain period. The stakeholders can be issued certificates by carrying out energy conservation projects or purchase certificates from other stakeholders who have done so in a degree that exceeds their quota. Which group that shall bear the accountability may vary. An EEC scheme could include different business sectors and stakeholders but is likely to be focused toward energy utilities as they often have experience working with large industrial customers on improving their energy efficiency. This is also how the system is designed in other EU countries that have introduced an EEC scheme. The system is only suited to target larger energy consumers as the administration burden of the system would otherwise potentially be too large.

The increase in collaborations between pulp and paper companies and energy utilities, where the utilities manage the energy operations in the industry (Möllersten and Sandberg, 2004), serve as an example which could be strengthened by the introduction of an EEC scheme as the feasibility would increase.

A project called “A Comparison of Market Mechanisms for Energy Efficiency”, or “White and Green”, was carried out at the International Institute for Industrial Environmental Economics at Lund University under the EU SAVE program. By using the MARKAL\(^{164}\) model they established that cost neutral energy savings in the EU-15 of up to 15 %, until 2020, could be achieved by using EECs (Farinelli et al, 2005). The less stringent target of 1 % per year 2006-2012 can be fulfilled at negative costs. The project also found that since the above evaluation is made with a focus on financial conditions, the potential for energy savings at zero cost is much higher, if looking also at environmental conditions, and suggests savings of up to 35 %. The

\(^{164}\) An IEA modeling tool (MARKet Allocation) for the optimization of technical energy systems development with respect to cost minimization.
project furthermore identified that EU carbon dioxide emissions could be cut with 5\% \(\text{roughly } 190 \text{ Mton}\), if the potential for cost neutral savings are fulfilled. While it should be taken into consideration that the cost effectiveness is the result of a model, and as such imperfect, it signifies an important potential of EECs as a policy instrument. The system was deemed to be effective in promoting technology development but a successful scheme management should include informative campaigns to encourage single households to make use of these technologies. The project also identified a number of barriers to an effective implementation, including reluctance among utilities to explore the possibilities that lie in demand side energy management.

Langniss and Praetorious (2006) has in an analysis of a possible EEC system in the EU, found that there are several design obstacles that have to be bridged. These include the establishment of an EEC market, its compatibility with the EU-ETS, which stakeholders to impose obligations to and how to measure improvements. They acknowledge that fact that an EEC system must be compatible to the EU-ETS and must not impose any additional large transaction costs. Langniss and Praetorious also find that the benefits of an EEC system would have larger positive societal effects than an ETS as it does not only mitigate GHG emissions. The latter is an important aspect of EECs as they also reduce energy demand and as such could reduce of polluting marginal production alternatives and increase the security of energy supply.

It can be argued that an EEC scheme is superfluous alongside an implemented ETS as the latter will promote energy efficiency measures through setting a price on carbon dioxide emissions. An EEC scheme could however be utilized to promote energy efficiency improvements within sectors not included in the EU-ETS. The implementation is however only justified if a large enough price difference exists for improvements that exceed the additional cost of administering the EEC (Bertoli and Huld, 2006).
The system is to a certain extent implemented in Italy and UK, while being under preparation in France and consideration in the Netherlands (COM(2005) 265 final). IEA (2004) analyzed the French initiative, considering it promising and suggesting that possibilities for simplifying the administration should be introduced wherever possible.

The system thus seem to have some positive trademarks, seemingly promoting energy efficiency in the industry, energy efficiency technologies and services at low or even negative costs. Whether this is possible to accomplish at a larger scale will become clear if EU’s initiative to promote a Union-wide participation is realized.

Stakeholder Perspectives

Many of the interviewees had limited knowledge about EECs, which is natural considering the relatively untested character of the policy instrument. The general thought, when briefly explained of the design basics, was that it would only add additional administrative burdens on top of other policy instruments. In an SEA (2006h) report the agency highlights the question of the possible acceptance of an EEC scheme and the results here would indicate that the instrument is not favored by the industry sector, albeit being promoted by environmental NGOs.

Birgitta Resvik (2005) at the CSE identifies that working with energy efficiency are part of the basic industries business strategies due to the energy intensive nature of the operations. Resvik argues that the policy characteristics of the PFE (Chapter 7.3), including capacity building and investment support, are better way to support this work than EECs. Resvik highlights that improving the promotion of new efficient technologies is accomplished through a long-term perspective and stability of the existing policy instruments, as this enables stable investment calculi.

Maria Sunér Fleming (2005) at Swedenergy identify that a negative characteristic of an EEC scheme is that it induces another policy instrument commodity to trade and
that this may simply be too much. Sunér Fleming also opposes an EEC scheme where the utilities should be responsible for the efficiency improvements.

Peter Chudi (2005) at E.ON Sverige regards that the potential for cost-effective efficiency improvements in the industry are of such magnitude that an external instrument supporting this work is unnecessary. He therefore concludes that the introduction of a new instrument bears the risk of complicating, rather than aiding, the situation. Peter Chudi also emphasizes that energy efficiency is already promoted by several policy incentives such as the PFE and EU directives on, for example, End-Use Efficiency (2006/32/EC) and Energy Efficient Buildings (2002/91/EC).

Gunnar Käck (2005) at Fortum Värme estimates that an EEC scheme will not be implemented in the short term. Leif Brinck (2005) at Preem was not familiar with the concept of EECs but identified a possibility to utilize a similar instrument as a replacement for energy taxes on fuels and electricity.

Thomas Levander (2005) at the SEA argues that the system is very difficult to administer and more suitable on an EU level than in individual countries. Levander further argues that an EEC scheme could have difficulties of being politically accepted, if resulting in foreign investments rather than domestic. The system is nevertheless identified as a possibility for the Government to reduce the need for subsidies and support to energy efficiency. Levander also identifies that the industry stakeholders in general are negative to the instrument design.

Svante Axelsson (SSNC, 2005a), secretary-general at the SSNC, supports the use of EECs and suggests that the electricity utility companies should improve their efficiencies with a minimum of 1% of the Swedish total energy consumption per year, during the years 2006-2012. Axelsson estimates that this would save 8 TWh of electricity, which corresponds to two Barsebäck reactors. Axelsson further believes that EECs would be very beneficial for the market of energy efficient products.
6.4 Summary

The market based instruments analyzed in this chapter are all new to the policy framework. The implemented instruments have nevertheless been well received by the Trading Sector in general terms. This is due to these instruments’ market characteristics that provide a high degree of cost-efficiency through enabling a relatively high freedom for the Trading Sector to choose which measures to adopt. Looking at the design of these instruments in closer detail, it is however apparent that the business sector has a number of objections that are argued to reduce the efficiency of the instruments. The main objections are associated with a lack of harmonization and stability. These issues should be observed in light of the effectiveness of the policy framework and the competitiveness of the Trading Sector. An important aspect in relation to the EU-ETS is that the Government should redesign the national short-term climate goal to be fully compatible with all aspects of thereof. This is further discussed in Chapter 10.1.

The chapter highlights the interaction between the instruments in the policy framework and one important aspect is that the final steering and economic effects of the recently installed policy instruments are not yet known. This situation is emphasized in the case of the market based instruments, as these require some time to establish mature markets. Before this is accomplished the actual outcomes are difficult to predict. The Swedish Government should take measures to alleviate this uncertainty through long-term goals and stable policies. This is however not accomplished at present, which is exemplified by a number of decisions on important design features in these instruments that has been postponed, vague and short-term. The situation would be improved if the Government defined which policy goals that have highest priority in order to enhance the understanding of which future trade-offs that may occur in relation to the development of individual policy instruments as well as the policy framework overall.
If the EU introduces an EEC scheme, which is likely if the EU energy efficiency goals are at risk, the combined policy effects would be strengthened in relation to energy efficiency. Energy efficiency would be regulated by a number of instruments, including two market based instruments. If so, the possibility of initiating an exchange scheme of the three market based policy commodities would be beneficial to increase the flexibility and cost-efficiency of the individual schemes. EECs could prove effective in supporting both the climate and energy policy framework, as energy efficiency tackles these issues from a bottom-up perspective. This must however be weighed against the uncertainties and added administrative burdens of implementing further instruments in the policy framework.

The EU is determined to make the EU-ETS an efficient mechanism that can work as the main climate policy instrument in a post-2012 perspective. The EU is open to work for an improved design that would increase the efficiency of the scheme and better adjust it to the individual sectors included. This namely includes the allocation procedure to the Member States and the Trading Sector, with regards to taking specific conditions and potential for reductions into stronger consideration. It notably also includes the important issues of increased harmonization and transparency as well as increased stability through longer allocations periods. If these measures are taken they will improve the efficiency of promoting large-scale investments and technology development. They will also increase the policy acceptance for the EU-ETS, forming a basis for the continuous work on the climate policies, which is important in light of a future progressive climate agenda. The acceptance will however, independent of the design and harmonization on an EU level, remain low if the scheme is not accompanied by an international ETS with broad participation and similar emission commitments. It is however positive that the EU takes a proactive position on emissions trading, as to promote important decisions on a post-2012 international agreement. *The allocation procedure is further discussed in Chapter 10.3.*
The REC scheme was initially designed with a timeframe that was too short to promote large investments in new production capacity. The scheme provided stronger support for capacity increase in existing operations. As the timeframe was extended from 8 to 28 years, the instrument has received a much higher acceptance in the basic industry and energy utilities. As this timeframe also to a much greater extent complies with investment calculi in the business sector, the efficiency of promoting new investment have been significantly improved. The stability is currently depending on amendments of included RES, quota levels, stakeholders and countries. Any changes of these characteristics should thus be weighed against the possibility of reducing the increased stability and thus efficiency of the scheme. A positive development would be to expand the scheme to other countries, as a broader participation has positive REC market effects. The introduction of a time-limit on the issuance of RECs can be challenged on the grounds that this adds to the electricity price increase resulting from the scheme. This issue is important in light of the increase in electricity prices already seen as an effect of the EU-ETS. The interviews provide a contradictory picture of whether feed-in tariffs or RECs are the better option in the support of RES.

While some interviewees argue that the REC scheme should be superfluous parallel to the EU-ETS, the scheme is justified on the basis of RES targets and the importance of energy security. This is emphasized by the interviews that indicate that the EU-ETS is not effective in promoting RES. There REC scheme is also supported by indications that the scheme could reduce the cost of complying with the EU-ETS. The interviews identify that the REC scheme has been important for increased electricity production with RES both in utilities and the pulp and paper industry. Research have however shown that the REC scheme does not provide sufficient support to prioritized RES developments, such as offshore wind power, which would promote the continuation of policies specifically supporting this development. The additional support could be supplied by the EU-ETS, especially if designed with increased
stability and EUA prices stabilized at higher levels than at present. This could prove vital if subventions are phased-out due to EU policies. The RES support of the REC scheme and EU-ETS in combination is however difficult to predict, as discussed above.
7. Non-Market Based Economic Instruments

The main non-market based policy instruments in the energy and environmental sector are taxes and tax subventions. There are currently three energy taxations aiming to influence the type and carbon dioxide intensity of utilized fuels – the carbon dioxide and energy taxes.\textsuperscript{165} Subsidies are, as a result of EU directives and the Common Market, generally being removed and instead replaced by taxes or market based instruments. Technology procurement is used as a policy instrument to promote environmental technology development. Voluntary agreements are another instrument that can be established between the Government and business sector where both parts undertake obligations in the other parts favor.

\textsuperscript{165} The third energy taxation is a sulphur tax but since sulphur emissions are not part of the thesis scope it is not discussed here.
The explanation of a fiscal policy system is difficult – readers should bear in mind that it is not uncommon that the Swedish National Tax Board releases their own interpretations of how the fiscal policy system and changes thereof should be interpreted. The following however clarifies the general outline of the system. The chapter ends with a summary that highlight the most important instrument characteristics.

7.1 Taxes

In 2001 the Government decided on a green tax-shift aiming to utilize the tax system to support the environmental goals through stronger environmental steering (Bill 2000/01:1). The shift involves that the environmental taxes, for example energy and carbon dioxide taxes, are raised without raising the total tax burden, as the raise is offset by reduced taxes on labor. This shift emphasizes the effects of the taxes and consequently strengthens the steering effect of the individual levies. This type of tax systems are promoted in the EU sustainable development strategy (European Council, 2006b).

An important aspect in tax administration, as defined by inter alia Hammar (2005), is that their steering power is stronger the closer the tax level is to the marginal emission abatement cost, as the incitement to change under those conditions is maximal. The relative steering efficiency decreases at higher tax levels and raising taxes from an already high level consequently have limited effects. It is important to make a distinction between fiscal taxes and governing taxes – the former aims at producing an income to the Government to cover national expenses while the latter aims at reaching specific goals. Both naturally have implications for the other. This

\[166\] See specific laws for complete information on tax designs.
distinction is however not always clear and using governing taxes for fiscal purposes, or vice versa, could imply that inaccurate tax levels are levied. Regarding policy stability, the Swedish tax system has received criticism by the IEA (OECD and IEA, 2004) for being short-term, causing negative effects on the design of the instrument steering efficiency. This viewpoint was also expressed during the interviews by Anders Lyberg (2005) at Cementa.

Green Tax-Shift

The Government sees the green tax-shift as a central tool to fulfill the political vision of an ecologically sustainable society by creating economic incitements that promotes products with lower environmental impact (Bill 2000/01:1). Green tax-shifts are generally regarded as a positive policy tool, albeit several articles (Beuermann and Santarius, 2006; Clinch and Dunne, 2006; Dresner et al, 2006; Klok et al, 2006) points to the necessity of assuring a correct design as to be accepted by the public and business sector. Bosquet (2000) has analyzed environmental tax-shifts in several countries, finding that the empirical evidence indicates that countries could gain both in environmental and economic terms by enforcing them. Important is, that Bosquet concludes that the tax reform may be harmful for the competitiveness of the energy-intensive industry. A report by Brännlund (2005) has criticized the tax-shift in a report that analyzes the effects of the shift up to 2005. Two of the main points of criticism are that the high double dividends that any tax-shift aims for has not been accomplished and that the system has undermined the positive steering effects and economic efficiency of the carbon dioxide tax due to several exemptions.

In the 2001 National Budget (Bill 2000/01:1) it was estimated that a total of SEK 30 billion could be shifted between 2001-2010 and according the 2005 and 2006 budgets

\[167\] Also called environmental or ecological tax reform.
3.4 billion SEK will be rotated during 2005 (Bill 2004/05:1) and 3.6 billion SEK during 2006 (Bill 2005/06:1). The new Government initially decided to annul the tax-shift (Bill 2006/07:1) but statements in the media by the Environmental Minister have later indicated the opposite (Veckans Affärer, 2006). There have consequently not been taken any decisions on the magnitude of the upcoming tax-shifts.

The tax-shift system can be criticized to jeopardize State finances, as the environmental tax incomes are volatile and that the tax-shift income base, for example fossil fuels, is steered away from. The Government has however argued the income base to be relatively stable and that the tax-shift base, if necessary, could be broadened to include for example biofuels – although at a lower tax level as not to remove their competitiveness (Bill 2000/01:1; Swedish EPA, 2004). However, the idea to impose taxes on biofuels in order to maintain an environmental tax-shift is extremely ambiguous. If such measures are necessary it should be considered that the energy system has reached the level of sustainability that the tax-shift aimed for and that the tax-shift consequently should be canceled. By continuing the tax-shift through including biofuels if, or when, the energy system reach such level would cause serious acceptance and credibility problems in the business sector. The taxation of “greener” alternatives should consequently be avoided within a “green” system.

**General Taxation Rules and Tax Levies**

The taxes included in the scope of the thesis are the energy taxes, carbon dioxide and nuclear thermal effect tax. The energy taxes are divided into three parts including the fuel, electricity and sulphur taxes.\(^{168}\) A general Swedish rule is that energy should only be taxed once and no tax is therefore levied on fuels that are used in electricity production. The fuel and electricity used in heat production is taxed, as no tax is

\(^{168}\) The sulphur tax is not included in the scope of the thesis.
levied on heat. Biofuels are generally only taxed if they are sold as engine fuels, with exception of, for example, synthetic methane. There has been an extensive debate on whether peat should be considered as a fossil fuel or a biofuel. Some institutions assert that peat should be viewed as a fossil fuel while other considers that it should be treated as a biofuel. (For more information about peat, see Chapter 3.3.) Fuels used in pilot projects aiming at developing more environmentally friendly fuels are excluded from taxes. Both the carbon dioxide and energy taxes are recalculated each year.

Table 7.1 Swedish energy and carbon dioxide tax levels (2006)

<table>
<thead>
<tr>
<th>Energy source</th>
<th>Energy Tax</th>
<th>Carbon Dioxide Tax</th>
<th>Total(^1) (öre/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fuel</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas Oil (No1, SEK/m(^3))</td>
<td>-</td>
<td>551</td>
<td>551</td>
</tr>
<tr>
<td>Medium Heavy Fuel Oil (No5, SEK/m(^3))</td>
<td>-</td>
<td>551</td>
<td>659</td>
</tr>
<tr>
<td>Coal (SEK/ton)</td>
<td>-</td>
<td>479</td>
<td>629</td>
</tr>
<tr>
<td>LPG (SEK/ton)</td>
<td>-</td>
<td>579</td>
<td>579</td>
</tr>
<tr>
<td>Natural Gas (SEK/1000m(^3))</td>
<td>-</td>
<td>413</td>
<td>413</td>
</tr>
<tr>
<td>Crude Pine Oil</td>
<td>551</td>
<td>-</td>
<td>551</td>
</tr>
<tr>
<td>Peat (SEK/m(^3))</td>
<td>-</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td><strong>Electricity Consumption</strong></td>
<td>0.5</td>
<td>-</td>
<td>0.5</td>
</tr>
</tbody>
</table>

\(^1\) May differ due to other taxes such as sulphur tax

*Source: National Tax Board of Sweden, 2006 (Data for industries included in the EU-ETS plus heat production in district heating plants. These operations receive 79 % carbon dioxide tax deduction and 100 % energy tax deduction. The above data is associated with conditions such as sulphur and moisture content. The waste incineration tax is associated with a number of conditions making it difficult to provide a specific levy here. For exhaustive and continuously updated information see http://www.skatteverket.se.)*

The Swedish energy tax system, governed by the Law of Energy Taxes (SFS 1994:1776), currently levies different tax levels on different business sectors. This is conflicting with EU Community guidelines on State aid for environmental protection (EC, 2001b), meaning that the Swedish carbon dioxide and energy taxes must be
modified so that they are equal for all stakeholders. The European Treaty of Nice (European Union, 2002) labels energy tax subventions to the industry as state aid, which must be granted by the European Council. The EU further harmonizes the tax rules through the Energy Tax Directive (2003/96/EC).

