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Country Profile for SWEDEN

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Contents

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Introduction

1.1 SETatWork Country Profiles

This report is one of a set of Country Profiles produced by **SETatWork**. The global society is faced with a huge challenge in order to meet the threat given by global warming. The project **SETatWork - Sustainable Energy Technologies at Work** aims to meet this challenge through the collaboration and partnerships between organisations in EU, Asia and South America, supported by the EU's Seventh Framework Programme (FP7). The activities take place over two years from 1 September 2008 to 31 August 2010.

The aim of this country profile, is to provide an overview of the carbon market in Sweden with a focus on RTD needs, implementation options and perspectives associated with energy efficiency and savings in the carbon market (short term and medium-long term).

The main target groups for this country profile are companies (financial investors, project developers, technology providers, ESCOs, consultants, etc.), organisations and administrations that are interested in a short overview of relevant information in the development of carbon projects and markets in Sweden. This information may also be of relevance to readers from other countries that are interested in an overview of Sweden as well as for national readers that need to have information on their national developments.

SETatWork Country Profiles can be found online at: http://www.setatwork.eu/countries.htm

1.2 SETatWork Sustainable Energy Technology (SET) Priorities

In each country, companies and organisations were interviewed by SETatWork in order to identify indicative priority rankings for various Sustainable Energy Technologies (SET) and Industrial Sectors. The results of these interviews for each sector can be viewed on the following page: http://www.setatwork.eu/maps/index.html

The SETatWork Priorities for Sweden are shown below. Where data is not yet available, the bar chart columns are left empty.

The companies agreed that increasing energy efficiency in existing processes is the most important issue.

They also indicated that the following are very important also:

- Design in Policy strategy and monitoring
- Company image and marketing
- Energy efficiency in Industry
- In-house savings
- Sector benchmarking and assessment tools

When it comes to technology, bioenergy, fuel switching and Industrial CHP are given the highest ranking in Sweden. The pulp and paper industry ranks bioenergy high and that could be due to their use of wood as a raw material and because they have bioenergy within their portfolio.

The Carbon Market is not yet on the agenda and the companies rank it as of low importance. This could be because they don't have tough demands. These companies have enough carbon credits so that they can save to the next period. However, it could be that they don't have enough information in how they can use their credits and get involved in the CDM/JI market.

2. General country overview

2.1 The energy situation in Sweden

Total energy use in 2006 amounted to 624 TWh. Of this total final energy use was 403 TWh with conversion and distribution losses of 177 TWh, of which 126 TWh related to nuclear power production. Bunker oils for foreign maritime transport, together with the use of potential energy products for non-energy purposes, accounted for a further 45 TWh.

Although industry, and the residential and service sector, both use more or less the same amount of energy now as in 1970, much has changed: the total heated floor area of commercial premises, for example, is greater, population numbers have risen by 12.8 %, and industrial production is considerably higher than it was in 1970. The move away from oil to electricity and district heating has 'transferred' some of the losses to the supply side of the energy system.

Total energy use by the transport sector (excluding foreign maritime traffic) has increased by 80% since 1970. For the industrial sector, the variations in energy use from one year to another are due mainly to economic conditions, while for the residential and service sector they are partly due to differences in the climate from one year to another. Energy use in the various sectors shows that electricity and district heating are the most important energy carriers for the residential and service sector, that electricity and biofuels are the most important for industry, and that oil products totally dominate energy use in the transport sector.

Since 1970 the demand for energy has increased by 7.5 %, from 375 TWh to 403 TWh (Figures 1 and 2). However, over the same period, total energy supply has increased by 36.5 %, from 457 TWh to 624 TWh. The reason for the supply of energy increasing almost five times more rapidly than the demand for energy is because both the industrial, and the residential and service, sectors have carried out a major shift away from oil to electricity as the main energy carrier during the period. Although electricity is a very efficient energy carrier as far as users are concerned, it is associated with major losses on the production side, e.g. when produced in nuclear power stations. As a result, much of the conversion losses have been transferred from the end users to the supply side of the energy system. These losses

are not shown as part of the end-users' demand, but as an item in their own right. Losses occur, for example, in electricity production, in the production of district heat and in refineries. By assigning all the losses proportionally to the use of electricity, district heating and oil products in the user sectors, an alternative picture of the development of energy use in the various end-user sectors is obtained.

Sweden's total energy supply in 2006 was 624 TWh, including a net import of about 6 TWh of electricity. The greatest proportions of energy supply were oil and nuclear fuel, followed by biofuels and hydro power. Since 1970, the make-up of energy supply has changed. The supply of crude oil and oil products has fallen by about 43 %, while the net production of electricity has increased by about 137 % as a result of the construction of nuclear power stations and expansion of hydro power production. The supply of biofuels has increased by over 170 %.

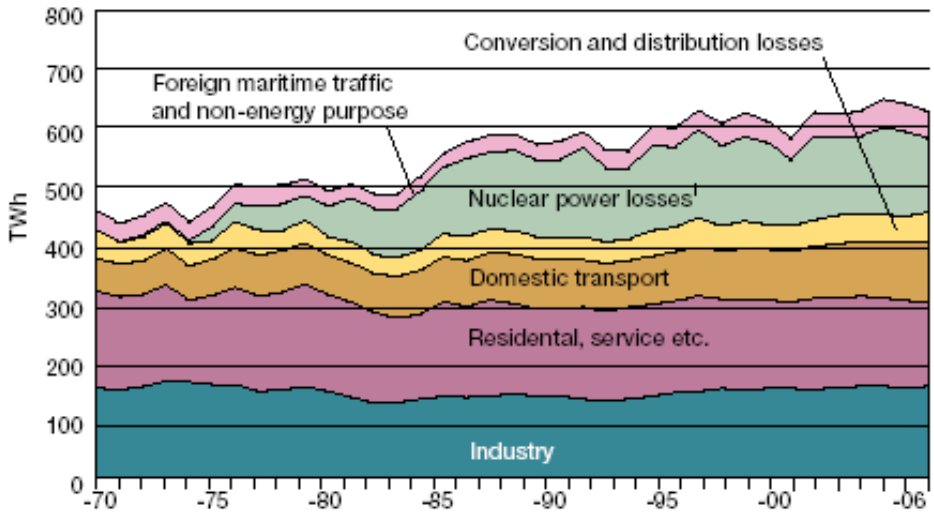

Figure 1. *Sweden's total energy use, 1970–2006*

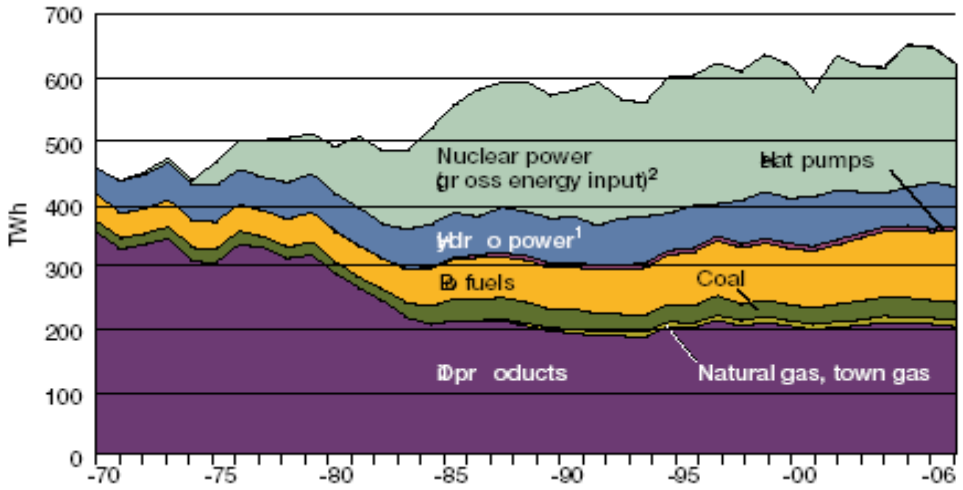

Figure 2. Total energy supply in Sweden, 1970-2006, excluding net electricity exports.

During the 1980s some local authority energy utilities installed large heat pumps for supplying district heating. At the same time, natural gas was brought to towns along the west

coast. Construction of wind power machines started in the mid 1990s. The use of coal and coke as fuels increased during the 1980s, but has since declined somewhat. Nuclear power used 194 TWh of fuel energy input in 2006, to produce about 65 TWh of electricity.

Hydro power produced 61 TWh of electricity, which is low in historic terms. Hydro power production varies widely, depending on the amount of precipitation during the year - average annual production is 67.5 TWh. Fuel-based thermal power production amounted to 12.6 TWh of electricity, while wind power supplied about 1 TWh. About 55 TWh of fuels were used for district heating. The contribution of renewable energy sources in the country's total energy supply amounted to 29 % in 2006. This is a relatively high figure in international terms. Renewable energy sources include biofuels, hydro power, wind power and other sources.

2.2 The Swedish Policy on climate

Sweden has made a radical change from oil to none fossil based energy sources including biofuels, which has led to a reduction of its greenhouse gas emissions by more than 40 per cent since the mid-1970s. Between 1990 and 2006, such emissions fell by almost 9 per cent. At the same time, GDP increased by 44 per cent. But much remains to be done. The following are some examples of measures under way to reduce the impact of emissions on the climate.

In the field of climate and energy, the Government is providing a SEK 1 billion (the 'climate billion' for the period 2008–2010. In addition, the state is investing SEK 420 million in energy efficiency measures over the same period. These measures will be implemented through policies related to environment, forestry, agriculture and energy. Initiatives are being taken in the following areas:

- Climate research (SEK 24 million)
- Energy efficiency measures (SEK 310 million)
- Pilot and demonstration projects for second-generation biofuels (SEK 150 million)
- Network for wind power (SEK 40 million)
- Sustainable yield of bioenergy in agriculture and forestry (SEK 40 million)
- Climate investments in other countries (SEK 96 million)
- Programme for sustainable cities (SEK 340 million)

2.2.1 Initiatives in the energy sector

In the energy sector it has been possible to make major reductions in carbon dioxide emissions by radically reducing the use of oil for electricity production and heating. One aim of the energy policy is to promote efficient energy use and cost-effective energy supply that meets high standards for protection of health, the environment and the climate.

Since the Swedish electricity system is linked to the European network, more effective use of electricity and the provision of renewable electricity production in Sweden can also partially contribute to lower emissions of carbon dioxide in other countries.