The Committee on Energy Taxation of the Business Sector

As part of the adaptation to the Energy Tax Directive (2003/96/EC) a committee named Skattenedsättningskommittén (SNED), or the Swedish Committee on Energy Taxation of the Business Sector, was in 2001 appointed by the Government to examine the taxes levied on energy used for heating and operation of stationary motors in the business sector. This was done to support the green tax-shift in the light of the EU rules and to analyze how the taxes could be reduced for the business sectors that are subject to international competition. The Committee’s findings were presented in 2003 in the report “Svåra Skatter!” (SOU 2003:38), which presented a new energy taxation model. The main element of the model was that all business sectors, including energy utilities, are subjected to competition. The model, called the business-sector model, excludes business activities from the energy tax, only levying the carbon dioxide tax plus the EU minimum tax on electricity consumption called for by the Energy Tax Directive. Energy utilities are taxed the same way as other business sectors, thus having the energy tax removed. The report furthermore suggested that the tax levied on carbon dioxide emissions and electricity consumed should not exceed 0.7% of energy intensive companies’ sales values, if not conflicting with the EU minimum tax rates. Due to suggestions by the Committee the exclusion of energy tax on electricity consumed in the industry has been removed.

---

169 Based on an evaluation by the Commission according to state aid rules.
171 Eng: Difficult Taxes! The report supported its title by being 716 pages long.
172 Sulphur tax also levied.
and replaced with a process related electricity tax that corresponds to the EU minimum electricity tax level of 0.5 Euro per MWh. The industry can reduce this tax through participating in the Programme for Energy Efficiency (Chapter 7.3).

The 2005 spring budget (2004/05:100) established that a further review of the tax system is necessary, inter alia due to a possible increase of progressive environmental features due to the transition to a sustainable society. A Bill (2006/07:13) on the last adaptations to the Energy Tax Directive was published in 2006. The Bill resulted in a taxation of tax relieved biofuels as Sweden currently has no authorization from the European Commission for this policy.

**Taxation of Wastes**

An official committee, called “the BRAS investigation”, has analyzed the possibilities to encourage a higher level of recycling of waste material. The investigation was commissioned to identify whether this, if environmentally motivated, is best achieved through designing a new tax on waste incineration or by using other economic policy instruments. The findings were presented in an official report (SOU 2005:23), which concluded that the fossil fraction of incinerated wastes is subsidized, as other fossil fuels are taxed under the Law of Energy Taxes (SFS 1994:1776). This situation is deemed to undermine the purpose of tax exemptions on biofuels. The best way to amend this issue, and to promote higher levels of recycling, was identified as levying the present fuel energy tax on the fossil fraction of waste. Birgitta Resvik (2005) at the CSE identifies that this design of the tax can cause erroneous incentives if the utilization of certain industrial internal fuels, for example process gases in the chemical industry, are classified as waste as this would cause sub-optimizations from a resource and energy management perspective.\(^{173}\) The waste

\(^{173}\) These gases receive full subvention from carbon dioxide and energy taxes since 1 January 2007.
incineration tax was introduced 1 July 2006, through the Bill 2005/06:125, which includes the tax in the tax deductions (100 %) that applies for the industry and heat production in cogeneration plants.

The Swedish Society for Nature Conservation (SSNC, 2005a) has criticized that the BRAS investigation did not include any general combustion tax on waste. Their critique has its origin in the EU waste hierarchy, which is supported by Sweden (Bill 2002/03:117), that waste should foremost be prevented or recycled. The option to incinerate waste should thus only be used when these two options are not possible. The SSNC considers that the suggestions made in the report do not change the situation where it is much more profitable for the waste companies to incinerate than to recycle and identifies a waste incineration tax as the most effective way to reach the waste goals.

7.1.1 Carbon Dioxide Tax

As the first country in the world a Swedish carbon dioxide tax was introduced in 1991 on a proposal by Miljöavgiftsutredningen. The tax was introduced to serve as an incentive for consumers to switch to fuels with lower carbon content, improved utilization efficiencies and the implementation of new technologies. The Government identifies that the tax has been effective, having successfully accomplished large-scale emission reductions (Bill 2005/06:172). This position is supported by the SEA and Swedish EPA (2004d) who has identified that the tax has been most effective in the promotion of RES in district heating systems (2006b). The agencies further identify that the carbon dioxide tax has a high level of goal compliance, but that the possibility to further increase its steering through increased tax rates is limited, due to the high levels already being levied (ibid). This challenges earlier suggestions in a

174 In English the Environmental Fee Investigation
Swedish EPA (2004) report concerning the structure of the tax-shift that a scenario, where the carbon dioxide tax is annually raised with 5 % is identified to have the best prerequisites to support the Government’s long-term climate goal.

The tax is based on the consumed fuels instead of on carbon dioxide emissions. Fuels used in forestry and industrial operations – manufacturing, sales, administration and R&D – receive a 79 % tax deduction. A 100 % deduction of the carbon dioxide tax is applied to fuels consumed at oil refineries plus carbon fuels and petroleum coke in metallurgical processes – from sintering to castings. A full deduction is also applied to all fuels, except for high-taxed oil, for production of taxed electricity. For CHP plants the tax is proportioned to the different fractions of electricity and heat that is produced. Fuels that are proportioned to the heat production deducted based on the production efficiency while fuels for the electricity proportion are fully (100 %) deducted. The tax is levied by volume or weight of consumed fuels. District heating deliveries receive full energy and 79 % carbon dioxide tax deductions. In an international perspective the carbon dioxide tax levy has been high and still maintains a very high level as it has been strengthened over time. The use of CCS would lead to reimbursement of paid tax in relation to achieved emission reductions.

The National Budget for 2006 (Bill 2005/06:1) heeded the business sector’s call for annulling the carbon dioxide tax. The Budget thus suggested that industries and  

---

175 Other than petrol and high-taxed oil.  
176 This does not apply to the portion of fuel used to generate electricity consumed in the production processes (5 % according to current standard.) From 2006 the deduction is however removed for electricity, heat, gas and water utilities (Bill 2005/06:1).  
177 For more information and tariffs, see SFS 1994:1776.  
178 This have only occurred at a few occasions where greenhouses have received reimbursement for sequestration vegetables.
high-efficiency CHP plants\textsuperscript{179} included in the EU-ETS would be excluded from the tax while other included energy utilities would receive a tax deduction of 13 öre per kg carbon dioxide. The changes were set to be in force from the 1 January 2006 but the spring budget (2005/06:100) later postponed this until 1 January 2007. The 2006 Climate Bill (2005/06:172) established that the phase-out of the tax should be gradual. This is an example of a procedure that can hinder positive environmental investments and reduces the policy acceptance due to short-term politics. Whether or not the tax deductions will be realized is however now related to a European Commission investigation on whether the annulment constitutes as impermissible state aid. The investigation is initiated against the background of whether the tax deductions would violate the minimum tax levels in the Energy Tax Directive and the polluter pays principle (EC, 2006e).

The industry can apply for a tax reduction for the share that exceeds 0.8 % of the sales value, which is meant to improve the energy intensive basic industries’ international competitiveness. The reduction is allowed to an amount that does not exceed 24 % of the surplus tax of the fuel. The reduction is allowed by the EU as long as the EU minimum tax rates for different fuels is not surpassed and the rules for deductions, stipulated in the Energy Tax Directive (2003/96 /EC), is adhered. The 0.8 % rule has been reviewed accordingly and has been adapted to the EU definition of an energy intensive industry (Bill 2006/07:13). A rule that allowed tax reduction with 1.2 % of the produced sales value in the production of commodities from non-metallic minerals, such as cement and glass, has been phased-out.

\textsuperscript{179} A suggestion for a full deduction of the tax for high-efficiency CHP operations (at least 38 % electric efficiency and at least 89 % total efficiency) has been submitted to the EU for approval. The definition is different to that within the EU, which defines high-efficiency cogeneration operations as having improved the total efficiency by at least 10 % compared to separate production (Directive 2004/8/EC). This definition is also used in labeling of high-efficiency cogeneration (\textit{Chapter 9.2}).
**Stakeholder Perspectives**

The basic industry and energy utilities take the unanimous position that the carbon dioxide tax results in double financial burden due to the introduction of the EU-ETS (Carlsson, 2005; Chudi, 2005; Hannus, 2005; Käck, 2005; Levander, 2005; Lyberg, 2005; Resvik, 2005; Sunér Fleming, 2005; Tollin, 2005). This is also supported by *inter alia* Sorrel (2003) who nevertheless identifies that retaining the tax may be necessary to strengthen the polluter pays principle in the case of free allocations.180

Birgitta Resvik (2005) at the CSE identifies that it is important that the tax is removed for the Trading Sector as a measure to alleviate some of the effects of the EU-ETS, in particular for the basic industry. Resvik regards that this was promised the business sector before the scheme was launched. Thomas Levander (2005) at the SEA makes a reservation in reference to CHP production which he argues should be subjected to the tax as the sector could otherwise revert to fossil fuels. The SSNC consider that the double burden should not be considered as a problem, as the industry has to take their responsibility for the environmental impact of their operations (Rylander, 2005). The SSNC argues that the tax, that has proven historically successful, should not be removed or altered until it is proven that the EU-ETS is efficient in accomplishing reductions of carbon dioxide.

Gunnar Käck (2005) at Fortum Värme identifies that the tax level increase – resulting from the green tax-shift – is larger than necessary, concluding that it had sufficient effect at previous levels. Maria Sunér Fleming (2005) at Swedenergy argues that the carbon dioxide tax has previously hampered the development of the CHP sector and that the tax deduction, levying the same lower tax level on CHP production as for the industry, therefore is positive. Birgitta Resvik (2005) at the CSE identifies that the carbon dioxide tax have had a strong impact on the operation and choice of fuels in

180 See discussion on allocation difficulties in *Chapter 10.3* for further notes on these aspects.
CHP plants. One of the reasons for this is that the costs for these measures can be laid out on the customers in regional markets such as district heating systems (ibid).

7.1.2 Energy Tax

The Swedish energy tax is levied on fuels and electricity and is used both for governing energy consumption and for fiscal reasons, where the latter usually has been the driving force. In contrast to the carbon dioxide tax the energy tax differentiate oil products in different environmental classes. The tax is proportioned to the environmental impact of fuels and not to the different energy values. The SEA and Swedish EPA (2006b) identifies that the energy taxes have a high level of goal compliance efficiency and includes a positive environmental side effect.

The energy tax on fuels is in most occasions levied in the same fashion as the carbon dioxide tax, it is for example subject for deduction when the fuel is consumed in forestry and industrial operations. Oil refineries, metallurgical processes plus CHP and electricity production have the same energy tax deduction rules as applies for the carbon dioxide tax. The difference is that the deduction is 100 %. An energy tax is levied on crude pine oil, and while it is not subject to carbon dioxide tax since it is a biofuel, the energy tax corresponds to the combined energy and carbon dioxide tax levied on low taxed light fuel oil.\(^{181}\)

The Swedish legislation on energy taxation has, as discussed above, been adjusted to the EU Community Law with respect to the Energy Tax Directive (2003/96/EC). Countries can however levy selective taxes on fuels that are not included in the

\(^{181}\) There are some exemptions and additions to these rules, for more information and tariffs see SFS 1994:1776.
Community Law as long as it does not result in any border controls between Sweden and another EU membership country.

Table 7.2 Fuels with minimum tax levels in EU

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Tax Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaded and unleaded petrol</td>
<td>Methane</td>
</tr>
<tr>
<td>Diesel oil</td>
<td>Natural gas</td>
</tr>
<tr>
<td>Light fuel oil</td>
<td>Coal fuels</td>
</tr>
<tr>
<td>Heavy fuel oil</td>
<td>Petroleum Coke</td>
</tr>
<tr>
<td>Paraffin</td>
<td></td>
</tr>
</tbody>
</table>

*Source: Directive 94/74/EC*

The Community Law includes rules on minimum tax levels on the fuels in *Table 7.2* and it is not allowed to levy lower tax levels than this, albeit the EU minimum level can be zero. The minimum levels are differentiated and in most cases have three different minimum levels depending on whether they are used for heating, stationary motors or vehicles.

Fuels within the EU can be distinguished as EU-harmonized and non-EU-harmonized fuels, where the former have common taxation rules in all member countries. EU-harmonized fuels are mainly gasoline, diesel, light fuel oil, paraffin, methane, LPG and petroleum gas. These are directly taxable, which means that they are subject for taxation regardless of where they are used if no tax exemptions are applied. Fuels not attached to this group are classified as non-harmonized and thus not directly taxable with the exemption of natural gas, coal fuels, petroleum coke and crude pine oil. Furthermore, products that becomes taxable if sold or consumed as motor fuels or for heating purposes belong to the non-harmonized group.
The majority of electricity produced in Sweden is subject to energy taxes on electricity. Some exceptions from this apply, for example, for electricity produced in non-commercial wind turbines. A special tax deduction is also available for the first 20 MWh produced in commercial wind power turbines, which is meant as an environmental subvention (Chapter 7.2).

The EU minimum electricity tax rate of 0.5 Euro per MWh, modified to 0.5 öre per kWh in Sweden, was introduced on the 1 January 2004 through changes in the Law of Energy Taxes (SFS 1994:1776). A Government Bill (2003/04:144), on tax deductions for electricity in certain industrial processes, however suggested, in accordance with the Energy Tax Directive (2003/96/EC), that this tax should be excluded from certain activities. The Bill was accepted resulting in the exclusion of the tax for electrolytic processes and chemical reduction\textsuperscript{182} if the majority of the electricity is consumed in the processes. Furthermore, electricity for heating of kilns used in metallurgic processes from casting to forging, including the consumption in hot galvanizing was excluded. Moreover, electricity consumed in mineralogical process for production of for example cement, lime and glass is also excluded. Electricity consumed by motors, pumps, fans, lighting and other auxiliary systems included in all industries. The energy intensive industry can annul the new electricity tax through participation in the PFE.

**Stakeholder Perspectives**

The industry sees the introduction of the PFE as positive as the programme provides an opportunity to annul the tax (Chapter 7.3). Peter Chudi (2005) at E.ON Sverige identifies that the energy taxes have been short-term and laboratorial, which have created difficulties for the energy utilities to optimize their operations. This has

\textsuperscript{182} These processes are mainly used in the metallurgic and mineral industry.
resulted in uncertain investment calculi that have hindered the company to realize new investments, particularly in CHP production.

Swedenergy (Sunér Fleming, 2005) identifies taxes as less effective than market based instruments and that this situation is emphasized when the taxes and tax levels are not internationally harmonized, as is the case in Sweden. Maria Sunér Fleming (2005) at the organization identifies that the level that the tax has been raised to lacks a larger system perspective. Gunnar Käck (2005) at Fortum Värme argues that the electricity tax should be allocated to the consumers, especially if viewed as a fiscal tax and for energy efficiency steering reasons. Anders Lyberg (2005) at Cementa identifies the EU Energy Tax Directive (2003/96/EC) to be a positive example of efforts aiming to harmonize policy instruments.

7.1.3 Nuclear Thermal Effect Tax

This tax may not be of immediate importance here, as it does not directly affect the emissions of carbon dioxide from the Trading Sector. Since it nevertheless is an energy tax and affecting nuclear operations and the energy system it is mentioned briefly. It is, in contrast to the carbon dioxide and energy taxes, based on the production rather than the consumption of energy. The tax is levied as a sanction, but does not cover the dismantling and waste management of the plants, as this is covered by a separate fee. One reason for the implementation of a nuclear energy tax is to balance out the carbon dioxide tax market effects in reference to RES. The carbon dioxide, implemented to promote RES, would otherwise steer the development also towards nuclear energy. Following this, the nuclear thermal tax must follow the development of the carbon dioxide tax and the relationship between the production and fuel cost of RES and nuclear utilities.

The tax was formerly levied on the amount of electricity produced at nuclear plants. This was changed in 2000 when a tax that is levied on the thermal effect of the plants
was introduced. In 2005 the tax level was 5,514 SEK/MW\textsubscript{thermal} and month, which resulted in average level of 2.7 öre per kWh produced (Swedenergy, 2005). The tax was almost doubled in 2006 to 10,200 SEK/MW\textsubscript{thermal} and month.

### 7.2 Subventions, Subsidies and Investment Programmes

All the above different tax reductions are subventions\textsuperscript{183} that are meant to improve the market conditions for specific stakeholders, operations and commodities. There is, internationally as well as within EU’s free market, a strong resistance towards subvention systems, as they tend to distort the market conditions with regards to pricing and resource allocation. The Commission, for example, take a strong position against their use in the EU sustainable development strategy (COM(2001) 264 final), which promotes that they should be eliminated to 2010. The updated strategy (European Council, 2006b) declares that a report on how to eliminate environmentally hazardous subventions should be put forward by 2008. Kverndokk \textit{et al} (2004) identifies that subventions have negative implications on the market introduction of new technologies.

Subventions have nevertheless been popular by politicians in a past perspective, as they are effective policy instruments that clearly depict the Government’s will. They are today gradually being phased-out and are often replaced with taxes, but are nevertheless expected to be used in the transition towards a sustainable energy system. Most subventions targeting RES have been replaced with the REC system,

\textsuperscript{183} The difference between subsidies and subventions used in the thesis are that subsidies are a financial \textit{contribution} while subventions are a \textit{reduction} of a financial burden.
which is meant to work as continuing support for the wind power goal as well as other renewable energy goals.

Wind energy developments are prioritized by the Government and specific policy instruments therefore support the production. Wind power installations receive an energy tax subvention\textsuperscript{184}, which in 2006 is 6.5 öre/kWh for land-based turbines and 15 öre/kWh for sea-based turbines in Lake Vänern or the Baltic Sea, on produced electricity during the first 20,000 kWh produced. The subvention is gradually being phased out (Table 7.3) and will end in 2010. This phase-out is identified as positive by Johan Tollin (2005) at Vattenfall, who views this to be in agreement with the framework established through the REC scheme (Chapter 6.2). Wind power investors can also apply for a governmental investment subsidy for technology development and construction of wind turbines.\textsuperscript{185} The 2006 Bill (2005/06:143) on wind power does not include any information on the financial support other than the REC scheme and the current design is thus likely to remain in the short-term.

Operators of small-scale electricity production (<1.5 MW) receive a reduction of the grid connection costs and only pay for the costs of measuring and reporting. This reduction does not change the situation where larger installations of for example wind turbines have higher feasibility. The 2002 Energy Bill (2001/02:143) raised the concern that this reduction should be annulled and a 2004 Government inquiry (SOU 2004:129) has supported this. A 2006 Bill (2005/06:158) also support this, but nevertheless find that the issue need to be further analyzed.

\textsuperscript{184} Also referred to as an environmental bonus.
\textsuperscript{185} Åstrand and Neij (2006) have criticized the policy support to wind power, Chapter 3.2.4.
Table 7.3 Energy tax deductions for wind turbine installations (öre/kWh)

<table>
<thead>
<tr>
<th>Year</th>
<th>Land based</th>
<th>Sea based</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>2005</td>
<td>9</td>
<td>16</td>
</tr>
<tr>
<td>2006</td>
<td>6.5</td>
<td>15</td>
</tr>
<tr>
<td>2007</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>2008</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>2009</td>
<td>0</td>
<td>12</td>
</tr>
</tbody>
</table>

Source: Bill 2003/04:1

Strict subsidies are increasingly difficult to implement due to for example the EU Common law and state finances. The support thereof is consequently low and the SEA and Swedish EPA (2006a) have also identified subsidies as being less cost-effective than taxes. The use of subsidies is nevertheless identified as offering a policy solution when taxation is impractical. Subsidies supporting operations have thus, apart from wind investment subsidies and KLIMP (below), been replaced with investment support that provides a larger stability in the financial support for the receiver.

In 1998 the Government initiated a Local Investment Programme (LIP) that was aimed at subsidizing climate investments. The LIP was in 2003 replaced with a Climate Investment Programme (KLIMP) with the same objectives. The support is provided to investments GHG reduction activities or equipment, transition towards RES and energy efficiency improvements. The KLIMP is aimed to have large effects in a long-term perspective to 2050 as well as in the short-term 2008-2012. The programme is mainly directed towards municipalities but the industry can apply for funds if the project involves measures in more than one county. The KLIMP programme has been identified by the Government as being an important policy
instrument and therefore suggested, in the 2006 Climate Bill (2005/06:172), to strengthen the instrument with additional funds and to allocate 320 MSEK for 2007 and 2008. The available sum for 2007 is SEK 2.4 billion. A study (Johansson, 2006a) of the LIP programme identifies that the subsidy programme was an efficient policy instrument, from a carbon dioxide emission reduction perspective as well as from a cost-efficiency perspective.

7.3 Voluntary Agreements and PFE

Voluntary agreements can be established between the Government and private stakeholders. Within the scope of the thesis, these are the Trading Sector. The agreement takes the form of a binding contract where a company undertakes quantified environmental goals, which have been negotiated jointly with the Government. These goals can be focused on different measures, such as emission reductions or energy savings. The Government corresponds by offering the company different benefits, such as tax subventions or consultancy services. The instrument is categorized as economic, since the Government usually offers tax subventions, but could also been viewed as an administrative instrument as it takes the shape of a binding contract. Voluntary agreements can be used in different ways depending on the environmental target, for example to promote emission reductions, and has particularly been used in improving energy efficient technologies and measures. Voluntary agreements can also be used to relieve different business sectors of other policy instruments that are considered to cause competitive disadvantages, which is the case of the Programme for Energy Efficiency (PFE) explained below.

Voluntary agreements have mainly been used in combination with taxes or other policy instruments to provide an incitement for companies to participate. This type of combination has been found to be beneficial for the effectiveness of the instrument (Helby et al, 1999). A study of Danish industrial voluntary agreements showed that a
system, where carbon dioxide tax reductions are offered to the participating companies, have a significant influence on their energy consumption and were more effective than just levying the tax (Bjørner and Jenssen, 2002). Noteworthy is that the study suggests that the agreement alone, demanding certain energy saving measures, led to reduced energy consumption (-9 %), but that the tax reductions under the agreement led to higher consumption of energy (+1-5 %). This indicates that the energy consumption of the industries participating in the PFE should be monitored and the offered tax reductions evaluated against this background. Johannsen (2002) have identified negative aspects of voluntary agreements, such as high administrative costs and modest diffusion of efficient technologies between companies. In the Netherlands case, where long-term voluntary agreements have been utilized as they key policy instrument promoting industrial energy efficiency, the outcome has been an estimated 27-44 % energy savings in the participating companies (Rietbergen et al, 2002).

The basic requirement for a voluntary agreement is that the negotiated targets must be stringent enough to make the measures taken by the industry additional, meaning that they result in further improvements than would otherwise have been accomplished. The possibility to put sanctions on the stakeholders that do not fulfill the contract is necessary to get an efficient policy instrument management. The EU (EC, 2005a) supports the use of voluntary agreements to promote improved energy efficiency in the industry sector and has issued policy design recommendations (COM(96) 561 final).

Swedish voluntary agreements on energy efficiency have previously been used in the EKO-Energi programme, open for signature 1994-1997 ending in 2002. The programme committed the 47 participating companies to implement energy management systems and show results of improved efficiency. The Government offered energy audits or environmental certification if the target was fulfilled. The positive results of the programme were that some companies incorporated energy
efficiency as an environmental goal and that the knowledge of energy efficiency as a
corporate strategy disseminated in the company structures (Helby, 2002). From a
marketing perspective the participation in the programme, leading to an EKO-Energi
label, was barely used for marketing purposes (ibid). Neij and Öfverholm (2001) have
identified some positive characteristics of voluntary agreements in connection to this
programme, where participating companies that adopted energy efficiency policies
have allowed longer payback times for investments in energy efficiency, thus
regarding them as strategic. Göran Carlsson (2005) at SSAB identify that voluntary
agreements possibly could be utilized as an alternative to the EU-ETS.

One of the positive trademarks of voluntary agreements is that they can be adopted
to specific market conditions and thus reduce the sensitivity that could occur with
binding instruments. Ylva Rylander (2005) at the SSNC identifies voluntary
agreements as potentially effective policy instruments but argues that they are
heavily reliant on the participation by the main stakeholders to receive a market
penetration that will also encompass smaller operations.

Programme for Energy Efficiency (PFE)

A large-scale voluntary agreement scheme has been introduced through the
Programme for Energy Efficiency, targeting the energy intensive companies in the
industrial sectors (SNI 10-37) that are subjected to the new process related electricity
tax.\(^{186}\) A programme targeting energy efficiency was first mentioned in 2000 when
the Government appointed an official investigation on the possible design of long-
term agreements with the energy intensive industry aiming at improved energy
efficiency and reduced emissions of GHG’s.\(^{187}\) The Energy Bill (2001/02:143)

\(^{186}\) Thus excluding the mineral and metallurgic industry sectors.

\(^{187}\) Göran Carlsson (2005) at SSAB mentions that discussions on voluntary agreements were carried out
during this period but that the discussion came to nothing.
established that implementing voluntary agreements into the energy and climate policies could contribute to the fulfillment of Sweden’s national climate target as well as the KP commitment. The Energy Bill further emphasized that the instrument should promote cost-effective efficiency measures and the international competitiveness issues. The official investigation established that such a programme would be effective and that an economic incentive, preferably tax subventions, should be added as these stakeholders are subject to international competition (Ds 2003:51). The PFE also complies with the requirements of the EU End-Use Efficiency and Energy Services Directive (2006/32/EC) with regards to energy audits and voluntary agreements.

When the EU opposed the Swedish zero tax level on electricity, the Government implemented the EU minimum electricity tax level and raised the tax to 0.5 öre per kWh. As a result, following previous official reports, the PFE was introduced to allow a total deduction of the new tax level for participating companies in the energy intensive industry, taking EU rules into account. The programme design was outlined by the Bill 2003/04:170 and is regulated through the law SFS 2004:1196.

To participate in the programme companies have to be approved by the SEA, acting as the supervising authority. The approval is based on four requirements:

1. The company shall run industrial operations
2. It shall use electricity in the production processes
3. It shall be energy intensive\textsuperscript{188}
4. It can be expected to fulfill the requirements of the programme

\textsuperscript{188} The definition of the energy intensive industry is the same as in the 2003 EU Energy Directive (2003/96/EC).
Companies, or a part thereof that can operate independently, can participate if they meet these requirements and if the purchase of energy products and electricity amount to at least 3 % of the production value or the national energy tax amounts to at least 0.5 % of the added value.\(^{189}\)

The programme requires the participating industry companies to initiate a standardized energy management system (EMS). This system shall be documented and include requirements that the company has to:

- Establish an energy policy
- Continuously analyze the overall energy consumption and the specific electricity consumption, and declare what efficiency measures that are planned
- Declare energy targets that are quantifiable and dated
- Establish an action plan which outlines how the energy targets are to be met, what resources this demand, when actions shall be initiated and completed
- Initiate routines to secure that the company;
  - evaluate its energy use
  - measure the consumption that is essential to fulfill the energy targets
  - follows the EMS
  - Inform and educate employees in such an extent that the EMS can be fulfilled
- Create an organization and supply the funds that is required for the EMS to function

\(^{189}\) Calculated on a typical-year basis following the EU definition of energy intensive industries in the Energy Directive (2003/96/EC). Although the Swedish Government has chosen not to, countries are allowed to impose more stringent rules with regards to sales value, process and sector definitions.
Companies are also obliged to describe the energy use in its processes and how the energy efficiency can be improved in the short and long term.\textsuperscript{190} Identified efficiency improvements with a calculated payback time shorter than three years shall be included in the abovementioned action plan. Any projections and/or changes in the processes shall be evaluated using LCA. Purchased electricity intensive equipment shall be of the highest energy standard class or have the lowest LCA-cost (if the additional cost of equivalent equipment have a lower payback time than three years). Under extraordinary conditions companies can apply at the programme’s supervising authority for permission not to carry out an efficiency measure. If the contract is not fulfilled the tax deduction has to be reimbursed.

The programme runs over a period of five years that is individual for each participating company. During the first \textit{two years} of a contracting period the companies are responsible for performing an energy survey and analysis of its energy use, introducing and certifying an EMS. The companies also have to issue an inventory of planned measures that are expected to realize the same level of efficiency improving as the tax of 0.5 Euro per MWh would have imposed. Companies shall also have introduced routines for changes in the purchasing processes of electricity intensive equipment as well as issuing a document proving that the measures follows the recommendations in the PFE. \textit{During year three to five}, companies are obliged to apply the EMS plus other routines and measures. \textit{After five years}, the companies shall issue a document identifying that the requirements have been fulfilled and the effect of the implemented routines. It is then possible for companies to participate in the programme for another period. This follows a suggested framework for voluntary agreements by Lindén and Carlsson-Kanyama (2002), in a study which draws conclusions from the EKO-Energi programme.

\textsuperscript{190} Five and ten years.
In March 2005, the SEA predicted that about 100 companies would eventually participate in the programme, covering about 75% of the industrial electricity consumption (Åberg, 2005). The six largest companies account for 30% of the total consumption included and the largest participating sector is the pulp and paper industry. If the system however proves to be ineffective in promoting energy efficiency measures, further exemptions from the tax are unlikely to be allowed by the EU (Peterson, 2005). An evaluation after the two first years of operation the SEA (2007x) has reported that 117 companies participates, representing one-fifth of the Swedish and half of the industry sector’s electricity consumption. These will under the PFE invest SEK 1 billion in measures that are estimated to accomplish electricity savings of at least 1 TWh per year.

Figure 7.1 Participation in the Programme for Energy Efficiency (2006)

![Participation in the Programme for Energy Efficiency (2006)](image)

Source: Information available at the PFE information website (http://www.stem.se, Visited 3 March 2006)

The basic industry that are levied the new energy tax is positive to the introduction of the PFE and the SKGS promoted its introduction towards the Government. At a
seminar at Energitinget 2005, Sven Wird (2005) at the paper company Holmen AB discussed the PFE from an industry perspective. Wird pointed out that some of the constructive aspects of the programme are that it has a systematic approach through the implementation of the EMS and that it leads to activities that are positive for the businesses and highlights the energy issues. Wird also identified some negative features with the programme design, identifying the rules for the first two years as problematic as some companies may want to get an approval to proceed with the implementation at an earlier date and therefore suggests that the formulation should be changed to “no later than two years” after the programme start. Wird further identified that the lack of detail regarding the stipulated measures is troublesome. This was agreed by Mikael Åberg (2005) at the SEA. Wird identified that many of the participating companies would be forced to comply with the programme once signed, as a reimbursement of the deducted tax for most companies would probably be of such magnitude that it would conflict with stock exchange rules.

Stakeholder Perspectives

Birgitta Resvik (2005) at the CSE views the introduction of the PFE as a result of pressure from the business sector to provide an incitement for operations to adopt an EMS. Birgitta Resvik identifies that a positive characteristic in the programme is the voluntary nature of which measures to carry out by the participating operations. The PFE is also identified as having further increased the importance of energy consumption in the participating companies’ managements. The CSE ask for a continuation of the system to create a more stable policy instrument design. Birgitta Resvik concludes by sharing the opinion that the programme could be expanded to smaller industries, imposing lesser demands and offering other benefits than a tax reduction. This is a positive suggestion as the potentials for energy efficiency improvements in industries that are less energy intensive is likely to be less known with large individual potentials. Maria Sunér Fleming (2005) at Swedenergy identifies that the PFE can offer business opportunities for the utility sector. This is
also supported by Peter Chudi (2005) at E.ON Sverige who identifies the PFE as an opportunity for the utilities energy management services. Göran Carlsson (2005) at SSAB argues that the work to administer the PFE is higher than the reduced costs of the tax. Thomas Levander (2005) at the SEA identifies that the programme together with other instruments creates a large administrative burden and thus argues that a less complicated policy instrument should have been used. The SEA is however positive to EMSs and is thus positive to certain characteristics of the instrument.

Anders Lyberg (2005) at Cementa has neutral opinions of the PFE and states that the company has prioritized working with energy efficiency due to the energy intensity of the processes. The tax reduction is identified as low, meaning that it is not sufficient incitement for a larger priority of energy efficiency in the company.

Mikael Hannus (2005) at Stora Enso identifies the PFE as a positive element in the policy framework but challenge this view if the system is not extended to form a stable basis on 15-20 years on which an investment cycle can be based. The main positive aspect of the PFE is identified as the voluntary nature of the programme, allowing for the participating stakeholders to gradually improve the operations based on own decisions, as this is regarded to crate a cost-efficient system without sub-optimizations.

### 7.4 Technology Procurement

Procurement of technology through the Government can work as a strong catalyst to promote the development of equipment with better performance than provided by the existing products on the market. Technology procurement reduces the development risk by initiating procurement competitions for a certain product. The rules of the competition are formed by the requirements that are outlined in the product specification. These requirements are defined by the large consumers or
consumer groups that are potential buyers of the new product or service. As these product developers engage in the competition voluntarily, stricter requirements can be put on the product than would be possible under other conditions (Olerup, 2001). Different governmental agencies supervise the competition and the SEA is supervising body in the case of energy efficient equipment, which is the area of technology procurements of interest here.

Technology procurement programmes often include an external inspection of the products or services that the competitors deliver and the SP Swedish National Testing and Research Institute have been responsible for this in the energy sector. The inspection must include thorough testing to control that set requirements are met. The winner (or winners) in a procurement competition receives a prize of excellence, marketing help for the new product and is guaranteed a limited first sale. The initial order can in some competitions be large enough to enable serial production. The buyers of the product undertake an obligation to inform their customers about the winning contribution in order to promote it.

Other characteristics should be considered in the design of a procurement programme are that the programmes should provide sufficient funding and time during the process and that the complexity of functional requirements should not be too high (Neij and Öfverholm, 2001).

The SEA has initiated several procurement programmes, for example, industrial pumps and fans, ventilation systems and control systems. The main goals in these procurement competitions have been better energy efficiency and lower environmental impact. This type of programmes is also used by international stakeholders, such as the IEA and business collaborations. The market introduction of the goods developed through technology procurement can be further promoted through jointly running a market transformation programmes that aims to remove
market barriers and increased knowledge dissemination for the technologies developed (Neij and Öfverholm, 2001).

7.5 Summary

Sweden has been a forerunner in utilizing the national tax system to promote climate change policy objectives, introducing the world’s first national carbon dioxide tax in 1991. The continued use of the tax system in promotion of climate and energy goals is highlighted by the tax-shift. Taxes and subventions can be important policies to compensate for imperfections and other effects of market based policy instruments. The EU membership has large effects on the tax system in relation to establishing tax levels and other design features, having required changes in the current tax system. While this initially has reduced the short-term policy stability, the positive outcome is an increased harmonization of the tax system. The harmonization is however only achieved on an EU level, which similarly to the EU-ETS is a problem, as international harmonization is important for competitive reasons.