Measures being taken in the energy sector at present include:

- Municipal energy and climate advisory services and information, training and regional actions that are important measures for reaching consumers and small entrepreneurs. Local and regional measures for energy efficiency are being strengthened in the period 2008–2010. These measures include an obligation for all county administrative boards to develop regional climate and energy strategies in 2008.

- Measures to facilitate the development of wind power include the provision of SEK 30 million as special financial support for planning in municipalities and regions. Initiatives,, amounting to SEK 70 million in 2008, are underway to encourage the technical development and market introduction of wind power.

- To speed up the expansion of wind power, a national network for wind power will be established, with the Swedish Energy Agency as its hub. This is aimed at supporting regional nodes disseminating knowledge, information and opportunities for local and regional development based on wind power. In the framework of the 'climate billion', SEK 40 million have been set aside for the period 2008–2009. The Government has also appointed an inquiry to look into the possibilities of simplifying sections of the regulatory framework that affect conditions for establishing wind power facilities.

- Since 2005, a Programme encouraging Energy Efficiency has been undertaken within the energy-intensive industrial sector. In exchange for conducting systematic work resulting in improved energy efficiency, a company is exempt from tax on the electricity used for production.

2.2.2 Initiatives in buildings

Energy consumption in the building sector has remained relatively stable since the early 1970s. Oil crises, energy price increases, changes in energy tax systems and investment programmes have all influenced a shift from oil to electricity and district heating for heating purposes.

During the 1970s and 1980s, single-family homes in rural and suburban areas were mainly built with electric heating. The majority of the buildings in urban areas have replaced individual oil-fired heating systems with district heating run on biofuels.

Energy consumption in the building sector accounts for 39 per cent of Sweden's total final energy consumption and for about 50 per cent of total electricity consumption in Sweden. The energy is used to heat areas and water, as well as to operate equipment. Heating and hot water account for more than 60 per cent of energy consumption in this sector.

Improving energy efficiency in buildings makes it possible to reduce the need for energy for heating, and this can lead to a reduced use of fossil fuels and the conservation of other energy resources. The potential for improved energy-efficiency in buildings is very large.

Measures being taken in the building sector at present include:

- Support to encourage the conversion from direct electric heating in housing that will continue until the end of 2010. The financial allocation for this purpose amounted to SEK 330 million for 2008 and is expected to amount to SEK 330 million for 2009 and SEK 280 million for 2010.

- Support for energy investment, that includes energy surveys, in premises used for public activities will continue from the allocation of SEK 700 million for 2008 and is expected to be around SEK 300 million for 2009.

- Support for the installation of energy-efficient windows in single-family homes or for the installation of biofuel heating systems in newly built single-family homes amounted to SEK 50 million in 2008.

- Support for the installation of solar heating in housing and for the installation of solar heating in commercial buildings amounted to SEK 27 million for 2008 and is estimated to amount to SEK 24 million for 2009 and 2010.

2.2.3 New action for sustainable cities

The Government is taking action to promote sustainable cities and communities. The ambition is to bring together the state, the business sector and local authorities in a national platform to create examples of areas in Sweden that demonstrate cutting-edge technology for sustainable housing solutions and visions that have been realised in blocks, neighbourhoods or local communities. One of the aims of this initiative is to encourage urban development projects that help improve the environment and reduce climate impact. This is also expected to facilitate the export of Swedish environmental technology.

The Government is in the process of appointing a delegation to establish a national strategy for sustainable cities. SEK 340 million will be allocated from the beginning of 2009 to mobilise the business sector.

2.2.4 Environmental technology initiative

The Government has initiated a project with a value of SEK 530 million, to run over several years, aimed at developing Swedish environmental technology. The intention is for measures to be designed in consultation with business and industry, to be forward-looking and to focus on promoting competitiveness in the field of environmental technology. The initiative aims at increasing opportunities for Swedish exports in the field of environmental technology with a longer-term focus on small and medium-sized businesses.

2.2.5 Action in the transport sector

The transport sector is the largest source of greenhouse gas emissions. One of the main challenges facing Sweden is to adapt transport to climate concerns. Sweden is a large country, with transport needs extending over vast distances. The population cannot cope without using cars, car travel must not contribute to increased emissions. The Government is working towards a transport sector that will have a decreasing impact on the climate. Step by step, taxes, regulations and economic instruments are being developed that favour environment friendly choices. These activities will take place both in Sweden and at EU level.

Measures being taken in the transport sector at present include:

- The introduction, by the Government of a green car rebate of SEK 10 000. The purpose is to stimulate demand for both fuel-efficient cars and cars that run on alternative fuels.
- The introduction of a permanent congestion charge in the Stockholm as from 1 August 2007. This has had a positive impact on the environment.
- The development of more environmentally sound cars. The Government invested SEK 400 million in relevant research and development in 2008. Six large joint programmes are being run in conjunction with the automotive industry. Together with industry the Government is also investing SEK 62 million in a project to develop and demonstrate plug-in hybrids, the next generation of hybrid vehicles that can be charged directly from a wall socket.
- The continuing expansion in the number of biogas stations
- A continuing climate programme with an investment of some SEK 400 million in 2008.
- Exemption from tax of ‘green’ fuels such as ethanol and other biofuels .

- Proposals for further development of second-generation biofuels with a contribution from the climate billion includes amounting to SEK 150 million over the period 2008–2010. As a result Sweden has a good chance of positioning itself as a leading nation in terms of developing second generation biofuels for the future.

2.2.6 The climate tax package

In December 2008, the Riksdag approved implementation of a climate tax package proposed by the Government in the 2008 Budget Bill. The climate tax package comprises a total of more than SEK 3 billion in higher energy and climate taxes in the Budget Bill for 2008. Carbon dioxide tax was raised by SEK 0.06/kg carbon dioxide to a total of SEK 1.01/kg carbon dioxide. For consumers, this means a total cost increase of SEK 0.29/litre petrol. In addition, the energy tax on diesel also increased by SEK 0.20, which means a total price increase of SEK 0.55/litre for diesel oil.

2.2.7 Public procurement

The public sector is expected to set an example for companies and the public and accelerate developments. One action taken by the Government is to tighten the requirements for the share of environmental cars in public procurement and leasing of cars by the central government from 75 per cent to 85 per cent. In addition, the Government is introducing a requirement that at least 25 per cent of emergency vehicles have to be 'green'. Stricter environmental requirements are to be introduced for public procurement. To support environment requirements in public procurement, the Swedish Environmental Management Council received an increase in resources of SEK 10 million in 2007 and will receive SEK 6 million per year for 2008 and 2009. The Government also wants the public sector to take a leading role in improving energy efficiency.

The Swedish Energy Agency has been commissioned to review the methods of specifying energy management requirements in public procurement may be improved. The Swedish Government has also decided to pay compensation for emissions from air travel by Government Officers. SEK 2 million has been allocated for this purpose for 2008. Compensation is paid via UN-controlled Clean Development Mechanism (CDM) projects, an investment in emission reductions in Brazil, for example.

2.2.8 Research in the climate sector

The Government invested just over SEK 1 billion on climate and environmental research in 2008. The allocation to the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (FORMAS) was increased by SEK 88 million for research on environment and sustainable development. In addition to this, universities and other higher education institutions also fund climate and environmental research from their own appropriations.

Examples of ongoing research programmes in the climate sector include:

- The Rossby Centre at the Swedish Meteorological and Hydrological Institute that consists of a research group working on the development of regional climate models and climate scenarios for precipitation and temperature on a 50–100 year perspective. An additional allocation of SEK 8 million per year to the Rossby Centre is proposed from the climate billion for the period 2008–2010.

- Initiatives for research, development, demonstration and commercialisation in the field of energy. The Swedish Energy Agency is supporting research and development on biofuels, fuel cells and other technologies.
- The Foundation for Strategic Environmental Research (Mistra) is supporting research on the importance of land use for the climate and research on carbon sinks.
- FORMAS is supporting research on greenhouse gas balances and the effects of climate change on various ecosystems, infrastructure and buildings.
- The Swedish Environmental Protection Agency is supporting research on climate tools to give various actors a better basis for drafting adjustment strategies ahead of climate change.

2.2.9 Sweden in the EU

In the EU Sweden is pressing for an ambitious climate policy. The EU heads of state and government have decided to reduce greenhouse gas emissions by 20 per cent by 2020 compared with 1990 levels. The EU will also continue to drive for a commitment by industrial countries to cut their greenhouse gas emissions by something in the order of 30 per cent by 2020. If an international agreement can be reached, the EU will undertake to reduce emissions by 30 per cent by 2020. The EU also wants the industrialised countries to collectively reduce their emissions by 60–80 per cent by 2050 compared with 1990 levels. In January 2008, the European Commission presented a climate and energy package. An important part of this package is how much each member country must reduce its emissions by 2020 for the EU to succeed in achieving the climate targets established by the European Council. The proposal includes the emissions that are not covered by the European Emissions Trading Scheme (ETS). For Sweden, the proposal means that greenhouse gas emissions are to be reduced by 17 per cent compared with 2005 levels.

Other parts of the climate and energy package include:

- Directives on promoting renewable energy: The EU has adopted a binding target of a 20 per cent share of renewable energies in overall EU energy consumption by 2020. The European Commission has also presented proposals on how responsibility for increasing renewable energy is to be shared between countries. For Sweden, the proposal means an increase in the proportion of renewable energy from 39.8 to 49 per cent.
- Review of the EU Emissions Trading Scheme for the period after 2012: The European Commission has proposed that aviation and several other industries be included in the EU Emissions Trading System. Sweden is proactive in promoting the inclusion of more sectors and more gases in the trading system, and wants emissions trading rights to be auctioned.
- Legal framework for carbon capture and storage (CCS): The package also includes a proposal on the legal framework for the capture and storage of carbon dioxide. Negotiations have begun in the EU on the various parts of the package, aimed at a decision being taken at the beginning of 2009.

2.2.10 Greater international climate cooperation

The climate issue is global and requires measures in all countries. Sweden expects to be the leading international role model, with a high rate of growth that is environmentally sound and based on sustainable resources. This means being a fossil-free, environmentally driven economy in rapid growth. Sweden is working actively on developing the project based mechanisms of the Kyoto Protocol: *Joint Implementation and the Clean Development Mechanism in global climate cooperation* that encourage concrete projects for reducing greenhouse gas emissions and contributing to sustainable development. Cooperation with

developing countries is a particularly important part of long-term global work to address climate change. In the climate billion, the Government proposes an increase in the allocation for these activities from more than SEK 18 million per year to SEK 50 million per year.
Projects will be spread among several countries. Countries with rapidly increasing emissions have priority. Sweden's Government has also taken an initiative for an international Commission for Climate Change and Development with a Secretariat based in Stockholm. The Commission's tasks are to present proposals showing how development assistance can be 'climate-proofed' by integrating risk reduction and adaptation to climate change in the development and poverty reduction plans of poor countries. The results will be presented in the spring of 2009. Sweden will play an active role in persuading the countries of the world to agree on a new climate treaty by 2009 at the latest. Sweden will hold the Presidency of the EU for six months of 2009 when decisions on a new global climate agreement beyond 2012 will be taken. The EU – and therefore Sweden as well – will most likely have an important role to play in leading these negotiations to a successful conclusion.