Despite the substantial tax subventions that the Trading Sector receives, the tax pressure on the industry is high in an international comparison. Any increase in the carbon dioxide from the current levels therefore has small effects on the steering effects thereof. As emissions trading can be seen as a market-based carbon dioxide tax, the total tax levy is also higher than the actual carbon dioxide tax. This reduces the steering effects of a levy increase in either one of these policies. This also indicates that levying the carbon dioxide tax parallel to the EU-ETS is not as efficient as the individual instruments separately. The possibility to levy high taxes is larger for the utilities than the basic industry, as the utilities have superior possibilities to transfer the added costs to the customers. This however inevitably have the secondary effect to subject the basic industry due to higher electricity prices.
Main stakeholders, such as the SEA, Swedish EPA, FlexMex2 committee and a unanimous business sector, all suggested at an early state that the carbon dioxide tax should be annulled for the Trading Sector. The Government indicated for some time that this decision was to be taken shortly, but the decision nevertheless lingered for a long period. The fact that decision now is up to an EU inquiry does not lessen the fact that this incurred insecurity and instability in the policy framework.

The tax-shift initiative is positive but the system must be associated with a correct design to be accepted. As an environmental initiative, the tax-shift should naturally be strictly associated with a fossil energy perspective on the tax revaluations. The possibility, stated by the Government, to include RES would have absurd effects on the aim of the shift. It would result in a taxation of RES and impair the structure of the policy framework. To avoid this, new taxes or a redesign of the entire tax system would be necessary to provide a maintained steering effect towards RES. This would clearly complicate the system, resulting in significantly reduced steering efficiency and low acceptance. The green tax-shift should thus be annulled, or redesigned in a different way, if the tax base becomes insufficient.

As the tax-shift can have negative effects on the competitiveness of the business sector and seeing that this is also an effect of the EU-ETS, subventions are reasonable in order to reduce the pressure of the tax system and the overall policy framework. The influence of the EU membership is however making the utilization of subventions more difficult, as they represent state aid and thus must be approved by the Council. The EU also promotes a phase-out of subventions which interfere with the market based instruments and reduce the support to RES. Subventions furthermore has a negative effect on the introduction of new technologies. The latter is negative considering that realizing substantial GHG emission reductions will require the deployment of a broad range of technologies, as this will not be accomplish by a single solution. Subsidies can be effective if taxation is impractical, ineffective or if a certain sector or commodity needs specific support. Subsidies are
however associated with a low cost-efficiency but may nevertheless, due to the above, be prioritized over subventions in the long term.

The introduction of voluntary agreements through the PFE has been well received. Many of the main industry actors are participating which may promote a broad participation. The positive aspects of the PFE are that the companies are allowed to choose which measures to take in order to receive the tax subvention. This reduces the risk of sub-optimizing industry operations and investments as a result of strict policy steering. The efficiency of the PFE would however benefit from increasing the flexibility in the schedule of the project cycle, to allow actors to proceed at a faster pace. A negative effect of the PFE is the added administrative burden, which calls for an uncomplicated design. This should be considered in the development of the PFE as well as other instruments. While being subject to approval by the European Council, the system would benefit from a longer timeframe in order to strengthen the promotion of larger investments. This would also strengthen the promotion of technology development. The use of voluntary agreements has internationally proven effective in promoting a positive energy efficiency development. The progress within the PFE should however be monitored, as research has shown that albeit the overall outcome is positive, both positive and negative effects on the energy consumption occur. The monitoring should thus aim to optimize the design, based on these effects. Voluntary agreements are also effective in promoting energy management services at the utilities as well as ESCOs, which can provide long-term effects through changed market behaviors.
8. Administrative Instruments

Administrative instruments include control and command stipulations but do not directly impose any tax or other economic effects on the targeted stakeholders. They are inherently strong policy instruments and can be complex when covering large policy areas. There are no administrative instruments that exclusively aim to reduce the emissions of carbon dioxide, neither for the basic industry or the energy utilities. The one major administrative instrument in the present climate and energy policies is the Environmental Code. Municipal Energy Planning also is of importance as it addresses efficient energy utilization from a broad system perspective. Other administrative instruments in the climate area, but not included within the scope of the thesis, are laws that prohibit the utilization of certain substances resulting in GHG emissions. The Planning and Building Act includes general environmental considerations, referring to the Environmental Code for specific regulation. Other laws that are vital for the energy system are the laws concerning nuclear operations,
though mentioning that these forbid any new nuclear operations and regulate the phase-out of the existing, should be sufficient within the scope of this thesis.

8.1 The Environmental Code

The Environmental Code (SFS 1998:808) was introduced in 1999 based on the Bill 1997/98:45, incorporating 15 old environmental laws and issues such as emissions, acidification, traffic, waste, environmental degradation and environmental hazardous substances. Important corner stones in the Code are the Agenda 21, sustainable development, the cautionary principle, the natural cycle principle, Polluter Pays Principle (PPP) and BAT principle. The legislation establishes the fundamental environmental protection rules, which applies to all human activities that may harm the environment, and aim to fulfill the fifteen Swedish environmental goals. Operations that are identified as environmentally hazardous, such as basic industry and energy utility operations, are imposed with strict rules and operational permits.

The Code has been amended at numerous occasions to reflect changes in policy areas in connection to environment. This has, for example, been the case in the inclusion of stipulations in the IPPC Directive (96/61/EC) and the Emissions Trading Directive (2003/87/EC). The Code has received much critique for hampering investments and realization of renewable energy projects which has been supported in the interviews (see Stakeholder Perspectives).
Table 8.1 Basic industry and energy utility operations under certain conditions liable for Governmental permissibility consideration

| 1. | Iron and steel works, metallurgical works and Ferro-alloy plants |
| 2. | Pulp plants and paper mills |
| 3. | Crude oil refineries or heavy petrochemical plants |
| 4. | Plants for the manufacture of basic chemicals or fertilizers |
| 5. | Cement plants |
| 6. | Combustion plants with an input power of not less than 200 MW |
| 7. | Wind farms consisting of clusters of three or more wind turbines with a total output of not less than 10 MW |
| 8. | Facilities for the storage of not less than 50 million m³ of natural gas |
| 9. | Facilities for the treatment of hazardous waste where most of the waste that is to be treated in the facility is from other establishments and more than 10 kton of hazardous waste are incinerated per year or otherwise recycled or disposed of at the facility |
| 10. | Structures for the extraction of substances or materials in the areas mentioned in chapter 4, section 5 |
| 11. | Construction of platforms with the purpose to extract oil or gas within sea areas and other constructions other than temporary anchoring and mooring of such platforms for repairing, reconstruction or other reasons |
| 12. | Hydroelectric power plants designed for an installed generator output of not less than 20 MW |
| 13. | Water regulation facilities with a water reservoir capacity of not less than 100 million m³ per year or 10 million m³ per week |
| 14. | Diversion or other removal of water from watercourses or lakes with a normal low flow without water regulation of not less than 10 m³/s at the point of outlet, where the amount of water used is such that the flow is less than 4/5 of the normal unregulated low flow. |

Source: SFS 1998:808, Chapter 17, Section 4. (Non-Trading Sectors excluded)

The code prescribes that environmentally hazardous activities must apply for an operational permit.191 Furthermore, many industrial operations (Table 8.1), including practically all basic industry and energy utility operations, can be liable for a

---

191 Most activities are deemed hazardous, the exact specifications are explained in the ordinance SFS 1998:899.
permissibility consideration by the Government if initiated by the municipal council. This can however also be initiated by the Government if the operations are estimated to have a potentially large impact on the environment. The Government can also supersede decisions not to allow *inter alia* combustion installations >200 MW and wind power installations (if more than three mills of at least 10 MW in total). The permissibility process requires that an Environmental Impact Statement (EIS) is issued by the company. How the assessment of the EIS and the approval of the operations shall be carried out is largely governed by the EU Directives on EIS (85/337/EEC) and IPPC (96/61/EC). It is thus considered that an activity that has been examined according to the Environmental Code has undergone the review that is required according to the IPPC Directive. Permissions must also be applied for when environmentally operations are changed and the permission may then apply only to the changes. The operations that violate the Code or the conditions set in the permit can be imposed with an environmental sanction fee of up to 1,000,000 SEK or a maximum jail sentence of six years.

The Code includes preventive principles, which applies to all activities that are not of insignificant importance from an environmental perspective. The main principles are the Polluter Pays Principle and that BAT should be considered in all professional activities.\textsuperscript{192} It also includes the Precautionary Principle, meaning that precautionary measures shall be taken if an activity can be assumed to be harmful for the health or the environment. The Precautionary Principles have implications in relation to energy utilization and climate change. In what is referred to as the “economizing principle”, it is stated that all activities shall be energy and resource efficient, giving preference to renewable energy. This consequently promotes the implementation of energy efficient technologies and utilization of RES.

\textsuperscript{192} Supported by the IPPC Directive (96/61/EC)
As stipulated in the Emissions Trading Directive (2003/87/EC), the Code was amended in 2004 with regards to the operations included in the law on trading with emission rights (SFS 2004:656\textsuperscript{193}). This excluded the Trading Sector from having specific conditions concerning their carbon dioxide emissions or use of fossil fuels, with the intention to reduce carbon dioxide emissions, applied to their permits (SFS 2004:667). The Emissions Trading Directive (2003/87/EC) also establishes that Member States can choose not to impose energy efficiency regulations on the operations included in the scheme. No such amendments have however been introduced in the Environmental Code and the IPPC rules on BAT are consequently in force in Sweden.

The approval process has been a problem for many companies and was the main concern regarding the Environmental Code by all interviewed stakeholders. For example, Johan Tollin (2005) at Vattenfall said during the interview that they have to apply for the wind power technologies that they estimate will be available and most viable at a point in the future when they expect to receive the permit. Maria Sunér Fleming (2005) at Swedenergy highlights an example where a Jämtkraft application failed to receive approval after 14 years. Johan Tollin (2005) highlighted a Vattenfall application process that was initiated in 2000 that in 2005 still had not been approved. This naturally creates problems for all parts – both the supervising authorities and the companies – due to a lack of insight in what the characteristics and environmental performance of such operations will be. The prolonged process has, fully inconsistent to the aim of the Code, hampered new investments and execution of renewable energy projects that would improve the environmental characteristics of the energy system. The issue of complex authorization schemes has also been identified as a problem by the EU Commission, identifying this as one of the main obstacles for efficient introduction of RES (EP, 2005b).

\textsuperscript{193} Later replaced by SFS 2004:1199.
Parliament has therefore declared this one of the priorities in a policy context for the future (ibid).

An Environmental Code Committee, appointed to make the Code more efficient and simplified, verified in an interim report (SOU 2003:124) that the administration for permit approvals is unnecessarily complicated. The Committee estimated that a governmental approval process, for processes with significant environmental impact, in general take about 18-24 months. The Committee found that the Code placed too specific requirements on EISs and identified a need for a more case-sensitive approach, taking the specific conditions in each case into account. The interim report further identified that the Swedish rate of complete EIS requests is the highest in the EU and therefore suggested a harmonization to the rules of other countries where the rate is lower.

Based on the findings of the Environmental Code Committee a Bill (2004/05:129) suggested a number of changes that are intended to create a more efficient approval process. Since permit considerations are compulsory also when operations are changed, it means that companies must undergo this process more than once, imposing large administrative efforts and costs. The Bill therefore amended the application requirement to apply only to the changes in the operation. The Bill also reduced the operations requiring a compulsory governmental permissibility consideration to only include nuclear operations and large infrastructure projects. The Committee suggested that the companies should be able to request a guiding statement on the scope of the required EIS in order to reduce delays in the approval procedures. This was however amended to a formulation that a consultation with the authorities shall be carried out. The new Government has stated that the review of the Environmental Code will continue, focusing on which operations that will

\[194\] Adopted through the law SFS 2005:571
require operational permissions according to the Code (Carlgren, 2006). The aim of this work is to reduce the administrative burden with 25%.

Changes are also underway for an improved harmonization between the Environmental Code and the Planning and Building Act (PBA). A joint analysis by the Environmental Code Committee and a PBA Committee has established that the designs today contradict – a project can be allowed according to one law but not the other, which can result in large administrative losses – and that this problem will grow if it is not amended (SOU 2004:40). The committees suggested that the approval processes according to the two laws should be better coordinated for rationalization reasons.

**Stakeholder Perspectives**

While the basic industry stakeholders have criticized the Environmental Code, the interviewees seem more concerned about the design of the economic instruments. This is also true for the utilities, albeit these interviewees have shown a larger concern, having identified that the Code have reduced investments in renewable energy production.

The suggested changes to the Code that are outlined above, corresponds to much of the critique identified during the interviews (Carlsson, 2005; Chudi, 2005; Hannus, 2005; Käck, 2005; Levander, 2005; Resvik, 2005; Sunér Fleming, 2005; Tollin, 2005). The criticism is however not limited to these stakeholders. Bylund (2005) identifies the approval process as hindering a sustainable development. Birgitta Resvik (2005) and Ingela Bendrot (2005), at the CSE, identify the suggestions as an important improvement, which has the potential to simplify and shorten the permit approval times and thus facilitate an improved development in RES as well as other operations. Mikael Hannus at Stora Enso however argues that it remains to be seen whether these changes will have a positive outcome.
Birgitta Resvik identifies that the implementation of the Code has resulted in outsourcing. Cementa (Lyberg, 2005) are positive towards the amendments of the Code and identify that it has led to improvements in the application process. Mikael Hannus (2005) at Stora Enso argues that the Code is problematic from an energy perspective, as it in theory ultimately only will allow for bioenergy and other RES. E.ON Sverige (Chudi, 2005) argues that the Code facilitates actors to too easily obstruct projects through complaints and that this can impede developments that are promoted by energy and climate policies. This is also identified by Maria Sunér Fleming (2005), at Swedenergy, who identifies that at some occasions signs have been visible that appeals and calls for delays have been issued systematically by persons that have wished to postpone or hinder developments.

Thomas Levander (2005) at the SEA identifies that the old background of the Code result in a local perspective that is not up to date with current regional and global environmental problems. The current approach where the Code excludes the Trading Sectors of the EU-ETS from being imposed with carbon dioxide requirements is thus discussed as possibly being a positive development (i.e. to maintain the Code for local issues and utilize external instruments for environmental issues at a larger scale). The development of the Code to where decisions are taken at municipality levels is identified as reducing the legal security, as decisions vary between municipalities. Levander view the Code as a means to promote BAT but that this is difficult as the Code stipulates that permits shall not be altered during a 10 year period. This not only provides an obstacle to follow the technology development but is also misfortunate as the requirements are only strengthened for companies that invest in their operations. Levander thus emphasizes that general policy instruments are more effective tools to promote both energy efficiency and carbon dioxide reductions.

195 The Code originates from water laws, dating back to the 1950s.
Ylva Rylander (2005) at the SSNC identifies that the Code should utilize the Precautionary Principle in respect to climate change to exert stronger pressure on GHG emitters. Rylander further identifies that the long approval process in some cases is a result of appeals due to unsatisfactory EISs and that permit applications that fail to declare actual conditions. Due to this, Rylander argues that the basic industry and energy utilities can make large contributions to shorten the process through improving the applications. Rylander further argues that it is troublesome that the Trading Sector is excluded from permit stipulations of carbon dioxide emissions and use of fossil fuels, as this is identified to possibly resulting in construction of new operations within the Trading Sector that utilize coal rather than biofuels.

8.2 Municipal Energy Planning

It may perhaps be controversial to categorize Municipal Energy Planning as a policy instrument. The policy is not included in SEA evaluations of the policy instruments but is included in a report on the Swedish climate strategy (SOU 2000:23). Introduced in 1977, the law (SFS 1977:439) governing the plans however holds a large potential for increasing the energy management and efficiency of municipalities from a larger system perspective, which is requested by some interviewees (Brinck, 2005; Resvik, 2005). The law establishes municipal responsibilities within the energy policies, declaring that all municipalities shall plan for economizing the local energy consumption. The municipal energy plan shall include a current plan for the supply, distribution and consumption of energy as well as an analysis of inter alia the environmental impact and economizing of resources. The energy plan shall furthermore analyze the possibilities for municipalities and main energy consumers and producers, such as the basic industry and energy utilities, to cooperate for higher resource efficiency and when such possibilities are identified to include them in the
plan. Stakeholders whose operations require a large amount of energy and those that produce and distribute energy shall supply the information required for the planning. The law also provides the opportunity for these stakeholders to discuss the energy issues of special importance to the operation with the municipality. The law on Municipal Energy Planning consequently does not only target the private sector but also, due to its policy instrument design, also the public sector.

Energy planning however has low priority in the municipalities (Carlstedt et al., 2001). This is supported in the interviews and Leif Brinck (2005) at Preemraff highlighted a situation where the refinery in Lysekil could distribute heat to regional district heating systems in Uddevalla, Trollhättan and Vänersborg. Brinck identified that such a project would be beneficial for all parties, but had not been realized due to lack of political will, resulting in that the district heating company invested in a new CHP plant. The law does not establish that possible energy economizations like this have to be realized but, since it promotes energy economization and seeing that reduced environmental impact and sustainable development are prioritized on all public levels, it unquestionably works in their favor.

The low priority of energy planning in the municipalities is partly supported by Nilsson and Mårtensson (2003) who identifies that there are large variations in quality of the plans between different municipalities, often lacking in detail and regular revisions. While Nilsson and Mårtensson do not suggest it, arguments in the study indicates that a reason for this may be that other work in the same field, such as the Agenda 21 and waste-management, have taken over some of the focus. The law is however very general and does not in detail specify what the plans should include and how often they should be updated. An official report (SOU 1999:5), questioned in 1999 the necessity of the law in the policy framework.
8.3 Summary

Administrative instruments are essential to establish the foundation of a climate and energy policy framework through stipulating the baseline of resource and environmental considerations. The instruments are inherently strong, meaning that any erroneous effects are also strong and can result in forceful impediments to a positive development. Being based on regulatory stipulations, administrative instruments provide poor incentives for technology development and measures that exceed the stipulated levels.

The Environmental Code has been associated with a number of problems. The main issue has been that the Code has necessitated large administrative efforts that have been both time consuming and costly, which has been the case for public bodies as well as the business sector. The long application process has reduced the predictability in the system, as it has forced applications to include technical data of equipment that was not available at the time of application, but estimated as available at the end of the approval process. The delay in the permission application processes have also resulted in a reduced rate of realization of renewable energy projects. This inevitably have large negative effects on the steering and cost-efficiency of the Environmental Code. The interviews have also identified that the Environmental Code have had such adverse administrative effects that it has resulted in outsourcing. The recently adopted amendments are against this background positive. One interviewee commented that a positive effect has already been identified, but the full effects remain to be seen. A positive element in the review of the Code was the attention to an improved dialogue between authorities and companies. This can have positive effects on the acceptance of the instrument and serve as tool in the continuous improvement and rationalization of design in general and the application process in specific.
The exclusion of the Trading Sector from any obligations regarding the carbon dioxide emission levels is obvious, seeing that an emission trading scheme establishes a politically accepted emission volume from these sectors. This is parallel to the discussion on the carbon dioxide tax and national short-term climate goal. Any regulation, aiming at reductions of the targeted carbon dioxide emissions below an emissions trading cap, must be seen as interfering with the carbon market.

Municipal Energy Planning is a positive contribution to the policy framework as it highlights energy efficiency from a broad system perspective. Due to a lack of compliance mechanisms the law however currently works similar to an informative instrument. The law could be strengthened though including stipulations that the identified possibilities for energy economizations should be realized, promoted or incentivized. The law could also be strengthened simply through a larger attention and enforcement thereof. The plans can serve to provide energy management business opportunities for energy utilities and ESCOs.
9. Informative Instruments

The EU Green Paper on Energy Efficiency (COM(2005) 265 final) state that information and education is two “under-used tools”. Informative policy instruments can have a wide variety of designs and are thus more difficult to categorize than the other instruments with respect to scope. This chapter describes three types of informative instruments – information campaigns, labeling and research funding. The chapter does not, as a result of its brief nature, include a discussion. Due to the nature of informative instruments, the interviews did not include a strong focus on this group and separate sections for stakeholder opinions are thus also excluded.

Other types of informative efforts are various audits that focus on, for example technologies and energy consumption. These can, if effectively designed, help raising the awareness of the possible economic and environmental gains that business stakeholders can reap from stronger management schemes on these subjects. These could potentially be more effective if directed to small and medium-sized enterprises.
(SMEs), as large basic industry and utility corporations are more likely to have acquired knowledge of these issues due to the larger savings potential.

In the 2002 Energy Bill (2001/02:143) the Government allocated 135 MSEK for information campaigns, research and development, education, testing, certification and labeling under a five-year period. This was promoted as the Government identified that the public and business sectors, together with households, have a large positive potential to affect the availability of energy efficient services and goods. Informative instruments have, for example, been used in the Agenda 21 work as well as within the energy, transport and consumer policies. The 2006 Climate Bill (2005/06:172) strongly promotes the use of informative instruments in the short and long-term policy designs as they are important for *inter alia* stakeholder policy acceptance. It is thus possible that informative instruments will be allocated larger resources.

The potential of informative efforts are highlighted Brennan (2006), who raises a discussion on whether “green” preferences – that could be existing or resulting from information – could work as a regulatory instrument with the theoretical affect that other conventional instruments could be excluded or enforced with less stringency. While this is not proven by Brennan, it is logically sound and indicates the potential strength of market impact and stakeholder choices. The relationship between informative instruments on energy efficiency is raised by Peter Chudi (2005) at E.ON Sverige. Chudi identifies that a large share of the possible cost-effective efficiency improvements in the industry is not accomplished due to lack of knowledge and commitment to this work and that this situation could be improved through informative efforts.
9.1 Information Campaigns

Informative campaigns are difficult to define as they often have short time spans plus that they exist and have existed in large numbers. Examples of campaigns that have been used in Sweden are BAT information on auxiliary equipment by the SEA and on public awareness on climate change by the Swedish EPA. Thomas Levander (2005) at the SEA identifies informative campaigns as being important for promoting the effectiveness of other policy instruments. It is doubtful that specifying a specific informational campaign has any real importance here.

9.2 Labeling

Swedish labeling schemes that are of interest here are environmental certification of companies, labeling of electricity and energy efficiency labeling of auxiliary equipment, such as lighting, ventilation and motors.

Environmental Certification of Organizations

Environmental certification of companies can be carried out under different schemes and the most recognized in Sweden and Europe are the International Organization for Standardization scheme ISO 14000196 and the EU Eco-Management and Audit Scheme (EMAS). These are control instruments, as they are not politically governed or enforced by Swedish legislation. Companies that wish to acquire the certification have to submit to the rules of an external auditing process that the specific scheme advocates. After receiving the certification companies have to continuously improve...

---

196 The ISO 14000 series are a set of environmental tools that helps and guides the work to receive certification under the requirements that are specified in ISO 14001. The 14000 series includes four standards on GHGs with reference to quantification, reporting, validation and verification of emissions.
their environmental performance in certain areas as defined by the auditor. Companies can gain from certification, not only by communicating it in marketing campaigns, but also through improved knowledge of the different flows through the company structure, such as energy and material.

Electricity Labeling

The SSNC introduced an environmental labeling scheme of electricity called “Bra Miljöval” (eng. good environmental choice) in 1996 when the electricity market was deregulated. The labeling is a good example of the fact that there are other control instruments than policy instruments. The SSNC have issued guidelines for environmentally accepted electricity production. These rules are more stringent than the definition used by the Government when issuing RECs as they also include a number of preservation measures. Initially most of the electricity that was labeled and marketed with “Bra Miljöval” was sold to business customers (SEA, 2002) and the business sector has continuously been showing a large interest in the label (Kåberger, 2003). A reason for this could be that the business sector, with larger electricity consumption than private customers, renegotiates their electricity contracts and then selects environmentally labeled electricity for marketing reasons. Another suggestion can be that they were forced to do so through participating in an environmental certificating scheme, such as ISO 14000 mentioned above.

Energy utilities can probably profit from “Bra Miljöval”, as Roe et al (2001) has found that customers are willing to pay a higher price for electricity that is marketed as “green”. There are however indications in relation to other commodities that, albeit stakeholders may claim to be willing to pay a higher price, this is not the case at the time of purchase. Bird et al (2002) identifies that “green” electricity labeling have not, from an international perspective, been successful in any large-scale promotion of RES. This is however contested by Markard and Truffer (2006) who identifies that the
label, being well-known, effectively contributed to raising the public awareness of renewable energy production.

Due to the EU Directive on the Promotion of Cogeneration (2004/8/EC) Sweden was required to introduce a labeling scheme for high-efficiency cogeneration. The subject was analyzed in an official inquiry leading to the Bill 2005/06:83. The background of the incentive is to establish a system which allows for utilities to market their production. A similar Swedish system exists for electricity produced with RES, albeit this system has had a smaller market impact than the SSNC labeling. The labeling scheme base includes cogeneration that provides primary energy savings of at least 10 % compared with the references for separate production of heat and electricity.

**Equipment Labeling**

Labeling of equipment according to different standards aids customers in choosing energy efficient auxiliary equipment. Such labeling can also be a prerequisite for the implementation of other policy instruments such as PFE, which requires that auxiliary motors are of the highest efficiency class. Labeling is also a vital part in the dissemination of BAT. *This is further discussed in Chapter 4.6 on the basic industries’ and utilities’ auxiliary systems.*

**9.3 Research Funding**

Research funding is categorized as an informative policy instrument as the research result in new knowledge that is disseminated to the society. The research funding is provided by the government in cooperation with the private sector. The level of available funding is set by the Government and lower governmental funds lead to

197 Adopted through SFS 2006:329.
lower private counter funding and consequently less quantity or quality of research projects. The main driving force of energy research today is climate change (Korsfeldt, 2005). Research and development programmes in the climate and energy area are often funded through the SEA and specifically on climate by MISTRA and FORMAS.

In 2005 the Government decided to reduce the research funding to the SEA with approximately 50 % to approximately 450 MSEK per year during 2005-2007199 (Bill 2004/05:1). The SEA reacted to this cutback and brought forward a proposal (Korsfeldt, 2005) for a supplementary and long-term energy research funding where the SEA director general Thomas Korsfeldt emphasized that a more stable funding is essential for the Agency’s role as a negotiator in research projects and that lacking this stability creates insecurity with counter financiers (SEA, 2005). Reducing the energy research is likely to challenge Sweden’s climate and energy goals and reduce the important academic knowledge basis for the Swedish society on these issues.

The Bill (2005/06:1) on the national budget decided that the energy research funding should be greatly strengthened with about SEK 1 billion during 2006-2008. The increased funding is meant to support existing research programmes within renewable energy such as photovoltaics, bioenergy and wind power. It also promotes pilot projects within biofuels as well as gasification of biomass, black liquor and waste. The Government has published a Bill (2005/06:127) on the research and technologies for the future energy system. The prioritized research areas include fuel based energy systems, energy intensive industry and energy system studies. The Bill also establishes that the focus of the international climate efforts within the energy sector shall focus on the KP project-based flexible mechanisms. This position is

199 The funding was later raised with 100 MSEK per year for 2006 and 2007 in the 2005 spring budget (Bill 2004/05:100).
ambiguous position when the use of these mechanisms is not fully integrated into the Swedish climate framework.
10. Discussion

The discussion highlights the main issues in the policy framework that have been identified through the analysis of the interviews and other sources. This includes the overarching issue of the Swedish climate goal as well as the lack of stability and a long-term perspective in the policy framework. As the EU-ETS is the strongest policy instrument in the current framework and associated with several issues regarding the allocations process this is discussed in its entirety here. It is argued that these issues can be improved through improved stakeholder dialogue and this subject is consequently also included in the discussion. Finally the design and effectiveness of the current policy framework is discussed, which serves to sum up how the above and other issues affect the effectiveness of the framework. Stakeholder perspectives are provided throughout the chapter to provide a background to the analysis.
10.1 The Swedish Climate Goal

The 2002 Climate Bill (Bill 2001/02:55) declared the national short-term climate goal of reducing the national GHG emissions with -4 % to 2012, compared to 1990 levels, which is more stringent than the emission commitments under the KP. The Bill also established that the goal should be met without using the three flexible mechanisms of the KP or accounting for carbon sinks. The goal was reviewed at the climate policy 2004 control station where the SEA and Swedish EPA (2004c) recommended a redesign of its formulation. This was however not heeded by the Government, which in the 2006 Climate Bill (2005/06:172) decided to give the design continued support. The governmental position can be criticized on several notes, mainly regarding its stringency and position on the flexible mechanisms.

The main issue of the current emission goal is that it goes beyond the commitments under the KP. This is important for the Trading Sector as it will require additional policy instruments, such as the carbon dioxide tax, to achieve a higher level of emission reductions than what is called for by the EU-ETS. Even though the Trading Sector is allowed to use the flexible mechanisms to meet their emission quotas they must, although together with the whole Swedish society, reduce their emissions below the international commitment. While this policy has the benefit of providing a Swedish reputation as a progressive actor on climate change mitigation, the results of on the EU emission levels are none. Emission reductions in any Member State, that are lower than the cap that they have been allocated from EU’s total negotiated emission volume, will lead to higher emissions in the other States. The market will not achieve stricter emission reductions than is called for by the aggregate cap. This is one of the drawbacks with a “cap-and-trade” system – that it makes additional emission reductions futile. Due to the possibility to trade Swedish surplus EUAs, the effects of the national policy on the overall international emissions are neutralized within the system. The climate goal could conversely raise the global emission levels.
and worsen local environmental conditions if the production would be outsourced to countries that are not Annex I parties under the KP, as many of these countries have less stringent environmental regulations than is the case in Sweden. The risk of outsourcing should not be neglected, as the basic industry identifies the current lack of harmonization of the policy framework as a production obstacle, which is also supported in the EU-ETS review (McKinsey & Company and Ecofys, 2006).

Sweden has been negotiating with Russia about purchasing Russian surplus emission rights (SvD, 2005c). According to the Swedish chief negotiator in climate negotiations, Anders Turesson (ibid), the procurement of additional emission rights does however not necessarily mean that they will be used. Turesson states that, as Sweden is likely to reach the emission goal under the KP and EU-ETS without them, they can be used in other ways. One is to simply annul them, which would result in a “contribution” to the climate mitigation. This procedure could also be utilized to bridge the situation of surplus EUAs resulting from the national climate goal. Such measures are however very questionable from an economic perspective, if ever so commendable from a climate perspective. Another way is, according to Turesson, to use them as an investment as they can be banked to the 2008-2012 commitment period. This would however conflict with the national emission goal to 2012, as this should be met without the flexible mechanisms – including trading with emission rights. The above is criticized by the SSNC (ibid) as diverging from the national emission goals.

The 2006 Climate Bill (2005/06:172) establishes that the current uncertainty of the long-term price levels of emission rights is grounds for not changing the 2012 climate goal and thus postpones a possible redesign until 2008. This will seriously undermine the confidence for the climate policies as most remittance bodies\(^{200}\), in

\[^{200}\text{Remittance bodies are stakeholders that consider a proposed official, possibly legislative, measure.}\]
conformity with the SEA, Swedish EPA and FlexMex2 Committee, oppose the goal formulation (Bill 2005/06:172). One of the FlexMex2 reports (SOU 2003:60) concluded that the current goal design could incur large costs as the burden increases on the sectors that cannot utilize the flexible mechanisms to improve the cost-effectiveness meeting the national goal. The fact that the project-based mechanisms are not accounted for naturally worsens this effect. The reasons for not acting in accordance with these stakeholder opinions are, according to the 2006 Climate Bill, that the Swedish policies are accomplishing tangible emission reductions and are internationally seen as successful. While this is true, the policies are not complying with the Climate Bill’s specified goal that policies and measures to reduce GHG emissions shall also be cost-effective and not cause negative competitive consequences. A positive element is however that the Government has established that the goal will be continuously monitored with respect to the international developments on the energy and carbon markets. This may to a limited extent increase the acceptance of the implemented policy.

The Government (2005/06:172) argues that the national goal formulation will not hamper an effective utilization of the project based flexible mechanisms. This is an extraordinary position as it should be obvious to the Government that the Swedish business sector’s willingness to engage in these mechanisms will be reduced within a climate policy framework that does not fully allow their use. This is also supported by Stigson and Yan (2006), who in a survey of the Trading Sector’s attitudes towards the CDM identified a low interest. It can also be argued that if energy utilities utilize the JI and CDM they may incur additional emission reduction requirements on themselves. This due to the Emissions Trading Bill (2005/06:184) that establish that the allocations to the utilities shall be based on a marginal perspective and be adjusted in respect of the required emission reductions. As the required emission reductions shall consider the national climate goal, the allocations may become more stringent if the national emission volumes increase. Hence, if several utilities choose
to carry out JI or CDM projects to allow for larger emissions from the operations the national emission goal might be at stake, in which case the Government may then downscale the allocations even further. Such an irrational situation would solely be a foster of the formulation of the national emission goal and should consequently be amended promptly. Under the current design the project participants in JI and CDM projects have to compensate this ETS flexibility under other policy instruments. The only upside of this is that this policy instrument pressure is shared with the rest of the society. While the above may be regarded as acceptable with free allocations, in light of utility windfall profits, and that the effect are small for the average stakeholder included in the Trading Sector, it points to show the absurdity in the climate goal design.

The ambiguous position of the Government on the climate goal is emphasized by that the 2002 and 2006 Climate Bills identify the flexible mechanisms as positive features of the ETSs and that the SEA shall facilitate and promote the use of the CDM and JI by Swedish companies. At the 2004 climate control station the SEA and the Swedish EPA (2004c) identified the present climate goal to be illogic considering the “cap-and-trade” nature of the EU-ETS, thus supporting the views above. The agencies therefore suggested the introduction of a deduction goal that differentiates the Trading Sector from the non-Trading Sector. This would mean that the emissions from the operations included in the EU-ETS are considered equal to their allocation volume and therefore deducted from the national goal. The non-Trading Sector thus becomes committed to reduce their emissions by -4 %. The result would be that with a large allocation of emission rights to the Trading Sector, large emission reducing efforts needs to be taken by the non-Trading Sector. The report identified that from an economic perspective, a deduction goal would motivate a slightly smaller allocation than the current prognosis. The Government has a limited possibility to affect the rate of allocations to the Trading Sector, as this is guided by EU rules regarding the design of the Member States’ NAPs. As this consequently reduces the
Government’s influence of the above aspect a deduction goal becomes even more important in order to comply with the established policy framework with regards to cost-efficiency while also maintaining control over the competitiveness issues.

The SEA (2005e) has also analyzed the implications of the national goal formulation for other policy instruments and the cost-efficiency thereof. The conclusions are, once again, that the current design will reduce the cost-efficiency and the stability of the national policies. A deduction goal is however considered to eliminate the need to levy a carbon dioxide tax for the Trading Sector as well as establishing a much more stable framework for the emission abatement measures in the non-Trading Sectors.

The interviewees as well as the remittance bodies to the 2006 Climate Bill provide a support for a deduction goal for the business sector. Birgitta Resvik (2005), at the CSE, promotes a deduction goal to improve the national implementation of the EU-ETS, while also being consistent with an increased production within the business sector.