3. Legislation

Policy measures can be divided into a number of groups, depending on how they are intended to achieve their objectives.

Administrative policy measures are controls in the form of prohibitions or requirements, issued by political or administrative bodies that are mandatory in nature. The control may be quantitative (emission conditions, limit values etc.) or technical. Those issued under the environmental framework code form the basis of Swedish environmental policy. Regulations governing the energy efficiency of buildings are another administrative policy measure.

Economic policy measures affect the costs and benefits of the choices available to parties concerned. They consist of taxes and fees, transferable emission allowances or certificates, deposits as securities and various forms of grants and subsidies.

Information can bring about changes in behaviour and attitudes, but differs from controls and economic policy measures in that no compulsion is exercised upon the recipient, and nor is the individual exposed to any economic pressure since the desired changes are voluntary.

Research, development and demonstration activities may also be regarded as a form of policy measure. Although research and development may not in themselves bring about a change, technical development and knowledge of the effects of various changes are an essential contribution to eventually reaching various energy and environmental objectives.

3.1 Energy taxes

'Energy tax' is an umbrella name for spot taxes on fuels and electricity (table 1). They can be roughly divided up into fiscal taxes and taxes intended to achieve environmental objectives. This latter group of taxes includes the carbon dioxide and sulphur taxes, while the general energy tax is essentially a fiscal tax. However, there is no hard and fast boundary between these types, as both groups have an environmental effect as well as a fiscal function. The general energy tax, which has been in existance for several decades, with varying purposes, is levied on most fuels based on various factors such as their energy contents.

The carbon dioxide tax, which was introduced in 1991, is levied on the emitted quantities of carbon dioxide from all fuels except biofuels and peat. In 2007, the general rate of carbon

dioxide tax is 93 öre/kg of CO_2. A sulphur tax was introduced in 1991, and is levied at a rate of SEK 30 per kg of sulphur emission from coal and peat, and at SEK 27/m^3 for each tenth of a percent of sulphur by weight in oil. Oils containing less than 0.05 % of sulphur by weight are exempted from the tax. The environmental levy on the emission of NO_X was introduced in 1992, and is applied at a rate of SEK 40/kg of NO_X on emissions from boilers, gas turbines and stationary combustion plant supplying at least 25 GWh per annum. However, it is intended to be fiscally neutral, and is repaid to plant operators in proportion to their energy production and in inverse proportion to their NO_X emissions, so that only those with the highest emissions are net payers.

Table 1. *General energy and environmental taxes as at 1st January 2007, excluding VAT (Source: Swedish Energy Agency).*

	Energy tax	**CO_2 tax**	**Sulphur tax**	**Total tax**	**Tax (öre/kWh)**
FUELS					
Gas oil, SEK/M^3 (<0.05% Sulphur)	750	2663	-	3413	34.3
Bunker oil SEK/M^3 (0.4% Sulphur)	750	2663	108	3521	33.3
Coal, SEK/tonne (0.5% Sulphur)	319	2317	150	2786	36.9
LPG, SEK/tonne	147	2801	-	2948	23.0
Natural gas, SEK/1000 m^3	243	1994	-	2237	20.2
Unrefined tall oil, SEK/M3	3413	-	-	3413	34.8
Peat, SEK/ton 45% moisture (0.3% sulphur)	-	-	50	50	1.8
Domestic waste, SEK/tonne of fossil carbon*	152	3426	-	3578	15.0
MOTOR FUELS					
Petrol unleaded env. Class 1 (SEK/l)	2.9	2.2	-	5.1	55.9
Diesel fuel. Env class 1 (SEK/l)	1.1	2.7	-	3.8	37.3
Natural gas/methane (SEK/m^3)	-	1.1	-	1.1	10.3
LPG (SEK/kg)	-	1.4	-	1.4	10.8
ELECTRICITY USE					
Northern Sweden, **öre** /kWh	20.4	-	-	20.4	20.4
Rest of Sweden, **öre** /kWh	26.5	-	-	26.5	26.5
INDUSTRY					
Electricity, industrial processes, **öre** /kWh	0.5	-	-	0.5	0.5

Sweden's carbon dioxide emissions are to be cut, not least in order to comply with the country's commitments under the Kyoto Protocol. The previous emphasis has been on higher taxes on electricity and fuels used for heating. In recent years this has been extended to the transport sector, partly within the framework of a general shift in the tax regime towards environmentally targeted taxes.

Electricity production in Sweden is exempted from energy and carbon dioxide tax, although it is subject to the NO_X levy and sulphur tax in certain cases. However, the use of electricity is taxed at rates that vary depending on in which part of the country the electricity is used and

on what it is used for. Nuclear power plants were previously taxed on the basis of their electricity production, but since 1st July 2000 the tax has been based on the maximum permissible thermal power rating of their reactors. This tax was increased by 85 % in 2006, to SEK 10 200/MW per calendar month. In addition, there is a levy of 0.15 öre/kWh for decontamination and decommissioning of the country's previous nuclear facilities at the Studsvik research centre and a further levy that amounts to about 1 öre/kWh for financing future storage facilities for spent nuclear fuel.

Heat producers pay energy tax, carbon dioxide tax and, in certain cases, sulphur tax as well as the NO_x levy. The use of heat, however, is not taxed. In principle, biofuels and peat are tax-free for all users, although the use of peat attracts sulphur tax. The taxation regime for simultaneous production of heat and electricity (also known as cogeneration or CHP [Combined Heat and Power]) was changed with effect from 1st January 2004, so that the tax on the fuels used for heat production in such plants is now taxed at the same rate as on these fuels when used in industry. With effect from 1st July 2006, combustion of certain domestic refuse was also made liable to energy tax.

Table:2 *Energy and environmental taxes on industry, agriculture, forestry, fisheries and heat production in CHP plants from 1st January 2007 (Source: Swedish National tax Board and The Swedish Energy Agency)*

	Energy tax	CO_2 tax	Sulphur tax	Total tax	Tax (öre/kWh)
Gas oil 1 (SEK/m^3)	-	559	-	559	5.6
Bunker oil 5 (SEK/m^3)	-	559	108	667	6.3
Coal (SEK/tonne)	-	487	150	637	8.4
LPG (SEK/tonne)	-	588	-	588	4.6
Natural gas (SEK/1000 m^3)	-	419	-	419	3.8
Unrefined tall oil (SEK/m^3)	559	-	-	559	5.7
Peat (SEK/tonne), 45% moisture, 0.3% Sulphur)	-	-	50	50	1.8
Domestic waste, SEK/tonne fossil carbon)*	-	719	-	719	3.0
*Maximum CO_2 tax relief (79%) is received for an efficiency of 15%, Full relief from energy tax is received for an efficiency of 5%.					

The energy tax element amounts to SEK 152 per tonne of fossil carbon, while the carbon dioxide tax element is levied at the rate of SEK 3 426 per tonne of fossil carbon. 12.6 % by weight of the refuse is assumed to be fossil carbon. Electricity production plants are also subject to property tax. For hydro power plants, this tax was raised from 0.5 % to 1.2 %, with effect from the beginning of 2006.

Manufacturing industry, horticulture, farming, forestry and aquaculture pay no energy tax on fossil fuels and only 21 % of the carbon dioxide tax. There are special rules for energy-intensive industrial activities, reducing that part of the carbon dioxide tax that exceeds 0.8 % of the sales value of the products concerned. To qualify for this reduction, companies must (from 1st January 2007) meet the 0.5 % rule definition of an energy-intensive company. From the same date a the further reduction given by a 1.2 % rule has been abolished.

There are various tax levels for transport, depending on the environmental class of the fuel, which have resulted in reduced emissions of some pollutants. Tax rates on petrol and diesel fuel were left unchanged for 2007. No energy tax is payable on the use of diesel fuel or fuel

oils used in commercial maritime traffic or rail borne traffic, or on aviation petrol or aviation paraffin. No energy tax or carbon dioxide tax is charged on ethanol, rapeseed oil methyl ester (RME) or biogas, while natural gas used in the transport sector pays no energy tax.

Domestic users pay different rates of electricity tax, depending on whether they live in the north of the country or the rest of the country. Electricity tax was raised by 0.3 öre per kWh in 2007. The final price paid by consumers depends largely on taxation. In addition to the various spot taxes on energy, there is value-added tax of 25%, which is not paid by industry. In 2006, 57% of the cost of heating fuel used by owners of detached houses was made up of tax if the fuel used was oil, while only 18% of the cost was tax (value-added tax only) if the fuel was biomass pellets. For drivers, 62% of the cost of petrol was tax (including value-added tax) - Figure 3.

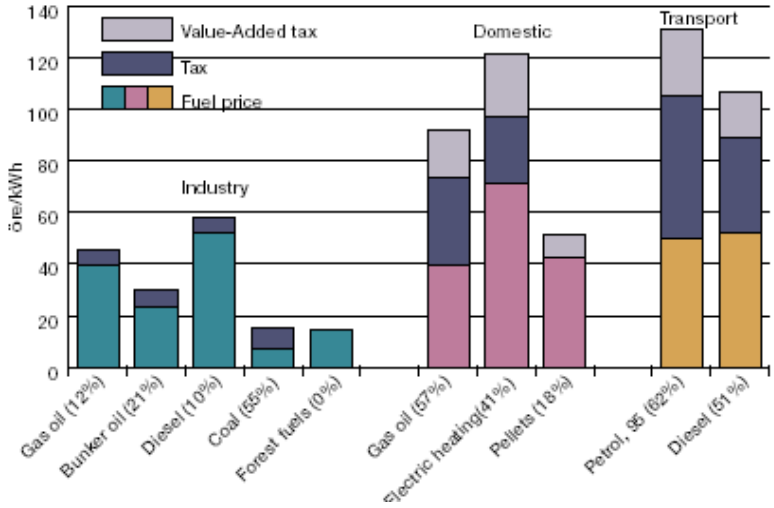

Figure 3. *Total energy prices for various user categories, 2006. Note: Prices shown for industry do not include any large-user discounts. The share of taxes is given in brackets. Source: Swedish Energy Agency*

3.2 Green electricity certificates

May 1st 2003 saw the introduction of a new support system for renewable electricity production, based on trading in certificates for renewable electricity. This certificate trading system is complemented by transition rules for wind power production in the form of an energy tax reduction (known as the environmental bonus) which, in 2006, amounted to 6.5 öre/kWh for onshore production and 15 öre/kWh for offshore production. This bonus has been, and is being, progressively reduced over the period from 2004 so that in 2009 there will be a 12 öre/kWh subsidy for offshore wind power production and no subsidy for onshore production.