A deduction goal should thus be adopted to overcome the obstacles of the current goal design. The climate goal for the basic industries and energy utilities, as the Trading Sector, should be set by the commitment under the EU-ETS. Including the Trading Sector in the more stringent national climate policies hampers the cost-effectiveness of the scheme, for example due to requiring additional policy instruments, and as such conflicts with the KP (Table 6.5). The flexible mechanisms should be fully accounted for within the climate policy framework. Kerr (2000) identifies the success of the ETSs as ultimately depending on national policies that utilize the opportunities of the international carbon market and the cost-efficient tools that it facilities. It is argued that the Swedish climate goal currently limits the success of the EU-ETS and thus also the KP. This conflicts with the policy framework that promotes ETSs as the main tool for global climate change mitigation.
10.2 Time Perspective and Stability of the Political Agenda and Policy Instruments

The policy framework on climate and energy, including the associated policy instruments, is continuously amended to follow the developments on national and international arenas. This is necessary as various economic and technological conditions as well as scientific bases are continuously changing. This inherently results in an element of uncertainty that give cause to instability and unpredictability in the policy framework. The framework must comply with the nature of the climate issue as extremely long-term and large-scale. The international climate regimes identify goal levels as distantly as year 2100 and an energy infrastructure takes about 50 years to change. The policies and policy instruments targeting the set of problems surrounding this issue must consequently be designed with respect to these conditions. This fact is acknowledged by the Government that have continuously emphasized the need for long-term policies, lately highlighted in the 2006 Climate Bill (2005/06:172), while also having identified that this has not been accomplished (Ds 2001:60). A long-term and stable policy framework is essential to effectively promote a positive development over time. Short-term policies simply do not establish the market conditions under which investments that support the policy goals are effectively realized.

From an EU perspective the European Environment Agency (EEA, 2005d) identifies stability as one of the main elements in designing effective policy instruments. The EU also focus on this subject in the Gothenburg Strategy (COM(2001) 264 final), which establishes that the policy efforts on sustainable development should be guided by a long-term perspective. The issue is in a Swedish context emphasized by the IEA (OECD and IEA, 2004) in a review of the Swedish energy and climate policies, identifying increased policy stability as one of the main suggestion for improved policies. The scientific support for the importance of a long-term
perspective is tremendously strong and the publications in this chapter represent a few examples.

This said, it should be mentioned that the long-term perspective of some policies, such as the ETSs, is not only steered by national policies but also international negotiations and the developments on for example the carbon markets. This also applies to policy instruments governed at an EU level that are agreed on at a higher political level. The Government can however alleviate the negative effects of the inherent amendments through a long-term and stable policy framework. Accordingly and naturally, a long-term agenda is imperative in the case of ETSs also in order to sustain a stable and reliable price on the carbon markets.

The long-term perspective that the Government should take into consideration in the design of policies and policy instruments are, besides the long timeframe of climate change, the payback time that the basic industry and energy utilities face in large emission abatement investments. The reason is that businesses will not feel confident in their investment plans if the financial conditions may alter due to removal of policy instruments or amendments in the policy design. While this change may not be of such magnitude to halt the investment it induces an element of uncertainty that may postpone it, causing a slower development and reduced policy goal compliance and efficiency. The business sector interviewees all define payback times between 15 and 30 years. While policy instruments with a shorter perspective than this undeniably can have positive effects, they are associated with lower cost-efficiency and acceptance by the business sector. This is however not necessarily the case for policy instruments that targets small-scale investments. As an example, the PFE encompasses a large element of small-scale energy efficiency improvements and is effective in promoting these. The programme is however not as effective in promoting large-scale improvements that are more costly with a longer pay-off period than five years. Short-term policies are furthermore inefficient in promoting technology development, albeit this does not apply to subsidies. Another example of
the importance of a sufficient time perspective are Geller et al (2006), who identifies that energy efficiency policies should be kept in place for a period of >10 years in order to be effective and have a lasting market impact. Such timelines should be established in the policy instrument designs in order to improve their efficiency through increasing their stability and market confidence.

The investment risk is inevitably increased when based on a short-term policy agenda, which for example reduces the diffusion of renewable energy technologies (Dinica, 2006). The time related risk perspective is also important for the possibilities for the business sector to receive investments from institutional stakeholders as well as bank loans. In an IEA report Blyth and Yang (2006) concludes that the lack of long-term stable policies can increase investment risks and thus reduce investment dynamics, and that policies thus should aim to overcome this obstacle. In a comparison between four countries’ green electricity market development a slower progress was identified in Sweden which was partly attributed to Sweden having inconsistent and changing policies (Gan et al, 2007).

Furthermore, promoting large-scale emission abatement investments requires a long-term perspective also from a policy instrument management point of view. A policy instrument that is short-term is only likely to promote small-scale measures (apart subsidy programmes with substantial funding) which may be associated with a large administrative burden relative to the effects of the measure. A large investment is however associated with a substantial analytical work, making the additional work to administer the policy instrument relatively smaller and less impeding.

The thesis argues that the policy framework has failed to heed the above conditions and highlights a number of examples and effects due to this. These are:

- The implementation of the EU-ETS has lacked stability in the allocation of emission rights. The utilities will receive allocations based on the marginal
success of emission abatement. More stable allocations are important, which could be accomplished through longer allocation periods.

- Removing the carbon dioxide tax for the Trading Sector was on the agenda for some time but the actual decision was continuously postponed. The removal decision is however now up to EU rulings.
- The REC scheme design initially had a too short time span, resulting in a reduced efficiency in promoting investments in RES utility production. The suggested amendments of the REC scheme’s issuance period awaited the final decision for a substantial time period.
- The annulment of the reduced grid connection cost to small-scale electricity production has been continuously support in government bills since 2002. The latest bill on the subject from 2006 however still identify that the issue needs further analyzing.
- The operation approval process under the Environmental Code has been highly inefficient, which has slowed down a positive development in renewable energy production and efficient production processes.
- Clear and long-term polices on the development of the energy system after a phase-out of nuclear energy has not been established.
- Policy instruments must be long-term to promote technology development.
- Short-term policies can result in sub-optimized operations in the basic industry and energy utilities.
- Lack of long-term policy instruments reduces policy goal compliance efficiency, which is associated with higher societal costs and a longer timeframe for the “greening” of the energy system.

Exemplifying the above, by looking at the issue regarding the issuance period under the REC scheme, it is important that decisions are decided on promptly. If decisions on policy amendments are left undecided, it neutralizes some of the steering effects
during this period – in the case of the REC scheme the positive stabilizing and long-term effects of the decision to permanent the scheme. This is for example supported by Bird et al (2002) who identifies that policy instruments, contrary to their aim, can initially stifle a positive development if introducing insecurity on the market. In a report to the SEA, Söderholm and Hammar (2005) emphasize the REC scheme’s reduced efficiency resulting from political insecurity. These effects may be difficult to avoid but should be assessed by the Government and kept to a minimum, for example through a stakeholder dialogue that increases the understanding of the implementation. A report by the expert committee for environmental studies (Expertgruppen för miljöstudier, 2006) on the wind power development highlights that the Government should have a higher priority to establishing a stable and long-term policy framework over strengthening the individual instruments.

**Stakeholder Perspectives**

The interview comments on this issue are many and most stakeholders argue that the Government has failed to establish a policy framework that effectively promotes emission abatement investments.

Maria Sunér Fleming (2005) at Swedenergy identifies that economical considerations, in many cases induced by policy instruments, have been the main driving force behind measures to shift fuels and reduce carbon dioxide emissions. Sunér Fleming stresses that this development could have been more efficient with longer-term policies and highlights the example of coal being a politically preferred fuel as recent as the 1980s. Sunér Fleming shares that Swedenergy has little confidence in the political goals as they have a history of being unstable and short-term, especially within the energy policies.

201 Another obvious example of this is the political agenda on nuclear energy that have shifted from a large-scale promotion in the 1960-70s to current policies on a complete phase-out.
Peter Chudi (2005) at E.ON Sverige argues that the Government’s task is to establish a market with clear guidelines and stable foundations that the policy instruments can work within and that the long-term perspective as such cannot be decided by the Government. Chudi further identifies that the decision on a continuation of the REC system is a positive contribution to a long-term policy agenda, which however is negatively affected by uncertainties regarding post-2012 developments. Chudi (2005) identified that changes in the instrument designs reduce the confidence for the policies, and that any amendments of policy instruments should analyzed against this background.

Raine Harju (2005) at Vattenfall and Gunnar Käck (2005) at Fortum Värme view long-term perspectives and predictability of the policy instrument designs as key priorities in the climate and energy policies. Gunnar Käck identifies a negative development where overall political negotiations are more essential for the outcome of instrument designs than the work of Government officials and that this reduces the predictability. Thomas Levander (2005) at the SEA and Birgitta Resvik (2005) at the CSE, both argue that a long-term perspective is essential for the efficiency of the policy instruments but that this has not been the case for many instruments. Anders Lyberg (2005) at Cementa highlights tax level changes as a negative example of short-term policy instruments.

Mikael Hannus (2005) at Stora Enso identifies that the stability and long-term perspective of the policy framework can be most effectively improved through a strengthened proactive dialogue with the business community. Hannus argues that changes in the Trading Sectors’ operations should not be guided by policy instrument if these are short-term as this is likely to result in sub-optimizations. Investment decisions must according to Hannus be based on business strategies, which possibly can be promoted by long-term policies. Hannus also raises the issue that climate and energy policies must have a longer perspective than the next
national budget and ask for thorough investigations into the correlation between different policy instruments.

10.3 Difficulties in Emission Rights Allocation

One of the main concerns in the design of ETSs is to establish a fair, common and uncomplicated allocation process. There are many allocation issues that are sensitive and the process can therefore be considered also as the most difficult aspect of an ETS. The difficulties include how the allocations should be distributed and whether they should be free or auctioned to the participating operations. Other potential difficulties are how to treat new entrants and closures during the scope of a commitment period. The allocation process is furthermore essential for the Trading Sector with respect to how they plan and operate their production. As such, the allocations will also be interpreted differently by different sector as well as within the sector depending on the operational characteristics. This is emphasized by Bode (2006), who identifies that energy utilities perceive the allocation procedures differently depending on the utilized production technologies and fuels.

Many of the current issues related to the allocation process can be related to a lack of harmonization of the allocation procedures within the EU-ETS as well as internationally. The allocation procedures in different countries must be carefully monitored so that national allocations are not issuing emission rights in such magnitude that the emission cap will be exceeded. Allocating more emissions allowances than necessary will reduce the emission reduction burden on the operations included in the ETS and instead increase the burden on those business sectors that are not. This is not the aim of the scheme and has strong negative implications for the cost-effectiveness. The issue of stability is raised by the International Emission Trading Association (2005), advocating longer allocation periods in a post-2012 regime, as to improve the stability of the instrument. The
current review of the EU-ETS includes a focus on these details and is analyzing the possibilities to improve the situation through more harmonized and transparent methods in the future. This could include allocations based on grandfathering or benchmarking as well as sector approaches and auctioning options (COM(2006) 676 final). The review also considers the possibility of more integrated EU-wide approaches to allocations. A stronger EU regulation is supported by Åhman et al (2007) as this is identified to hold a potential for improved allocation procedures. What the outcomes will be regarding these details remains to be seen at the publication of the result, which is planned to 2007. The future development of the EU-ETS should include that NAPs should strive for transparency and a long-term perspective as to decrease the negative influence on the business climate as well as to increase the acceptance of the policy instrument.

**Grandfathering**

Grandfathering is an allocation process that bases the allocated emission quota on historical emissions during a chosen base year period of one or several years. In a country such as Sweden, with a large share of electricity production from hydropower, yearly emission volumes fluctuate from dry to wet years depending on corresponding fluctuations in hydropower production (Chapter 3.2). This should be taken into account throughout the entire allocation process, from EU allocation guidelines to the allocations to the Trading Sector. Another factor that affects the allocations is the base year temperature profile. This is evident during the 1998-2001 base years were Sweden had a relatively small heating requirement and consequently lower emissions. The selected base years nevertheless impose additional emission reduction requirements for Sweden as these years were relatively wet with higher hydropower production resulting in low emissions. This issue has been emphasized in relation to the NAP2 where the Commission (EC, 2006b) has issued a complaint that the planned allocations are too generous. This has been criticized by Sweden on the background that 2005, being used as a reference
year by the Commission, was a relatively warm year with a high availability of Nordic hydropower, which reduces the emission levels. The historical allocation procedure also lacks a natural attention to new establishments and expansion of operations. The issues are therefore tended to separately in the law (SFS 2004:1205) on emissions trading.

Grandfathering can also have negative impacts for operations that have accomplished emission reductions earlier than the base year. These operations will receive smaller allocations than their actors that have been less proactive. While this creates erroneous incentives, a continuous updating of the baseline year could potentially stabilize this effect. This as all companies within the system then should have worked to reduce their emissions which – according to the probability that the initial measures holds relatively large and easy attainable improvements – reducing the emissions gap between “early doers” and “laggards”. This is a possible effect but various conditions and events could however cause another development. Leif Brinck (2005) at Preem identifies a difficulty in verifying accurate emission levels during the base years, as the measuring of that time was not of current standard. This provides support for updating as the allocations would be based on improved technical bases. Leif Brinck also identify that altered base years in the future will allow for operations to increase their emissions due to increased production levels. This is both positive and negative as the system must allow for a growing business sector, albeit preferably with reduced emissions. Raised emissions could however be met through the flexible mechanisms.

Updating however also cause problems. One is that updating creates more administrative work in regularly establishing new and correct base levels. This would however not necessarily be the case, as long as allocations reflect both new base years and their relation to the historical emission levels. Albeit this includes difficulties for predicting quota levels it can potentially improve the situation for forerunners. Maria Sunér Fleming (2005) at Swedenergy identify that changing base
year can also impose the risk of tactical running of the operations in order to receive a maximum allocation at the cost of larger emissions. Updated base years in connection to utilizing the flexible mechanisms instead of accomplishing emission reductions in the operations would also mean higher emission levels and continuously high allocations. Updating base years are currently not included in the law (SFS 2004:1205) on emissions trading, and the recent Bill (2005/06:184) on emissions trading suggests that the NAP2 shall be based on the same base years as the NAP1.

**Benchmarking**

Another allocation issue is that the emission patterns within the included operations vary between countries. The Swedish basic industry and energy utility operations are, as discussed in the previous chapters, often more efficient and have lower specific emissions than many of their European counterparts, especially in the southern EU. Many industry representatives including some of the interviewees, such as Birgitta Resvik (2005) at the Confederation of Swedish Enterprise, Göran Carlsson (2005) at SSAB and Leif Brick (2005) at Preem, therefore advocate the use of benchmarking in the allocation process for some industries. This is also promoted for the energy utilities by Swedenergy and Maria Sunér Fleming (2005). Benchmarking according to EU standards is also promoted by the SEA and Swedish EPA (2006b) for the sectors that are subjected to EU external competition.\(^{202}\)

Benchmarking can include other characteristics than historical emissions and could for example establish a mean value of the sectors’ specific emissions of carbon dioxide from production – relative the amount of goods produced – and allocate emissions based on this value. Such an allocation procedure have the potential to

---

\(^{202}\) These stakeholders are suggested to receive free allocations in future commitment periods if their competitors are not charged for the carbon dioxide emissions (SEA and Swedish EPA, 2006a).
reward operations that have low specific emissions and reduces the risk of penalizing operations that has performed emission reducing investments earlier than a grandfathering base year. Many of the issues with grandfathering highlighted above can consequently under certain conditions be improved through the utilization of benchmarking allocations. It should however be noted that benchmarking is only suitable with harmonized allocation procedures within the ETS, otherwise the harmonizing aspects disappear.

Johansson (2006b) and Åhman and Zetterberg (2005) identifies that benchmarking is a favorable allocation alternative. Johansson identifies positive elements both in the incentives that benchmarking has for improvements, while also being associated with reduced effects on the competitiveness. Åhman and Zetterberg however conclude that the benchmarking procedure is more cumbersome to administer, both in the NAP design and for the Trading Sector. The main burden lies in the establishment of the benchmark, which for some sectors is troublesome due to differences in products and raw material characteristics. Leif Brinck (2005) at Preem identifies that the IPPC BREFs could be utilized for this purpose for some sectors. Benchmarking is due to the above consequently not suitable for all sectors within the EU-ETS.

The SEA also supports benchmarking for the operations that are subject to international competition but not for the energy utilities. Thomas Levander (2005) at the agency would prefer an auctioning process over benchmarking but identifies the latter as the next best alternative. Birgitta Resvik (2005) at the CSE identifies that benchmarking should be offered to the steel industry, oil refineries and electricity utilities. Jernkontoret supports benchmarking on the basis that it allows for efficient operations to grow while creating an incentive for lesser efficient operations to improve their processes (SOU 2003:60). The FlexMex2 report on emission trading
(ibid) furthermore identify that benchmarking is also found positive by the Swedish Petroleum Institute. Svenska Kalkföreningen\textsuperscript{203} opposes the benchmarking process on the grounds that it is difficult to compare the lime operations as the energy demand and consequently also the carbon dioxide emissions of lime production are largely a result of the raw material which is different in different quarries (ibid). This is also the problem for other industrial sectors where it is difficult to attain reliable and comparable data for the industries in different regions. This view is supported by Gunnar Käck (2005) at the energy utility Fortum Värme, who also opposes benchmarking on the grounds of adding further governmental steering into the ETSs’ operation. The SSNC and Ylva Rylander (2005) identify that benchmarking have advantages but consider that it is difficult to accomplish on an EU level.

Maria Sunér Fleming (2005) at Swedenergy suggests a benchmarking method that establishes how the benchmark should develop over the years to finally reach a BAT state, as this would create a stable goal formulation. The suggested method would be designed with gradually strengthened requirements where each step towards the goal is previously declared. This method is also positive given that it takes technologically achievable emission reductions into account.

The allocation issues are subject to a continuing debate. The Commission guidelines (COM(2005) 703 final) on the NAPs for the second EU-ETS commitment period includes the possibility to utilize benchmarking allocations and the Swedish Government has established that this will be used for the steel industry and new entrants for the second commitment period 2008-2012 (Ministry of Sustainable Development, 2006b). The allocation will be based on production and emission statistics in the European production. The Bill (2005/06:184), preceding the NAP, also establishes that the Government sees many positive elements in benchmarking but

\textsuperscript{203} Eng. The Swedish Lime Association
only if it can be accomplished in an uncomplicated manner and in accordance with EU regulations.