The electricity certificate system is intended to reduce the production costs and support the development of new production in the long term by creating competition between different types of renewable electricity production. Producers receive one certificate unit for each MWh of renewable electricity that they produce. Qualifying renewables are electricity from wind power, solar energy, geothermal energy, certain biofuels, wave energy and small-scale hydro power. With effect from April 1st 2004, electricity produced from peat in cogeneration plants has also qualified for certificates. All electricity users, with the exception of energy-intensive industries, are required to buy certificates corresponding to a certain percentage of their electricity use. In 2006, users had to buy certificates corresponding to 12.6 % of their

electricity use. The proportion of certificates that users are required to buy (their quota obligation) varies from year to year. During 2006, the average price of electricity certificates was SEK 191. The system covers only electricity produced in Sweden. The purpose of the certificate trading system is to produce a greater proportion of the country's electricity from renewable sources, increasing it by 17 TWh between 2002 and 2016.

In June 2006, Parliament decided on changes to the electricity certificate system. The various changes were intended to extend the long-term strategic aim of the system as well as to increase the target for renewable electricity production. They include raising the target for renewable electricity production to 17 TWh in 2016 (as compared with production in 2002), and extending the life of the scheme to 2030. Quotas, including adjustment of numbers for 2007-2010, have been set for this period. Limitations on allocations of certificates have been introduced for the plants themselves, with new plants receiving certificates for 15 years. Those plants started up before May 1st 2003 will be progressively phased out of the scheme, starting from the end of 2012 or 2014.

From the beginning of 2007 a new definition of electrically-intensive companies has been applied. This is based on the amount of electricity used and the company's total sales value rather than being based simply on the industry sector in which the company operates. In 2006, 262 companies were registered as electrically intensive under the old rules, thus relieving them of quota liabilities of 40.5 TWh for the year. For 2007, 439 companies are registered as electrically intensive under the new rules. Production of renewable electricity under the certificate system amounted to 11.6 TWh in 2006, after subtraction of production from peat. 6.5 TWh of this production existed in 2002, which means that there has been a net increase of 5.1 TWh between 2002 and 2006 (Table 3).

Table 3 *Number of plants, installed capacity and renewable electricity production in the electricity certificate system.*

	No of approved plant[1]	Installed capacity (MW)	Renewable electricity production 2003[2] (MWh)	Renewable electricity production 2004 (MWh)	Renewable electricity production 2005(MWh)	Renewable electricity production 2006(MWh)
Hydro	1075	540	963637	1968325	1799446	2018577
Wind	706	583	455642	864546	909125	988340
Biofuels[3]	130	3643	4218256	8215561	8559802	9149918
Solar	3	0.036	4	6	5	20
Total	1909	4765	5637559	11049498	11298978	12156855

Notes: 1) Number of approved plants on 2007 -01-01; 2) For the period May - December 2003; 3) Electricity production includes peat which in 2004 provided about 545 GWh, in 2005 about 631 GWh, and in 2006 about 556 GWh.

3.3 Programme for energy efficiency improvement in energy-intensive industry (PFE)

The overall objective of the programme for energy efficiency improvement in energy-intensive industry (PFE) has been to encourage efficient use of energy. The main factor behind the programme is the energy tax on electricity used in manufacturing industry that was introduced on 1st July 2004, at a rate equivalent to the minimum required tax rate as set out in the Energy Taxation Directive. With effect from that date, manufacturing industry, which had hitherto enjoyed a zero tax rate on electricity used in processes, has paid an electricity tax of 0.5 öre per kWh. In June 2004, the Government presented a bill setting out an energy efficiency improvement programme, which came into force on 1st January 2005.

Companies participating in this five-year programme can receive a full rebate of the energy tax on electricity that they would otherwise have had to pay. In return, they undertake to introduce, within the first two years, an energy management system and to perform an energy audit in order to determine their potential for improving the efficiency of their energy use. Companies must also undertake to implement, within the five-year duration of the programme, all the energy efficiency improvement measures that have been identified to have a payback time of less than three years. A requirement for participation in the programme is that the company must be an energy-intensive company, as defined in the Energy Taxation Directive, i.e. it must fulfil one of the following criteria: a) Its costs for the purchase of energy products must amount to at least 3 % of its production value, or b) The total energy, sulphur and carbon dioxide tax for the company must amount to at least 0.5 % of its conversion value.

From energy management systems and energy audits, that form part of the programme, companies will increase their awareness of the potential for cost-efficient energy efficiency improvements. In addition, the companies benefit from the introduction of a process for continuous, structured improvement in their efficiency of energy use. In January 2007, there were 117 companies in the programme, operating around 250 separate plants. In total, they use about 30 TWh/year of electricity in their manufacturing processes, which means that they will now receive a total tax reduction of about SEK 150 million per year. Most of the companies are in the pulp and paper industry (46), the wood products industry (22) or the chemical industry (16). Other participants include companies in the food industry (10), the iron, steel and mining industry (15), the engineering industry and a few other sectors.

The scheme is open to admission of more companies up to and including 2009. 98 of the participating companies submitted their first reports describing the results of their work on energy auditing and the introduction of energy management systems to the Agency during the autumn of 2006. The reports also included details of implemented and planned efficiency improvement measures. They indicate that the companies involved have undertaken to improve their efficiency of electricity use by a total of 1 TWh/year at a total investment cost of somewhat more than SEK 1 000 million.

Approximately half of the efficiency improvements have been found in the production processes themselves, with the remainder in ancillary systems, such as pumps, fans and other motor driven systems. Many of the improvements are concerned with demand control response (e.g. speed control), process adjustments or optimisation, although replacement of older equipment by more energy-efficient equipment is also common. Many of the improvement measures pay for themselves in a very short time. In some cases, the electrical efficiency improvement measures have also resulted in a reduction in other forms of energy use. However, measures involving direct conversion from electricity to some other form of energy carrier do not qualify for the PFE tax reductions.

In addition to the measures described above, companies in the PFE scheme must also consider the life cycle costs of electricity-using equipment when purchasing new equipment and/or when planning, modifying or renovating plant or equipment. This will result in further improvements in efficiency during the remaining three years of the programme, with the results being included in the final five-year report of the scheme. The general indication is that the final total improvements in electrical efficiency brought about by this PFE scheme will be significantly greater than that so far reported.

3.4 Buildings

A whole range of policy measures are used in order to improve energy conservation and management in buildings. The relevant policy measures are The National Board of Housing,

Building and Planning's Building Regulations. In general, buildings must be designed and constructed to reduce overall energy use by means of low heat losses, low cooling requirements, efficient use of heating and cooling and efficient use of electricity. The Regulations contain specific requirements for energy use in buildings.

Another administrative policy measure is the Act Concerning Energy Declarations for Buildings, which is based on an EU Directive. Owners of detached houses, apartment buildings and commercial premises are required to provide information on the buildings' energy use, together with certain parameters of the indoor environment, in an energy declaration. The purpose is to encourage efficient energy use and good indoor environmental conditions in buildings. The launch of the energy declarations is at present in an introductory stage but is expected to come fully into operation by the end of 2008.

There is a system of solar heating grants, the purpose of which is to encourage the use of solar heating technology for heat supplies to detached houses, apartment buildings and certain types of commercial premises. The grant is for installation of solar heating systems for space heating and/or domestic hot water production, and has been available for projects started since 1st June 2000.

The purpose of these conversion grants is to reduce the country's dependence on oil, to encourage efficient and environmentally benign use of energy, and to reduce the use of electricity for heating purposes in residential buildings. Owners of properties having direct electric heating can receive a grant for the cost of conversion of such heating systems by district heating or by rock, earth or lake water heat pumps, or by biofuelled boilers. The grant has been available from the beginning of 2006 and will continue until the end of 2010. Until the end of March 2007, a conversion grant was also available to those replacing oil-fired heating systems by one of these alternative heating systems: a benefit that was taken up by about 50,000 owners of detached houses.

Builders of new detached houses can apply for a grant for the installation of a biofuel-fired facility, such as a pellets-fired boiler, as the primary heating source. Owners of single-family or two-family houses can obtain a grant for the installation of new windows having a maximum U-value of 1.2. The entire window – glass, frame and casement – must be replaced in order to qualify. In addition, the owner must live in the house. This grant was available until the end of 2008.

Grants for conversion and energy efficiency improvements in public buildings are available so that the public sector can lead the way in energy improvements and set an example to the population. Owners of premises used for public activities can apply for grants for conversion of heating systems from electricity or fossil fuels to biofuels, district heating or earth, rock or lake water heat pumps. Grants are also available for investments intended to improve the efficiency of energy use, and for the installation of solar cells in public buildings. These grants were introduced in 2005, and were available until the end of 2008.

3.5 Technology Procurement

Technology Procurement is a policy measure intended to encourage the development of new energy-efficient technology. As it involves a tendering process, it may be regarded as a form of competition between manufacturers. On receipt entries are tested and evaluated by an independent party and one or more winners are announced. The winners are given assistance with market introduction and are guaranteed a defined initial order for a specific quantity of the new product. In addition, the State provides information via a purchaser group that is intended to extend awareness of the winning technology. Technology procurement can be seen as a policy instrument intended to initiate market changes and to encourage the

spread of new, efficient technology in the form of new products, systems or processes. The main application areas are in the fields of heating and control systems, domestic hot water and sanitary systems, ventilation, white goods, lighting and industry.

The Swedish Energy Agency has prepared a list of all technology procurement projects within the energy field that have been carried out. Since the 1990s, 56 various technology procurement projects have been initiated and partly financed. Current technology procurement projects include demand-controlled ventilation in new apartment buildings, control and monitoring systems for properties, climate screen-integrated systems for solar shading and daylight penetration, industry-standardised information in the sawmill industry and pellets stores for detached houses.

3.6 Environmental Impact Assessment

Environmental Impact Assessment (EIA) is an aid to decision-making. It is a technique and a process by which information about the environmental impact of a planned project is collected and taken into account by the authorities in forming their judgements on whether a development should go ahead or not. In that sense EIA is a way of thinking ahead, to predict, describe and evaluate the consequences on the environment of a planned action. EIA is also the process in which the knowledge of different actors contributes to the foundation for decision-making.

The systematic process in which the environmental impact of development actions is examined involves a number of steps. These include, for example, project screening, scoping, consideration of alternatives, description of environmental baseline, identification, prediction and evaluation of impacts, public consultation, mitigating and monitoring of impacts, presentation and documentation, review and decision-making.

Development actions may be for a project, a programme, a plan or a policy. Predicting and evaluating environmental impacts at a more strategic level i.e. for policies, plans and programmes is called Strategic Environmental Assessment (SEA). The need for SEA is to the result of, among other things, the inability of an EIA to consider the cumulative effects caused by several projects. Furthermore, project EIAs cannot fully address alternative developments or mitigation measures because often alternatives are limited by choices made at an earlier more strategic level. If SEA is carried out for policies, plans and programmes that provide a framework for upcoming projects the establishment of the individual project EIAs is enhanced.

In Sweden the EIA legislation departs from the EIA directive 97/11/EC amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment. The Swedish interpretation of it is however very extensive leading to the creation of many EIA documents each year. In 2004 Sweden implemented the SEA directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment. SEA for plans and programmes is thereby conducted according to the EC directive interpretation of SEA and not according to the wider understanding of the SEA concept.

For more information, see http://mkb.slu.se/eiacentre.

4. Financial market

In general, most banks are now considering financing 'cleantech' projects. These include renewable energy and energy efficiency projects. Funds for this purpose have been developed, but not much of this activity is related to emissions trading, since such trading still remains a rather small issue in Sweden. The majority of the investments and capital announced in Sweden are related to funding new companies – seed money etc. In this field there are several national and regional initiatives, such as ALMI, VINNOVA, NUTEK on the national level and include initiatives such as Sweden Cleantech Incubators.

In addition, there are more than 112 investment companies in Sweden (figure from 2005) - these include both Swedish and foreign companies. Many of these companies have an increasing interest in the sustainable technologies. More information can be obtained from the Swedish Private Equity & Venture Capital Association (SVCA). SVCE is an independent, non-profit association supporting the interests of companies and individuals active in the Swedish private equity industry. The SVCA's objective is to promote an efficient private equity market, to inform and educate about the industry and to promote entrepreneurship.

The number of financial institutions and public bodies all cover the area of the S-curve shown in figure 4.

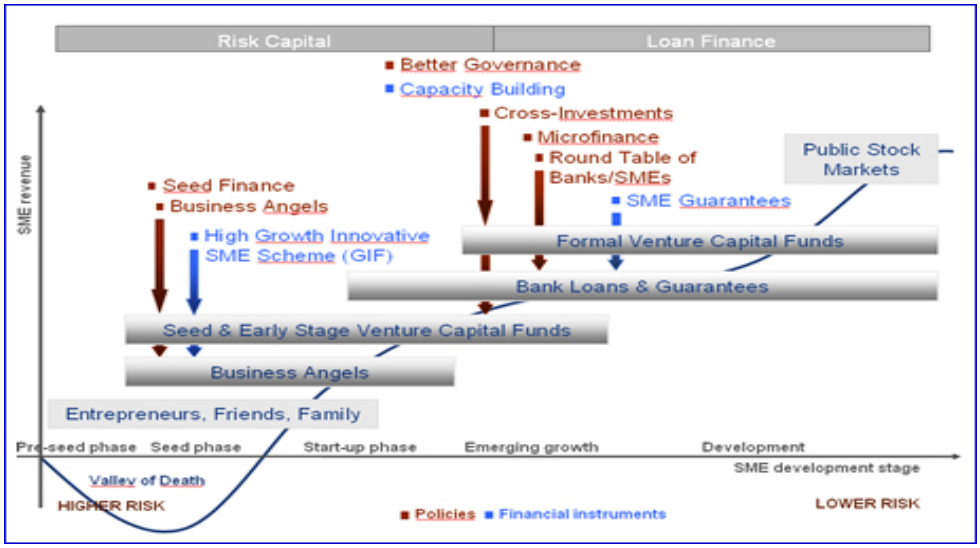

Figure 4 *Sources of funds available to SMEs through policies and financial instruments*

As far as emissions trading, CDM and JI there is a programme developed by the Swedish Energy Agency as discussed below. There are also a few project developers involved in the CDM/JI markets.

The financial markets have become increasingly important in Sweden with an annual turnover of thousands of billions of Swedish kronor. The positions outside Sweden (to which e.g. CDM could be included) are shown in figure 5.

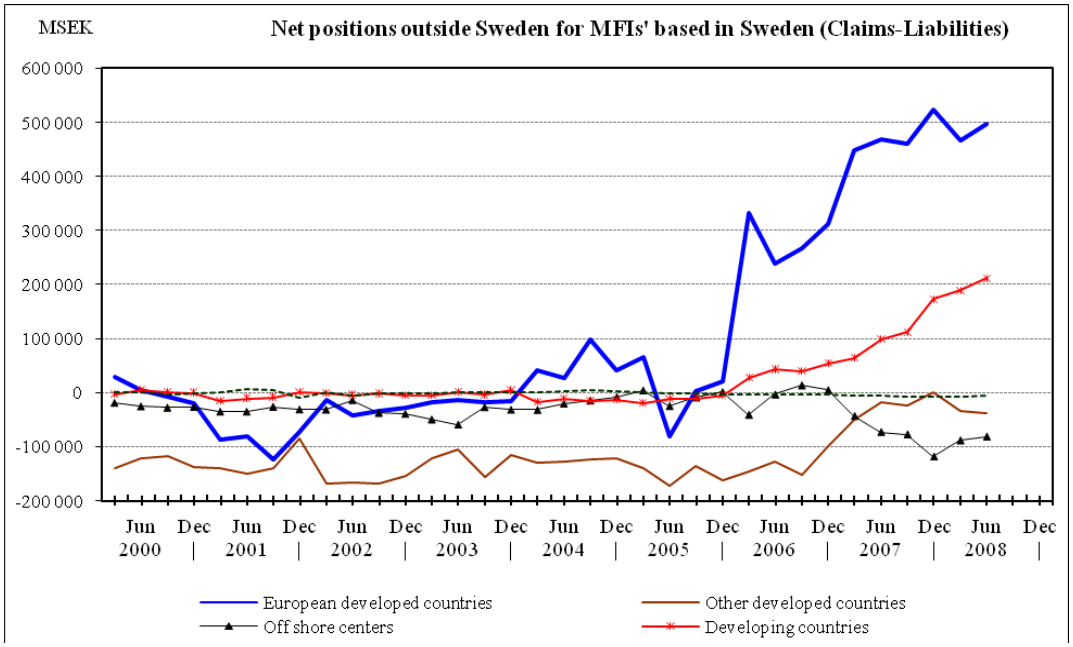

Figure 5 *Net positions outside Sweden for MFIs based in Sweden*

4.1 The Swedish CDM and JI Programme

The Swedish Energy Agency aims to participate in small and medium sized CDM and JI projects, mainly in the renewable energy and energy efficiency sectors. The Agency also aims at diversifying its project portfolio across regions so as to encourage geographical distribution of the CDM and JI activities. The Agency is currently involved in projects generating between 100,000 to 600,000 tCO_2e emission reductions per project over a period of 7–10 years.

Various modes of cooperation and partnerships are considered during project selection. When selecting a project for the programme, its contribution to the sustainable development of the host country is carefully considered. In addition, the Agency takes into consideration the financial status of the project entity as well as prospects for and availability of project finance. It is important that the project proponents are fully involved in the project and that the project meets the requirements for approval by the host country. The Agency can consider engaging in a project at any time during the project cycle and on a case-by-case basis, provide financial support for preparation of documentation and to cover transaction costs. In some cases the Agency may also consider up-front payment.

The Swedish Energy Agency is also participating in a newly-established trust fund, ”Asia Pacific Carbon Fund” (APCF), which is administered by the Asian Development Bank (ADB). The fund’s primary objective is to engage in CDM projects in renewable energy, energy efficiency and methane recovery projects in developing countries in Asia.

A proportion of the fund’s capital will be used to purchase carbon credits generated in the period beyond the Kyoto Protocol’s first commitment period that ends in December 2012. The participants in the fund represent seven European governments that have together committed a total of $152 million to the APCF. This includes a Swedish Agency contribution of $15 million.

The Swedish Energy Agency is also responsible for the Swedish participation in the Testing Ground Facility (TGF), which is a regional JI fund based in the Baltic Sea Region. TGF is a fund with contributions from both private companies and governments in the Baltic Sea Region. The fund amounts to €35 million and again includes a contribution from the Agency that amounts to €3.5 million.

The Swedish government also participates in the World Bank's Prototype Carbon Fund (PCF), and in a JI fund of the European Bank for Reconstruction and Development (EBRD).

4.2 Project developers

Within the emissions trading business area, *Tricorona* invests in emissions credits from various projects that are conducted in accordance with the Kyoto Protocol's flexible mechanism. The purpose is to create added value for end users by contracting emissions reductions and handling project risks on the basis of a portfolio perspective. The investments to date have primarily been focused on India and China, although there have also been investments in other parts of Asia and South America. During the year a representative office has been opened in Beijing, with the aim of increasing market presence in the important Chinese market. An office was also opened in Hamburg (Germany) during the year, the primary focus of which is sales to end users.

Another organisation, *GreenStream's* Green Investment Services, helps project developers, technology suppliers and investors benefit from the emerging greenhouse gas and green certificate markets.

4.3 Final comments

The main barrier to introduction of more Sustainable Energy Technologies in Sweden relates mainly to economic aspects, as well as a lack of knowledge by the right persons. For example, in industry the main aim generally to produce what is normally produced and then sell it at the best price. The issue of energy will often be regarded as of less importance if the cost of energy is not a significant part of production costs. Further, the 'energy question' may also not be addressed due to the fact that those responsible for this aspect of the business do not know enough to take a rational decision from an energy/environmental perspective. The situation is now changing due to higher costs for energy, even though , for example, the price of oil is fluctuating.

The availability of more information provided through the right channels (for example their respective branch organisations) could change the situation and encourage more attention to the energy question.