**Sector Approaches**

A commonly discussed method of amending many of the issues within the ETSs is the use of sector approaches. A sector approach can be designed in different ways and its key element is that it allows for the stakeholders included in an ETS’s different sectors to work within separate but parallel systems with, for example, detached allocations and targets. This approach can lessen the negative competitive effects of an allocation procedure that utilizes auctioning. The sector approach has due to this been discussed as a way to increase the international willingness to participate in ETSs, as the approach would mean that the industries could be included in a way that takes larger consideration for the sectors’ production specifics. This is among others supported by the Center for Clean Air Policy (Schmidt *et al.*, 2006) that identifies the sector approach as a possibility to overcome this and other barriers to create improved ETSs. No decision on introducing a sector approach has been taken but the subject is being discussed in high-level forums such as the COP/MOPs and side events thereof.

**Auctioning vs. Free Allocations**

There have been discussions originating from the start of the ETSs on whether the emission rights should be allocated free of charge or through auctions. Both alternatives are favored by different stakeholders seeing that they have different consequences. Free allocations can cause disadvantages for new entrants when the share of emission rights that are freely allocated for new establishments is finished, as this force the new stakeholders to purchase emission rights from the market. If auctioning would be used within a grandfathering system, this would hamper new business establishments as these utilize new technologies. This is consequently not a recommended procedure.
An auctioning procedure can be seen as a tax as it results in an income to the state finances. An auctioning procedure would also increase the negative competitive effects for the basic industries due to increased production costs. The energy utilities however should have fewer problems with auctioning, as it is obvious that the emission rights price affect the electricity price even though of allocations have been free. An auctioning could conversely have the positive effect to balance the current situation where utilities are making large windfall profits.

In a macro-economic state oriented approach, Sorrel (2003) argues that there is a scientific consensus that auctioning is the most favorable allocation option. He further argues that – as free allocations is identified as not promoting technology development as well as not being in accordance with the Polluter Pays Principle – free allocation requires parallel energy and/or carbon taxes to create an effective policy regime. Such a system is identified as the second best alternative to an auctioning procedure. One of the reasons for these findings is that free allocations and no levied tax do not provide fiscal incomes. It is also supported by the possibility of utilizing auctioning to recover some of the utility windfall profits through the tax. Sorrel’s conclusion that the current system would not promote R&D efforts however seems exaggerated as this effect is more a result of the stability of the scheme and the possibility to identify future carbon dioxide emission costs. The suggestion of running parallel ETS and tax schemes could however theoretically be an option for the utilities. This would however require that the allocations to utilities are more stable and full-scale as the sector would otherwise be subjected to a triple burden – emissions trading, reduced allocations and tax levy. The reduced fiscal income base should in the Swedish case be manageable through the tax-shift that has a broader base than the Trading Sector.

The utility organization Swedenergy (Sunér Fleming, 2005) promotes auctioning of emission rights exclusively to the utility sector, to overcome acceptance problems arising from windfall profits. The organization however identifies that allocations are
not recommended for the industry sectors as this may have a severe impact on EU industry if there is no real-global ETS. Gunnar Käck (2005) at Fortum Värme identifies auctioning as favorable from a fairness perspective but highlights that the procedure at the same time can cause competitive concerns. An example of this is that the emission rights prices are expected to rise if transport would be included in an ETS, due to the higher purchase willingness of actors within transport sector than mainly basic industry customers. This effect can however be amended by the use of sector approaches. Göran Carlsson (2005) at SSAB opposes an auctioning procedure as the scheme would otherwise result in large incomes to the Government and that this in theory could be considered a fiscal tax. Thomas Levander (2005) at the SEA promotes auctioning as free allocations include high administrative burdens for applications as well as difficulties for agencies to contest the prognoses of production and emissions that the companies report. Auctioning is however challenged for sectors that are subjected to EU external competition in regions that do not levy any carbon dioxide emission levies (SEA and Swedish EPA, 2006b). The SSNC (Rylander, 2005) promotes auctioning, as a free allocation is identified to work as capital transfer to the Trading Sector. Another reason is that an auctioning system provides the Government with funds to accelerate the introduction of RES through for example support to wind power (ibid). The latter would however only be possible if these incomes are earmarked for similar purposes, which has not been the case in other market based climate and energy policies.

10.4 Improved Stakeholder Dialogue on Policies and Policy Instruments

The rise of climate change to the top of the international agenda has resulted in a range of national and international policies and policy instruments primarily or secondarily targeting GHG emissions from the Trading Sector. The Trading Sector is
also facing increasingly globalized markets which have increased the international competitiveness situation. This development has made it more difficult for the business sector to participate in the shaping of the policy framework. This necessitates a domestic dialogue that allows the business sector to take part in this work through political channels. The internationalization and the development of new policies have been rapid and the effects of the new policy instruments are unknown previous to their implementation. A well-functioning dialogue between the Trading Sector and Government is against this background essential to trim the new framework into an effective regime from the development perspectives highlighted in the thesis. Regarding energy efficiency policies, Geller et al (2006) exemplifies this through identifying that that the private sector should be allowed to voice their opinions in the policy development in order to provide a large-scale and lasting market impact. Another example is Fouquet and Johansson (2005), who identify that negotiations with the main stakeholders is required in the work to establish an effective tax scheme.

The climate change issue cannot be solved without collaboration between all parts of the society and the thesis focuses on the collaboration between some of the Swedish society’s main emitters of carbon dioxide and the Government. In order to improve the prospects for an effective climate change abatement strategy in combination with a sustainable development, the Government should strive to accomplish a high level of acceptance for the policies and policy instruments that they establish. This can be accomplished through a strengthened dialogue with the business sector. This dialogue is however not always easy to accomplish and the Government officially carry this out through inviting stakeholders as remittance bodies to official inquiries.

Establishing an effective dialogue must include the sector organizations as many companies within the Trading Sector are not of such size that allows them to effectively argue their own case. This is emphasized by the abovementioned strengthening of international influence on the policy framework. The reliance on the
sector organizations, as spokespersons on these remittances and in international discussions, are however an important aspect for all stakeholders within the Trading Sector. As these sector organizations consequently are important in hearing a broad-based stakeholder view it is important that these organizations carry a constructive dialogue, which according to Thomas Levander (2005) at the SEA is not always the case. It should also be noted that some studies (e.g. Bailey and Rupp, 2004) are critical to governmental consideration of business attitudes in the design of new policy instruments, indicating that this would weaken the policy framework.

**Stakeholder Opinions**

The business sector perception of the dialogue with the Government varies but most interviewees have reservations. While a further involvement in the development of the policy framework is associated with larger costs and administrative efforts, it would have positive implications for the stability and thus the efficiency of the policies and consequently worth the effort.

Due to the importance of EU-ETS as a policy instrument, the implementation of the scheme was accompanied by a forum for stakeholder dialogue. The discussions took place within a high-level group called “Raketgruppen” where for example the CSE, Fortum Värme, SSAB, Cementa and Preemraff Lysekil were invited to participate. The initiative was appreciated and deemed important by the interviewees that participated (Resvik, 2005; Käck, 2005; Carlsson, 2005; Lyberg, 2005; Brinck, 2005). Gunnar Käck at Fortum Värme for example identifies that this dialogue was superior to the discussions about the establishment of the REC scheme. Käck however concludes that Raketgruppen in the end did not have any significant effect regarding the energy sectors needs on the outcome of the EU-ETS implementation.

Birgitta Resvik (2005) at the CSE has the opinion that there are no effective forums for discussions between the basic industry, energy utilities and Government on policy and policy instrument issues. The forums that exist – remittances of official proposals
and invitational discussions - are not sufficient. Resvik identifies that a satisfactory discussion in the climate and energy policy area is vital, seeing the fundamental importance of these issues and the necessity to maintain a competitive business sector.

Maria Sunér Fleming (2005) at Swedenergy identifies that the dialogue with the authorities works well in general. The organization has a satisfactory dialogue with officials at the ministries and agencies. The dialogue at higher levels is identified as less effective, which is argued to be a result of the balance of power that the Green Party holds in the minority Government. The process in the introduction of the EU-ETS and RECs has worked well, although Sunér Fleming expresses that as a sector organization Swedenergy would favor an increased dialogue and influence. Sunér Fleming also mentions that the REC system, as introduced based on an official report written by a representative from the utility sector, meant that the sector had a large influence on the development of the policy instrument.

Peter Chudi (2005) at E.ON Sverige states that the company at many occasions relies on the sector organization Swedenergy to carry out the dialogue on policy issues. He comments that it is difficult to address these issues through lobbying as this culture is not strong in Sweden.\textsuperscript{204} In an EU perspective, Chudi identifies EU directives as being based on better background information than Swedish bills. The dialogue with the agencies and authorities on the design of the REC system is identified as valuable.

Johan Tollin (2005) at Vattenfall regards that the company has good opportunities to voice their opinions in relation to the Government’s policy instrument work. The company is often invited to participate in debates and investigations, which is a

\footnote{204 Only one interviewee could personally identify that active lobbying had been utilized to apply pressure on policy administrators.}
natural consequence of the company’s position as the largest utility, owned by the state. Tollin however identifies that the larger international influence on the policy agenda makes it more difficult to attend all arenas for discussions, such as EU, making the company focus on the key issues that are identified as important to the company. Vattenfall consequently regard that they are allowed to participate in the dialogue on policy instrument designs. The company however mainly participates in similar forums through the sector organizations such as Swedenergy and Svensk Fjärrvärme as well as Eurelectric on an EU level. The company usually only enter the dialogue when an issue of special importance is identified.

Göran Carlsson (2005) at SSAB identifies that the dialogue with the Government and official bodies is mostly working well. Carlsson therefore does not identify a need for a particular forum for discussions as different forums are created as important issues arises. Anders Lyberg (2005) at Cementa identifies that the dialogue is often asked for by the Government and that it is working satisfactory.

Mikael Hannus (2005) at Stora Enso highlights the importance of a proactive dialogue between the government and business sector. Hannus identifies, as mentioned in Chapter 10.2, that this dialogue is essential for strengthening the stability and long-term perspective of the policy framework. Hannus is however critical to the Government’s efforts to heed opinions from the business sector. The reasons for this are identified as politicians only dutifully hearing the business stakeholder opinions and that it for that reason is difficult to receive attention to them. Hannus exemplifies the neglect for business stakeholder opinions and experience in relation to the review of the EU-ETS where the review inquiry forms – used for stakeholder consultation – were to be issued much too promptly after the scheme was initiated plus that they were clearly directed towards political stakeholders. Hannus does not regard the situation as any better for the SKGS or CSE, as these organizations have to tend to such a wide range of partners, often resulting in vague formulations. Hannus thus define the problem with an
unproductive dialogue more as a lack of interest from politicians rather than a lack of forum for this dialogue. Hannus the main issue as working towards a more proactive approach in the policy instrument designs rather than a reactive, as is thought to be the case today.

Leif Brinck (2005) at Preemraff Lysekil identifies that the sector organization SPI are efficient in communicating the company’s position on the climate and energy policy framework. This is seen as a result of the Preemraff’s position within the refinery sector, which is also identified to provide the possibility to participate in national high-level forums. Brinck argues that the central authorities are reasonably interested in a policy dialogue and that the dialogue works satisfactory due to this. Brinck further identifies that the Government probably is more interested in a dialogue with sectors organizations than with individual companies.

The SSNC (Rylander, 2005) identifies that their dialogue with the Government and especially the environmental minister is working well. A problem is however that the organization has much fewer representatives than the business sector and that this can disadvantage them in the dialogue. The SEA and Swedish EPA is considered to be active in inviting the organization to discussions and the SSNC is a remittance body for official suggestions. The organization is often invited to the expert councils that work with official inquiries.

### 10.5 Effectiveness of the Current Policy Framework

The effectiveness of the policy framework can be viewed from different perspectives. It builds to a very high degree, as discussed in Chapter 5.6, on the goal compliance and cost efficiencies of the policy instruments. These efficiencies are a result of many factors and one of the most important aspects for effectiveness of the framework overall are the time perspective of the individual elements therein. Other important
aspects are the stability, predictability, harmonization and acceptance of policies. These different design characteristics have therefore been highlighted in the thesis. Specifying or quantifying the effectiveness from these varying perspectives is not part of the scope of the thesis and the effectiveness is therefore mainly discussed in terms of the concerns that have been highlighted by the interviewees.

The policy framework foundation is established by policy goals and guidelines. To enable a high effectiveness of the framework, it is therefore essential that the goals are clear, reasonable and provide a long-term guidance. This is however not accomplished by the current climate goal of reducing the GHG emissions at a rate exceeding the international commitments. The reason is that the commitment is established through the Kyoto Protocol which is associated with flexible mechanisms that establish a carbon market. This aspect of the Kyoto Protocol means that these mechanisms must be utilized to take advantage of the higher cost-efficiency that the mechanisms provide. Failing to fully allow their use inevitably reduces the effectiveness of the policy framework without affecting the global GHG emission levels. As the EU-ETS establish a Trading Sector, a limited range of stakeholders are negatively affected by the climate goal and the reduced possibility to contribute to reaching the Swedish climate policies as effectively as possible. The reasons for this are many, including that additional policy instruments are required, policy acceptance is low and harmonization negatively affected. It also causes a reduced stability, due to plausible policy changes. The effectiveness would however be improved through a deduction goal including the Trading Sector.

The fundamental importance of the EU-ETS in the climate and energy policy framework causes a strong influence on the other instruments. Emissions trading sets a price for carbon dioxide emissions, which stimulates emission reductions both through technology implementation and development. A problem with market based policy instruments are that the price of reducing the energy consumption and GHG emissions is uncertain, why it is difficult to evaluate the economic conditions
for these abatement investments. To make ETSs work as an effective catalyst for emission abatement, it is therefore necessary to promote a stable ETS that creates long-term price incentives. This is a key issue as the large-scale basic industry carbon dioxide emission abatement possibilities in many cases are cost intensive and often requiring new process technologies. Strengthening emissions trading from this perspective mainly includes longer allocation periods, a wide participation and post-2012 commitments.

The carbon market should be allowed to function without obstacles in order to be as effective as possible. This is neither accomplished with current climate goal and nor a parallel carbon dioxide tax, as the tax exerts additional pressure on the Trading Sector while also reducing the acceptance for the policy framework. From this perspective the tax can consequently be argued to counteract the application of market instruments. As such, it should in accordance with the KP (Table 6.5) be reduced or phased out. Furthermore, the double burden that these two instruments exert on the Trading Sector is reducing the competitiveness. This situation has been acknowledged by the Government that at numerous occasions declared that the tax shall be removed or reduced for the Trading Sector. The Government however repeatedly postponed the actual decision, which resulted in an unstable policy environment.

Most policy instruments running parallel to a cap-and-trade scheme will not achieve further reductions than the aggregate cap. They will consequently in most cases increase the overall cost of reaching the cap level emissions (Sorrel, 2003). Other policy targets may however promote or necessitate additional instruments. Such a case is the EU RES-e goal that has resulted in national RES policies and the introduction of the REC scheme. While Birgitta Resvik (2005) at the CSE argued that a REC scheme should be superfluous next to the EU-ETS, there is nothing in the latter instrument that supports the achievement of the RES target. The cap-and-trade nature of ETSs furthermore does not support the policies of security of supply or
technology targets, such as the Swedish wind power goal. Sorrel’s (2003) argument that additional instruments will not accomplish emission reductions below the cap does not account for cases where stricter emission targets than the cap is established. Additional instruments will inevitably be required under those conditions, as an ETS is incapable of accomplishing this.

Additional instruments will however result in higher short-term abatement costs albeit also having positive spillover effects. A stronger policy framework may however possibly result in lower long-term costs due to strengthened promotion of technology development. As a result of these interactions and the goal of a cost-efficient policy regime, it is vital that the effects of parallel instruments are evaluated and the effects measured against the various goals in both the climate and energy policies. An important aspect in a policy development towards an efficient framework is to define which policy goals that have highest priority in order to enhance the understanding of which trade-offs that the Government makes in relation to the implementation and amendments of various policy initiatives.

The REC scheme was initially ineffective in promoting large scale investments due to the too short time frame. Since the scheme however has been prolonged the design characteristics has been improved. It should be analyzed whether the REC scheme is required or result in reduced policy efficiency if a stable ETS regime is established. As a long-term ETS establishes a price for utilization of fossil fuels in a future perspective, the ETS should also supply strong incentives for RES. EECS have positive characteristics due to its focus on energy efficiency, having a source rather than end-of-pipe application. The PFE could nevertheless be a better policy option as it can be designed with a more stable timeframe. The PFE also provide a high level of efficiency as it allows the companies to freely choose which measures to adopt to achieve the set targets. This policy instrument characteristic is identified by Worrel and Price (2001) as being essential to realize the individual potentials for energy efficiency that exist in various industrial sectors and technologies. The cost-efficiency
should however be lower than of an EEC scheme as the latter allocates the measures on a larger market. The introduction of EECs is not recommended at present as the function of the EU-ETS is not yet fully established and that it would create a larger administrative burden for the already heavy policy influenced Trading Sector.

The tax system could be further integrated towards the climate issue by earmarking a share of the fiscal incomes from the energy and carbon dioxide taxes to be returned to the tax objectives. This can for example be accomplished through utilizing the funds in subsidy programmes or public benefit funds promoting climate related initiatives. By utilizing this possibility the taxes could achieve a higher steering efficiency and thus improve the effectiveness of the climate policy agenda. Subsidies can provide a strong support for the investments in the application of a technology and thus support a positive development. This can however be more efficiently accomplished with a market based system that allocates the efforts with a higher cost-efficiency. Subventions are important to alleviate certain sectors from a strong policy pressure and the consequential competitive implications thereof. They are however increasingly difficult to utilize as they are objected to in both EU legislation and in the KP.