The current financial crisis has reduced the interest ratess from investments in general. In turn, this has implications for investments in energy efficiency measures. However, since a benefit of energy efficiency investments is that costs are reduced, where investments have short payback periods) investments can be made nonetheless.. However, this may not be realised since the application of LCA methods may not be the common way of thinking in these periods of financial crisis

5. National situation in the carbon markets

This section provides an overview of the EU-ETS in Sweden. It details the important elements in the national allocation plans with regard to the allocation methodology used and describes specific priority areas within the allocation that supports SET. CDM and JI are also described in brief.

5.1 European Emission Trading System (EU-ETS) and National Allocation Plan (NAP)

The EU Emissions Trading Scheme (ETS) is governed by the Emissions Trading Directive (2003/87/EC). Initially, trading only covers emissions of one greenhouse gas (carbon dioxide) from energy installations and certain energy-intensive industrial sectors. The European Commission views trading in carbon dioxide emission allowances as an important way of achieving the EU's Kyoto commitment to reduce emissions. The objective is to create an efficient European market in greenhouse gas emission allowances with the least possible negative effect on economic development and employment within the EU.

The first phase of the emissions trading scheme ran between 2005 and 2007. During the next trading period (2008-2012), the EU as well as individual countries may decide to extent the scheme to cover further sectors and other greenhouse gases additional to carbon dioxide.

The regulations for the first period of emissions trading have been applied in Sweden through the Emissions Trading Act (2004:1199, Lag om handel med utsläppsrätter) and the Emissions Trading Ordinance (2004:1205, Förordning om handel med utsläppsrätter).

In Sweden, the companies involved have been provided with the opportunity to apply for an allocated emissions allowance. Special allocation principles have been applied in considering each installation's application. Final decisions on allocations have been taken by the Environmental Protection Agency after consultations with the National Board for Industrial and Technical Development (NUTEK) and the Swedish Energy Agency. Emission allowances have then been allocated to the companies free of charge. Emission allowances can be accessed electronically via the Swedish Emissions Trading Registry, in which all participants must have an account so as to be able to register their transactions. The Swedish registry is known as the ETR and is linked to the CITL, which is the EU electronic registry. From 1 January 2005, Swedish companies included in the trading scheme must, in accordance with the Directive 2003/87/EC, have a specific permit to emit carbon dioxide. The permits are processed by the County Administrative Board in the county/region in question. Nobody is allocated emission allowances without such a permit. To qualify for a permit, the operator must be able to reliably monitor and report emissions.

5.2 Lessons-learned from the 1st NAP[1] (2005-2007) with regard to amount of allocations and the targeted sectors

Swedish carbon dioxide emissions in the trading sector totalled 19.04 million tonnes in 2007. This means that emissions within the trading scheme fell by around 870,000 tonnes as compared to 2006, as shown in table 4. Emissions in 2007 were also 350 000 tonnes lower than in 2005, indicating that companies have reported the lowest emissions since the trading scheme came into effect.

[1] NAP = National Allocation Plan

5.2.1 Energy

Emissions in the energy industry in 2007 decreased in comparison with other years in the trading period. Almost the whole of this decrease, around 500 000 tonnes, is accounted for by installations in the electricity and district heating sector. The reason for the decrease in emissions was that, it was a warm year and hence due to the warm weather the need for fossil fuels was reduced, since it is fossil fuel production that, in many cases, is removed first when the energy demand decreases. Increase in biofuel installations has reduced the use of coal, while newly installed waste-fired boilers have replaced some oil-fired installations.

A newly built installation with more efficient combustion has increased total emissions for a large provider of electricity and district heating, hence the emissions of several smaller installations have decreased as part of the source of heat has been taken up by the larger more efficient installation.

The difference between allocated level of emission allowances and emissions for the different types of incineration installations is also partly explained by the warm weather. Other factors have also played a part.

The reported emissions figures show a surplus of just over 3.26 million tonnes of carbon dioxide compared with the allocated level of emission allowances in 2007. The number of installations in the scheme increased to 733 during the year.

The emissions from energy use by Hospitals have decreased as the use of natural gas boilers has decreased and the use of waste heat has increased. Emissions from the Paper industry are lower than in previous years, due in part to a larger more efficient installation having entered service and taken over part of the countries paper production.

A large proportion of waste is fired in the new installation, resulting in lower carbon dioxide emissions than in those that used mainly fossil fuel. There is a large surplus of emission allowances in the Engineering sector, where emissions have been reduced as a result of a number of measures aimed at reduced energy consumption and increasing energy recovery, as well as increased use of district heating. Emissions in the combustion installations of the wood-products industry are almost twice as high as in the previous year.

The increased emissions come principally from an installation that increased its peat burning in 2007. It is reported that this reflects the fact that the the organisation would receive no allocation during the next trading period (2008-2012) and that the peat is cheap as the company has its own peat sources. The combustion installations in the chemical industry have a smaller surplus in 2007 than in 2006 while emissions in metal sector are of the same order of magnitude as in previous years. The the food industry continues to have a surplus of emission allowances since a number of installations have been closed while sugar production has decreased.

Table 4. *Reported emissions, allocated level of emission allowances for 2007 and difference compared with 2006 emissions, indicated on the basis of industrial sector*

2007				
Industry	**Emissions**	**Emissions, compared to 2006**	**Allocation**	**Surplus/Deficit**
Energy total	454847	-417784	5819398	1273551
Electricity and district heating	3550586	-423269	4425116	874550
Energy chemical	448979	57085	607289	158310
Energy Municipal	0	-1671	333	333
Energy Foods	177353	-9000	326462	149109
Energy Metal	53395	2389	72021	18262
Energy Mineral	2651	966	2446	-205
Energy Paper	145832	-53251	213856	68204
…Energy Hospitals	13701	2527	24157	10456
Energy Textile	0	0	16287	16287
…Energy Wood				
Products	91022	34500	37527	-53495
Energy Engineering	62348	-18028	93904	31556
Iron and Steel	6415246	179502	7241748	826506
Ore Production	511179	71675	472664	-38515
Pulp & paper	1582478	-387999	2715678	1133200
Mineral Total	3242700	-110619	3536600	293900
Mineral Cement	2107532	-169865	2198501	90969
Mineral Glass	268649	9259	266082	-2567
Mineral Lime	811823	55027	1009130	197307
Mineral Ceramics	54696	13476	62887	8191
Refinery	273083	200157	3024274	285191
Total	19036523	-865383	22294297	3257765

5.2.2 Iron and Steel

Emissions in iron and steel increased between 2006 and 2007, but there is still a large surplus of emission allowances. The increase in emissions in comparison with 2006 is almost entirely due to increased production. An installation has also started producing higher-quality products with a higher carbon content, which has led to increased emissions.

5.2.3 Ore Production

Emissions in ore production were higher in 2007 than previously and higher than the allocation. This is due to production having increased in 2007 while new activities were initiated.

5.2.4 Pulp and Paper

Emissions from the pulp and paper industry decreased by almost 400 000 tonnes in comparison with the other years and hence there was a large surplus of emission allowances for 2007. This is due in part to energy projects in which oil-fired boilers have been converted

to biofuel boilers at a number of installations while other boilers have been replaced by more efficient ones. The Swedish Environmental Protection Agency has indicated that, on the basis of information from installations with which it has been in contact, the trading scheme has had a guiding effect on this industry.

5.2.5 Mineral

The mineral industry includes production of cement, glass, lime and ceramics. These branches of industry had an aggregate reduction in emissions in 2007 in comparison with 2006 but emissions of the same order of magnitude as in 2005. The surplus of emission allowances for this industry during the first trading period averaged 250 000 tonnes per year, which may suggest a generous allocation.

Emissions in the cement industry decreased by 100 000 tonnes, partly due to a start having been made in 2007 on burning alternative fuels that result in lower carbon dioxide emissions than fossil fuels and in part due to a slight reduction in fuel use. Ceramics had higher emissions in 2007 than previously. The reason for the increase is reported to be that during the year in question installations were not able to obtain biofuel of a suitable quality and hence coal powder was used instead. Measures have been taken to ensure that this situation will not arise in the future.

5.2.6 Refineries

Emissions were somewhat lower in 2007 than in 2006. The reason being, first that a major block on installations was implemented in the spring of 2007. In addition one refinery had initiated a programme of measures that will extent over several more years with the aim of reducing energy use and increasing energy efficiency.

5.2.7 The first trading period

Table 5 shows the reported carbon dioxide emissions of the trading companies within the main industrial sectors for the whole of the first trading period, 2005-2007. Note that emissions from energy and iron and steel differ from the emission figures reported in SUS (Swedish emission allowances system), due to a transfer of around 2.3 million tonnes of carbon dioxide from iron and steel to electricity and district heating.

This table shows that emissions fell during the first trading period. On the basis of analyses presented by the Swedish Environmental Protection Agency this is due in part to warm weather and changes in production, but it also reflects the influence of the trading scheme encouraging companies to take measures to reduce their carbon dioxide emissions.

The Swedish Environmental Protection Agency also notes that allocation exceeded emissions by an average of 2.9 million tonnes during the first trading period.

Table 5. *Reported emissions and allocated level of emission allowances for the main industrial sector over the first trading period (2005-2007)*

Industry	Emissions 2005	Allocation 2005	Emissions 2006	Allocation 2006	Emissions 2007	Allocation 2007
Energy total	4889488	5471851	4963631	5611365	4545847	5819398
Iron & Steel	6415101	7239755	6235744	7240420	6415246	7241748
Ore Production	438672	438780	439504	438780	511179	472664
Pulp & Paper	1974861	2602625	1970477	2647909	15582478	2715678
Mineral Total	3217189	3519012	3353319	3527677	3242700	3536600
Refinery	2451693	3024274	2939240	3024274	2739083	3024274
Total	19387004	22294297	19901915	22490425	19036532	22294297

5.3 NAP II 2008 – 2012

In total there are more than 700 installation included in the Swedish NAP 2008-2012. The emission allowances allocated in 2008–2012 correspond to about 19.8 million tonnes of CO_2 equivalents per year. In addition, there is a reserve of 2.6 million tonnes of CO_2 equivalents for new entrants during this trading period.

The final allocation principles are set out in the Emissions Trading Ordinance (SFS 2004:1205), which also regulates the extent to which companies may use reduction units from climate projects outside Sweden's borders in the framework of the EU ETS (the Joint Implementation and Clean Development Mechanism projects). The Swedish Environmental Protection Agency decides on the number of reduction units allowed per installation. The margin has been reduced from 20 per cent to 10 per cent of the total allocation.

Unlike in the 2005–2007 trading period, existing installations in the Electricity and District heating sector will not be allocated any emission allowances in the 2008–2012 trading period. This means that existing installations in the combustion installations sector will have to rely entirely on the market to buy emission allowances equivalent to their emissions.

Industrial installations with fuel-related emissions will receive a somewhat reduced allocation, which will be decreased on a *pro rata* basis to achieve the reduction decided. Allocations to new entrants in the EU ETS will not be affected by these reductions.

Emission allowances are allocated to existing installations according to the following principles:

- No allocations to existing installations in the Electricity and District heating sector;
- For existing industrial installations, except ore-based steel production, the same allocation principles as during the 2005–2007 trading period will apply, i.e. the allocation will be based on average historical emissions in 1998–2001. For installations that started operation in 2001 or later, other years will form the basis of allocations. For operations where emissions come from non-replaceable raw materials, the allocations will be based on projected production in 2008–2012;
- For ore-based steel production, allocations will be made either based on a benchmark or in the same way as for other installations. The method chosen will be that leading to the smallest allocation (see Section 25a of the Ordinance on Emissions Trading);

- If the total allocation to existing industrial installations exceeds the total approved allocation, allocations for fuel-related emissions will be reduced on a *pro rata* basis.

Emission allowances are allocated to new entrants according to the following principles:

- Installations in the Electricity and District heating sector: allocation on the basis of benchmarks;
- Biofuel installations as well as new and extended condensation power installations and hot water boilers will receive no allocations;
- Industrial installations (including combustion installations) will receive an allocation on the basis of comparison with best available technology.

The Swedish national allocation plan for the forthcoming trading period (2008–2012) was submitted to the European Commission in August 2006. The Commission adopted its decision on the Swedish national allocation plan in November 2007. As a result, the total number of emission allowances to be allocated has been reduced from 24.9 million tonnes to 22.5 million tonnes per year compared with the original allocation plan presented to the Commission. This is a reduction by approximately 10 per cent, table 6. The reduction of the total number of emission allowances between Period 1 and Period 2 is larger than it would appear from the reduction in absolute numbers. This is because a larger number of installations will be covered by trading in Period 2.

Table 6 *Allocated emission allowances 2005-2007 and 2008-2012 (millions of tonnes of CO_2 per year)*

	2005-2007	**2008-2012**
Existing installations	20.2	19.85
New entrants (reserve pool)	2.4	2.62
Total for the period ()	22.6	22.5

The largest change relates to installations in the combustion installations sector, which were allocated, on average, about 80 per cent of the amount of emission allowances they applied for in 2005–2007. For the 2008–2012 trading period, no allowances at all will be allocated to this sector, which will instead have to rely on the market for emission allowances to compensate for its emissions.

Emissions of greenhouse gases from the trading and non-trading sectors in Sweden respectively are shown in figure 6 below, historically and according to the projection for 2008-2012.

This includes additional measures, in relation to planned allocation and Sweden's international commitment in accordance with the EU decision on burden sharing. For 1990, the separation of emissions on trading and non-trading sectors is an estimate and must therefore be interpreted cautiously.

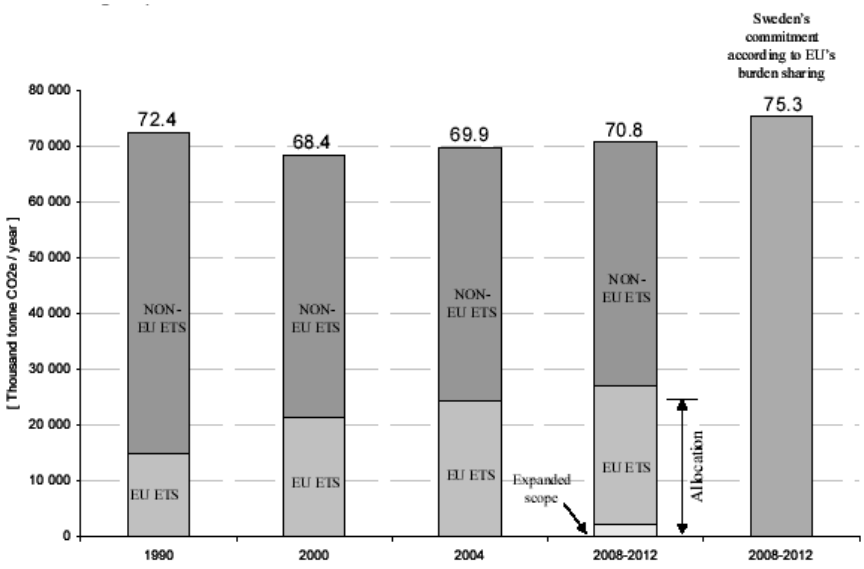

Figure 6. *Emissions of greenhouse gases from the trading and non-trading sectors in Sweden, both historically and according to the projection for 2008-2012*

As shown in this figure, the total emissions of greenhouse gases in Sweden have decreased since 1990. In accordance with the current projection they are expected to be less than the base year level during the period 2008-2012.. Swedish industry is modern, export-oriented and expansive which has resulted in an increase of total emissions from industries in the trading sector in Sweden over the same period. This increase has occured despite the decrease in specific emissions that has resulted from, among other things, measures to improve the energy efficiency of industrial processes. The increased productivity of Swedish basic industry has contributed to increased output and emissions that are in many cases directly linked to production without realistic possibilities for further reductions in the short-term.

Figure 7 shows the specific oil use in Swedish industry indicating a clear decrease in use and partly explaining the reduction of emissions by the industrial sector.

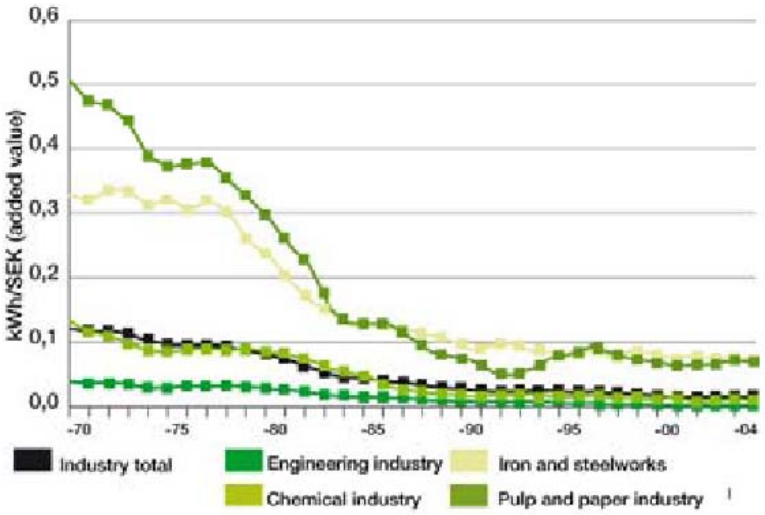

Figure 7 *Specific oil use by Swedish industry' between 1970 and2004*

Figure 8 shows distribution of allowances between existing installations in the indicated sectors in relation to projected carbon dioxide emissions in 2008-2012.

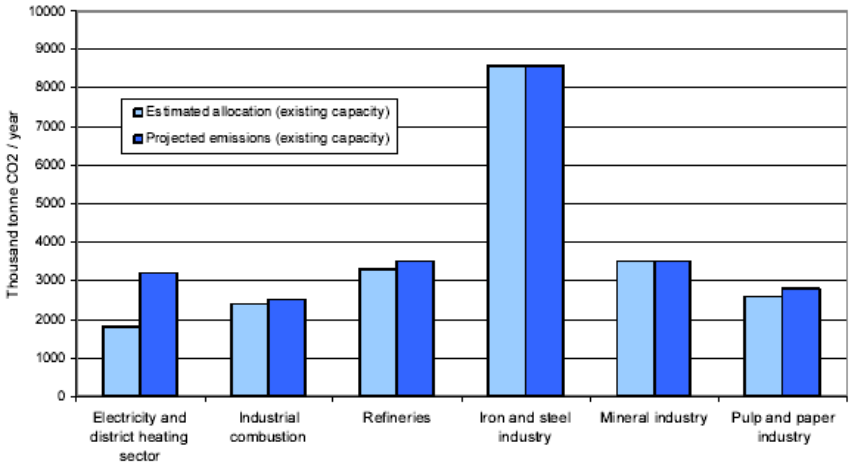

Figure 8 *Allocation of allowances to existing installations in 2008-2012*

5.4 Beyond 2012

Negotiations on the EU climate and energy package are at a very intense stage. The Swedish Government is currently working very actively so that an agreement with the European Parliament can be reached without the environmental levels in the package being watered down. There are Member States that feel concern about parts of the suggested actions during this period of financial crisis, while the Swedish view is that it is vital for the EU as a whole and in order to maintain EU's leadership in the climate issue that momentum is not lost. This view has been stated by the Swedish Minister for Environment Indicating that it is of the utmost importance that the European Council and the Parliament do their best to reach a common solution during the first reading of the proposals contained in the package.

Although the amount of information available now is limited it should be noted that Sweden is working hard to get a clear decision on the framework for the period beyond 2012.

5.5 Clean Development Mechanism (CDM) and opportunities, requirements and SET transfer demand

Under a special Linking Directive, installations covered by the EU ETS may take credit, to some extent, for emission reductions achieved through measures taken in the framework of the Kyoto Protocol project mechanisms JI (Joint Implementation) and CDM (Clean Development Mechanism).

Companies may obtain credit for approved reduction units in connection with their annual surrender of emission allowances. The number of reduction units that individual installations may surrender as an alternative to emission allowances is decided by the Swedish Environmental Protection Agency. Decisions on reduction units are made after final decisions on the allocation per installation have been made. The total amount of reduction units used by Swedish companies, however, may not exceed 10 per cent of the total amount of allocated emission allowances in Sweden's existing installations.

Rules on the use of reduction units are laid down in the Ordinance on Emissions Trading (SFS 2004:1205).

The main content of these are as follows:

- Operators with existing installations which came into operation before 2006 may use reduction units corresponding to 50 per cent of their verified 2006 emissions (total for the 2006–2012 period);
- Operators with existing installations which came into operation before 2006 but which were expanded or modified in terms of their nature or function between 1 January and 30 June 2006 may use reduction units corresponding to 50 per cent of their 2007 allocations (total for the 2008–2012 period). This rule also applies to operators with existing installations which came into operation between 1 January and 30 June 2006;
- Operators of certain existing installations which were not covered by the ETS in 2005–2007 but are covered in 2008–2012 (but which are not new entrants) may use reduction units corresponding to 10 per cent of their 2007 allocation (total for the 2008–2012 period);
- New entrants may use reduction units corresponding to 10 per cent of their total allocation for the period 2008–2012.