A strong Environmental Code is important to any national energy and climate policy agenda in order to establish the overall environmental framework. The Swedish Environmental Code has however reduced the rate of RES developments within the energy sector due to the cumbersome and withdrawn application processes. Measures to improve the situation have been taken and the initial signs indicate that they have a positive effect. The long-term effects of these measures however remain to be seen.
Stakeholder Perspectives

The Confederation of Swedish Enterprise has published a report (Brännlund, 2005) that identifies economic instruments as being superior to informative and administrative instruments. The reasons are that market based economic instruments are recognized as reaching the environmental goals at minimum costs as well as introducing a larger share of flexibility for the stakeholders on what measures to take in order to accomplish a goal. Market based policy instruments are furthermore seen as positive in promoting technology development and as part of a green tax-shift.

Göran Carlsson (2005) at SSAB identifies that the design of policies and policy instruments could be substantially improved through a better dialogue between the society and industries. Anders Lyberg (2005) at Cementa would like to see a rationalization of the current policy instrument mix in order to increase the individual effectiveness of the instruments.

Mikael Hannus (2005) at Stora Enso argues that the carbon dioxide tax and REC scheme should be removed in order to streamline the policy instrument mix and let the EU-ETS be the main governing instrument. Hannus promotes a policy framework which has one instrument for each goal and argues that this is essential for a cost-efficient policy regime. Hannus identifies that too strong policy instruments, such as ETSs and the REC system, can cause sub-optimizations as they require too rapid measures. Albeit being quite critical to the policy agenda, Hannus identify that the policy makers lately have shown an increased understanding for the serious negative consequences that the policy instruments are causing for the basic industry in general and the pulp and paper industry in specific.

Leif Brinck (2005) at Preem identifies that the number of instruments should be reduced as the effects of the current mix is difficult to comprehend, which is seen as causing a reduced predictability. Brinck is positive to the nitrous oxides emission charge system, which utilizes a pool to which all emitters pay and all stakeholders
receives a payback depending on their emissions in relation to their production. This instrument however faces similar benchmarking problems as is the case in the allocation of emission rights. In relation to the discussion on policy instrument efficiencies, Brinck highlights that the industry is not negative to instruments imposing costs as long as these instruments and costs are harmonized with other countries.

Gunnar Käck (2005) at Fortum Värme states that applied policy instruments have been instrumental for the company’s investments and operation of the production units. Käck identifies that the carbon dioxide tax resulted in investments in biofuel operations during the 1990s. Käck however argues that there must be a clear division between fiscal policy instruments and instruments that are implemented to accomplish an energy or climate policy target. Further design issues that are seen as important are one instrument per policy target and harmonization from an international and EU perspective. Käck further identifies that policy instruments today mainly target electrical efficiency while previously focusing more strongly on fuel efficiency.

Thomas Levander (2005) at the SEA identifies a number of possibilities to reduce the overall policy instrument burden, mainly through removing the carbon dioxide tax for the basic industries and electricity utilities. The SEA (2005e) identifies that an effective national climate and energy policy framework should include a deduction climate goal, a carbon dioxide tax for the non-Trading Sector corresponding to an estimated EUA price as well as accounting for the utilization of the KP flexible mechanisms towards the climate goal. The SEA (2006g) has further identified that the efficiency of the policy framework is reduced as a result of many policy instruments primarily targeting the same goal. Levander argues that it could be beneficial for the efficiency of the policy framework to introduce an exchange programme between emission rights, RECs and EECs, as they aim at the same goal – to reduce GHG
emissions. This would however require that such a procedure is approved by the EU or the COP/MOP.

The SSNC (Rylander, 2005) argues that the Government’s agenda on climate and energy is not sufficient and therefore should be more proactive, for example through an increased policy support to RES. Ylva Rylander (ibid) at the SSNC argues that taxes are better policy instruments than market based instruments. This is based on taxes as being strong instruments that have effectively steered towards their goal. Market based instruments are identified as more uncertain and depending on correct design characteristics. Rylander further argues that an important issue in the climate and energy policies are comprehensive, overarching and regular analyzes on how the policy instruments work together, as this is deemed important to avoid sub-optimizations. This is also identified as important to clearly communicate what goal the policy instrument has. The SSNC furthermore identify that the possibility that companies may outsource the production or move to other countries should not be exaggerated and regarded as a reason not to implement strong policy instruments. This view can however be challenged as outsourcing may very well be the case since the business sector takes business strategic decisions with a long-term perspective.
11. Future Policies

The business sector is generally dedicated to the climate change issue but only to a point to where it does not interfere with the core business and long-term strategies that aims for positive revenues. This focus cannot be accused of being in conflict with the society, as the long-term survival of the business sector is of key importance to the prosperity thereof. Joining forces with the business sector on climate change requires policy instruments that promote an effective mitigation regime, allowing the businesses to utilize their know-how to combine high levels of profitability and competitiveness with reducing GHG emissions. Technology development is important to achieve substantial emission reductions in the longer term, but there are no present technological barriers to effectively curb the emissions of GHGs and carbon dioxide to substantially lower levels. The European Parliament (EP, 2005c) exemplifies that the technologies necessary to reach the goals of 30 % RES utilization in the overall energy consumption to 2020 are available and that the main obstacle to
achieve the target are political action. It can consequently be argued that policies should include a strong focus on technology implementation.

The Government should focus on the long-term aspects of policy instrument designs, bearing in mind the payback periods for emission abatement measures in the Trading Sector. This is essential to provide the business sector with stable investment bases, which is essential to effectively promote substantial low-carbon technology investments. Failing to achieve this within the policy framework will inevitably lead to lower goal compliance and higher societal costs. While a 15-30 year perspective is not always possible, the design should at every occasion strive for a high level of stability and predictability. Many policy instruments have however fallen substantially short of meeting these requirements.

Other important aspects are to include a constructive dialogue to aid the stability and acceptance of the instrument implementation as well as striving for a high level of harmonization so that stakeholders in different sectors, regions and countries face similar challenges and risks. This is supported by the interview results as well as a large array of publications. Thomas Levander (2005) at the SEA, states that the solution to climate change in a Swedish perspective in many ways is in the hands of the basic industry and that the climate policy framework could facilitate much more effective mitigation efforts. One of the main measures to accomplish a truly stable policy environment would be to reach a broad political agreement on the climate and energy policies.

It must also be highly emphasized that solving the climate change issue and securing the energy supply is not a matter of one miracle solution but a combination of measures. A successful review of the KP to establish an international post-2012 GHG commitment is absolutely vital for the short-term success of international agreements combating climate change and the stability of the carbon market. This must
consequently be the focus of the Swedish Government in international discussions and at the COP/MOPs.

One of the main issues in the climate policies is the design of the national climate goal. The goal, towards which the Trading Sector shall work, must be amended as the current situation creates absurd effects within a cap-and-trade system, such as the EU-ETS. The EU-ETS has undoubtedly resulted in a large price increase for energy, a situation that has been further emphasized by the price increase from other instruments such as the REC scheme. The scheme is based on an international policy instrument on a level that is previously untested and the Government should consequently be sensitive to the Trading Sectors’ situation. Establishing an arena for an effective exchange of experiences of the current policy framework could potentially improve the political agenda. The negative aspects related to the current national climate goal design are abundant, which should prompt a required redesign. The amendment closest at hand is the adoption of a deduction goal, as this would improve the effectiveness of the implemented policy instruments. The policy framework should also consider adopting other sectoral policy goals, for RES and energy efficiency and not only climate, which are responsive to the Trading Sector’s business environment and allowing for a higher policy stability.

The emission rights allocation procedure is currently lacking in harmonization and stability. The latest Bill (2005/06:184) on emissions trading lacks in stability, namely through how it approaches the utility sector. The allocations to the utilities, being marginal towards the national climate goal, are difficult to predict and thus reduces the instrument’s efficiency of promoting environmental investments and technology development. The development of the EU-ETS should strive for longer allocation periods with a higher transparency and harmonization. Benchmark allocations with a wider scope than today should be considered.
The newly introduced market based policy instruments have unknown effects, individually as well as in combination. These effects and the increased administrative burden of these instruments must be evaluated as not to sub-optimize the policy framework. The policy theory of one-goal-one-target can be seen as one guiding principle. Introducing parallel policy instruments next to strong instruments such as the EU-ETS may however be important to achieve certain policy targets such as RES developments.

Amending these issues highlighted in the thesis should be a main priority in the work within the climate policies both on a national and international level. If the policy framework creates market conditions that are perceived as difficult to operate within, than the risk of reduced industrial activity in Sweden should be seen as a real threat – not to our national carbon dioxide emissions levels but to the global levels and the Swedish national economy.
12. References


http://www.svensktnaringsliv.se (15 March 2006)


2005/06:125. Beskattning av visst hushållsavfall som förbränns, m.m. Ministry of Sustainable Development, Sweden.


2005/06:83. Ursprungsgarantier för högeffektiv kraftvärmeel m.m. Ministry of Sustainable Development, Sweden.


2004/05:100. 2005 års ekonomiska vårproposition: Förslag till riktlinjer för den ekonomiska politiken och budgetpolitiken samt tilläggsbudget m.m. Ministry of Finance, Sweden.


http://www.cementa.se (28 December 2005)


(97) 514 final. A Community Strategy to Promote Combined Heat and Power (CHP) and to Dismantle Barriers to its Development. European Commission.


___, 2005a. EU emissions trading - An open scheme promoting global innovation to combat climate change. European Commission.

\textsuperscript{206} European Commission publications are available through http://europa.eu.int/eur-lex/en/search/search_dpi.html.


http://www.europarl.eu.int (5 October 2006)

http://www.europarl.eu.int (2 February 2006)

http://www.europarl.eu.int (2 February 2006)

http://www.europarl.eu.int (2 February 2006)


http://www.eurelectric.org (26 September 2005)

http://www.eurelectric.org (26 September 2005)


Climate Change: - Medium and longer term emission reduction strategies, including targets = Council conclusions (7242/05). European Council.


http://www.eex.de (Visited 12 January 2007)


Kriström, B., 2006. Professor at the Swedish University of Agricultural Sciences, Department of Forest Economics. Presentation at the Conference Sveriges Energiting (Session 5), 7 March 2006.


Montel Powernews, 2005a. E.ON planerar 1.000 MW vindkraftpark. Article, 15 November.

Montel Powernews, 2005b. No immediate price effects from Barsebäck shut down. Article, 30 May.


______________________________

207 The majority of the SEA reports can be downloaded from the agency’s home page, http://www.stem.se


408

http://www.regeringen.se/content/1/c6/06/06/92/5ff0d494.pdf (12 September 2006)


http://www.svenskenergi.se/marknad/priser.htm (13 June 2005)

http://www.svenskfjarrvarme.se (20 July 2006)


Swedish District Heating Association.

Swedish EPA, 2007. Information in the Swedish reports to the UNFCCC. 
http://www.naturvardsverket.se (16 November 2006)


__, 2004. Förslag om utformningen av en fortsatt grön skatteväxling. The Swedish Environmental Protection Agency.


Sydkraft, 2005. Information from the home page. 
http://www.sydkraft.se (15 August 2005)


Appendix I

Appendix I - Interview Questionnaire
Examples

Basic Industry Stakeholder

1. Vilka åtgärder har Ni tagit för att minska Era koldioxidutsläpp?
2. Vad har drivkraften bakom dessa åtgärder/investeringar varit?
3. Har Ni några mål avseende koldioxidutsläpp eller klimatarbete och hur avser Ni då att nå dem?
4. Vilka områden/åtgärder inom Er industrisektor anser Ni ha störst potential för att minska koldioxidutsläppen i nuläget samt i ett längre perspektiv?
5. Vilka energieffektiviseringsåtgärder har ni genomfört?
6. Vad har drivkraften bakom dessa åtgärder/investeringar varit?
7. Har Ni några mål avseende energieffektivisering och hur avser Ni att nå dem?
8. Vilka områden/åtgärder inom Er industrisektor anser Ni ha störst potential för energieffektiviseringsar i nuläget samt i ett längre perspektiv?
9. Hur ställer Ni Er till dagens klimat- och energipolitiska styrmedel?
   *(Utsläppshandel, Gröna el-certifikat, PFE, CO₂-skatt, Elskatt, Bränsleskatt, Miljöbalken)*
10. Vilken styrmedelsutveckling skulle Ni vilja se?
11. Vilken påverkan har styrmedel på Er drift?
12. Anser Ni att klimat- och energipolitiken skulle kunna förbättras? Hur?
13. Finns det något fungerande forum för diskussion mellan Er och staten avseende dessa frågor?

The questions have not been translated as this may alter how they were asked due to translation errors. Non-Swedish readers should regardless of this have no problems understanding the context in which the interview results are included in the text.
Appendix I

Energy Utility Stakeholder

1. Vilka åtgärder har Ni tagit för att minska Era koldioxidutsläpp?
2. Vad har drivkraften bakom dessa åtgärder/investeringar varit?
3. Har Ni några mål avseende koldioxidutsläpp eller klimatarbete och hur avser Ni då att nå dem?
4. Vilka områden inom energiproduktion anser Ni ha störst potential för utsläppsminskningar nu och i framtiden?
5. Vilka områden/åtgärder inom energiindustrin anser Ni kunna förbättra produktionseffektiviteten i nuläget samt ur ett längre perspektiv?
6. Hur ser Ni på framtidens energiproduktionstekniker ur ett klimatperspektiv?
7. Hur ställer Ni Er till dagens energi- och klimatpolitiska styrmedel? (Utsläppshandel, Gröna el-certifikat, PFE, CO₂-skatt, Energiskatter, Miljöbalken)
8. Vilken styrmedelsutveckling skulle Ni vilja se?
9. Anser Ni att energi- och klimatpolitiken skulle kunna förbättras? Hur?
10. Finns det något fungerande forum för diskussion mellan Er/energiproducenter och stat avseende energi- och klimatpolitiska frågor?
Appendix I

Business NGO

1. Vilka områden inom basindustrin och energiproduktionen anser Ni ha störst potential för att minska koldioxidutsläppen i nuläget samt ur ett längre perspektiv?
2. Vad har drivkraften bakom tidigare utsläppsminskningar varit?
3. Har Ni några mål avseende Era medlemmars koldioxidutsläpp?
4. Vilka områden inom basindustrin och energiproduktionen anser Ni ha störst potential för att förbättra energieffektiviteten i nuläget samt ur ett längre perspektiv?
5. Vad har drivkraften bakom tidigare energieffektiviseringsåtgärder varit?
6. Har ni några mål avseende Era medlemmars energieffektivisering?
7. Anser Ni att era medlemmar är villiga till att förändra sin energikonsumtion?
8. Hur ställer Ni Er till dagens klimat- och energipolitiska styrmedel?
   *(Utsläppshandel, Gröna el-certifikat, PFE, CO₂-skatt, Elskatt, Bränsleskatt, Miljöbalken)*
9. Vilken styrmedelsutveckling skulle Ni vilja se?
10. Vilken påverkan har dagens styrmedel på basindustrin och energiproducenterna?
11. Anser Ni att det miljö-/energipolitiska klimatet skulle kunna förbättras? Hur?
12. Anser Ni att det finns något som bromsar omställningen av energisystemet? Vad?
13. Finns det något fungerande forum för diskussion mellan basindustrin/energiproducenter och stat avseende dessa frågor?
Environmental NGO

1. Hur ser Ni på koldioxidutsläppssituationen inom basindustrin och energiproduktionen i nuläget samt ur ett längre perspektiv?
2. Vad anser Ni kunna driva fram utsläppsminskningar?
3. Har Ni några mål/riktlinjer avseende svenska koldioxidutsläpp?
4. Vilka möjligheter ser Ni inom förbättringar av energieffektiviteten inom basindustrin och energiproduktionen i nuläget samt ur ett längre perspektiv?
5. Vad anser Ni kunna driva fram energieffektiviseringsåtgärder?
6. Har Ni några mål/riktlinjer avseende energieffektivisering i dessa sektorer?
7. Hur ställer Ni Er till dagens klimat- och energipolitiska styrmedel?
   (Utsläppshandel, Gröna el-certifikat, PFE, CO₂-skatt, Elskatt, Bränsleskatt, Miljöbalken)
8. Vilken styrmedelsutveckling skulle Ni vilja se?
9. Anser Ni att det miljö-/energipolitiska klimatet skulle kunna förbättras? Hur?
10. Anser Ni att det finns något som bromsar en positiv utveckling av det svenska klimatarbetet? Vad?
11. Finns det något fungerande forum för diskussion mellan Er, basindustrin/energiproducenter och stat avseende dessa frågor?
Appendix I

State Agency

1. Vilka områden inom basindustrin och energiproduktionen anser Ni ha störst potential för att minska koldioxidutsläppen i nuläget samt ur ett längre perspektiv?

2. Vad anser Ni att drivkraften bakom tidigare utsläppsminskningar har varit?

3. Har ni några mål avseende koldioxidutsläppen från basindustrin och energiproduktionen?

4. Vilka områden inom basindustrin och energiproduktionen anser Ni ha störst potential för att förbättra energieffektiviteten i nuläget samt ur ett längre perspektiv?

5. Vad anser Ni att drivkraften bakom tidigare energieffektiviseringsåtgärder har varit?

6. Har ni några mål avseende energieffektivisering inom basindustrin och energiproduktionen?

7. Anser Ni att basindustrin och energiproducenterna är villiga till att arbeta med klimatproblematiken?

8. Hur ställer Ni Er till dagens klimat- och energipolitiska styrmedel?
   (Utsläppshandel, Gröna el-certifikat, PFE, CO₂-skatt, Elskatt, Bränsleskatt, Miljöbalken)

9. Vilken styrmedelsutveckling skulle Ni vilja se?

10. Vilken påverkan har dagens styrmedel på basindustrins och energiproducenternas klimatarbete?

11. Anser Ni att det miljö-/energipolitiska klimatet skulle kunna förbättras? Hur?

12. Anser Ni att det finns något som bromsar omställningen av energisystemet? Vad?

13. Finns det något fungerande forum för diskussion mellan basindustrin/energiproducenter och stat avseende dessa frågor?