All projects, the purpose of which is to generate reduction units, are assessed on the basis of special criteria before they are implemented. Swedish national project approvals are given by the Swedish Designated Focal Point/Designated National Authority for JI and CDM, which is managed by the Swedish Energy Agency.

Projects to reduce emissions under CDM rules also undergo international assessment, as do JI projects where there is no established national process to approve them. In addition, all investments to reduce emissions must be approved by the host country.
The aims of JI and CDM and the purpose in linking them to emissions trading is to make it possible to combine cost-effective emission reductions with technology transfers to countries where technology development has not progressed to the same level. Investments to reduce emissions are usually implemented in transition economies (former Eastern Bloc countries) or in developing countries.

The emission reduction units and certified emission reductions which the operator may use when surrendering allowances in the register do not include credits from project activities attributable to the absorption of carbon dioxide by land use and forestry. Moreover, credits from nuclear power projects may not be used for surrender in the Swedish emissions trading registry

5.6 Joint Implementation (JI) opportunities and requirements

These are discussed under point b) above.

5.7 Voluntary markets (VER) opportunities and requirements

There are several activities in Sweden that enable industrial and other businesses to compensate for their climate footprint, while several companies have stated their interest in becoming climate neutral. As a result of this interest, CERs are bought and due to this interest; whether this is for marketing purposes or not does not really matter.

The Swedish Energy Agency has prepared a report covering recommendations for Voluntary Compensations for greenhouse gas emissions.

6. Companies in the carbon markets (EU-ETS, CDM, JI, VER, GIS etc.)

6.1 General overview and structure of branches

The EU ETS is initially confined to a limited number of industrial sectors, primarily energy installations, as well as some energy-intensive industrial sectors. The types of installations covered are:

- Combustion installations with an installed capacity exceeding 20 MW and installations connected to district heating networks with a total capacity exceeding 20 MW
- Mineral oil refineries
- Coke ovens
- Installations for the manufacture and processing of iron, steel, glass and glass fibre, cement and ceramic products
- Installations for the manufacture of paper, board or pulp

In Sweden, all energy installations connected to a district heating network with a total capacity exceeding 20 MW are included, even if the individual installations are less than 20 MW each.

A total of just over 700 Swedish installations are now included in the EU ETS. During the 2008–2012 trading period, about 35 more installations will be covered as a result of the European Commission's expanded definition of 'combustion installations'. A more detailed description of the extent of the EU ETS in Sweden and the types of installation covered can be found in the Swedish allocation plan for 2008–2012.

The EU ETS is expected to cover installations equivalent to approximately 50 per cent of total CO_2 emissions in the EU. In Sweden, as a result of the very low level of fossil electricity production, .it is expected that only 40 per cent of emissions will be covered.,

All Swedish companies included in the EU ETS must have a greenhouse gas emissions permit (in accordance with the Act on Emissions trading. In order to receive a permit, an installation must be able to control, monitor and report emissions in a reliable fashion. Permit applications are submitted to county administrative boards (regional level).

6.2 Emission reduction from the sector installations

With a view to comparing potentials to reduce emissions between different sectors, the Swedish Energy Agency has analysed the possibilities of reducing emissions from the electricity and district heating sector. In this review, a number of possible technical measures were identified, such as different methods of fuel conversions and efficiency measures adopted. The study which is based on a survey of a number of district heating systems that together account for over half of the emissions from the sector in question, indicates a potential for reduction of annual emissions by approximately 1.0 million tonnes of carbon dioxide at a marginal cost of € 25 per tonne of carbon dioxide. Since this cost is calculated without taking into consideration other policy instruments it tends to be an underestimate of the emission reduction that can theoretically be expected to be undertaken at a particular emission price. The stated level corresponds to around 33 percent of the studied installations' annual carbon dioxide emissions, which indicates the relatively large potential of this sector in comparison with other sectors. However, this result is not directly transferable to the remaining emissions in this sector since an overall analysis shows that the average

carbon dioxide intensity is only about half as great for those installations not covered by the study[2].

Making emission reductions additional to that described above would be more expensive since it would to a large extent entail a replacement of waste fuel and fossil fuel-based peak load production which is seldom used. According to the study, one of the most cost-effective and largest emission reduction measures in the sector is conversion from use of peat to use of biofuel. Measures have also been identified which lead to increased carbon dioxide emissions locally but at the same time result in a decrease in global emissions since the perceived overall effect depends on the system limits that are established.

Even though the technical and economic potential to decrease emissions is relatively greater in the energy sector than in the industrial sector, it should be noted that the underlying characteristics of the system, as well as a transition in the electricity and district heating sector initiated at an early date, have led to Swedish specific emissions (tonne of carbon dioxide per generated GWh) being very low in terms of an international comparison. This combined with a large energy-intensive industry means that the energy sector accounts for only just under 20 per cent of the Swedish emissions in the ETS sector. IN comparison, the energy sector accounts for around 60 per cent of the total emissions in the trading scheme for EU-25.

The Swedish Environmental Protection Agency has analysed the technical and economic potential to reduce emissions of carbon dioxide from the various industrial sectors included in the ETS sector. On a percentage basis the largest reduction potential which it is possible to undertake in industry, taking into consideration the technical aspects, lies in the pulp and paper industry. There are only a few emissions related to raw-materials in this sector. Possible measures include increased energy conservation and continued replacement of light fuel oil with biofuel. However, such processes have been in place for many years, as a result of which the specific use of energy within the forest industry has decreased by around 30 per cent over the past three decades [3].

There is some scope for reduction of the specific emissions in the mineral industry through increased energy efficiency and increased use of renewable fuels. The total potential for technically possible measures to decrease emissions of greenhouse gases in this sector by 2010 amounts to around 0.12 million tonnes of carbon dioxide per year[4]. Many of the measures identified in this sector lead, however, to increased production capacity, which means that the absolute emissions from the installations can be expected to increase at the same time.

In the manufacture of cement in Sweden, limestone is mixed with other additives and fired in a rotary kiln after which the material is sintered to clinker. The process for producing lime and ceramic products is based on separation of carbon dioxide from limestone or dolomite. The majority of the emissions of carbon dioxide from the cement industry take place during this calcination of limestone. Since this industrial process is intended to release carbon dioxide from the raw material, this emission is therefore more or less unavoidable.

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2 The Swedish Energy Agency (ER 2006:17), *Potential of reducing carbon dioxide emissions – an assessment of the electricity and district heating sector*, in Swedish

3 The Swedish Environmental Protection Agency (Dnr 503-677-05 Hk), Assessment of the possibility to reduce emissions of fossil carbon dioxide from the industrial sectors covered by the scheme for greenhouse gas emissions trading, in Swedish

4 IVL Swedish Environmental Institute, Investigation into the possibilities of decreasing emissions of carbon dioxide from the mineral industry, B 1651, in Swedish, October 2005

The potential to decrease emissions from Swedish refineries is very small since a number of energy-saving measures have been taken in this industry which has made the Swedish installations the most energy efficient in the world. This is confirmed by regular comparisons based on the Solomon Energy Efficiency Index (EEI) in hundreds of refineries around the world. In 2000, the largest Swedish refineries were placed in second, third and seventh place among the most energy efficient refineries. Despite this, emissions from the Swedish refineries have increased at a faster rate than the output in the past ten-year period, the explanation for this is a substantial increase in the complexity of the installations. Futher measures that it might be possible to put in place by 2010, taking into consideration both technical and economic potential, total around 0.08 million tonnes of carbon dioxide per year[5] (4). In the operation of catalytic crackers in this sector, a coating of coke is created which must be regularly burnt off during regeneration in order for the process to continue. These emissions are included in this plan as raw-material related.

The ore-based iron and steel industry is the branch of the industry that accounts for the largest carbon dioxide emissions in Sweden and at the same time, one of the sectors that is considered to have the greatest difficulties in reducing emissions. When iron or steel is produced from ore in Sweden the processes makes use of magnetite ore pellets, coal, limestone and dolomite. The process mainly takes place in blast furnaces that produce pig iron. This is refined into steel which is cast into ingots for further processing. A chemical reaction takes place in the process so that the iron atoms in the ore are freed from oxygen atoms producing the liquid pig iron. Oxygen is removed by combination with carbon and hydrogen resulting in the production of carbon dioxide and water vapour. Using present technology, this chemical process is essential. Hence, the quantity of carbon dioxide released is closely correlated with the quantity of iron that is produced. Hence, a significant reduction in these emissions is not possible in the short or medium-term since this would require a change of technology.

Certain measures in the form of improved yields, process optimisation and improved balance in the hot flow can, however, give rise to some emission reductions in production of sheet bars. The Swedish steel works have previously reduced their energy use by, for instance, improving the quality of the coke and pellets used. In the review of possibilities to 2010, the most realistic technical measures that might be adopted for decreasing emissions from these installations include further optimisation of the ratio between coal and coke used in the process. The reduction of around 0.3-0.4 million tonnes of carbon dioxide per year to which such a measure would lead to has been included as one of the assumptions in the projection that serves as one of the starting points for allocation under this plan.

In the same way, the technical and economic potential to decrease emissions from the other energy and industrial sectors has also been incorporated in the total projection for the trading sector.

The review of the technical and economic possibilities to reduce carbon dioxide emissions from the industrial sectors show that there is considerable difficulty in achieving this for a number of manufacturing processes to reduce emissions without this taking place by decreased output. These emissions are referred to in this plan as raw-material related emissions and are generally created from carbon which is combined with the raw material which is to be refined or carbon that is added to remove an undesirable component from the raw material. In the short- and medium-term, there is no possibility for reducing emissions

[5] The Swedish Environmental Protection Agency (Dnr 503-677-05 Hk), Assessment of the possibility of decreasing emissions of fossil carbon dioxide from the industrial sectors covered by the scheme for greenhouse gas emissions trading, in Swedish

from use of these raw materials in the processes in question other than by reducing output at the installations concerned.

In the light of the difficulties in the short and medium term of replacing certain of the raw materials that give rise to carbon dioxide emissions in many of the processes in the ETS sector and the conditions related to the Swedish export industry's exposure to non-European competition, these raw-material related emissions continue to be given special consideration when allocating allowances between installations. Since this principle is also applied to allocation in the initial period, this is considered to have a minimal impact on the administrative burden for the operators concerned.

As indicated above, Swedish industry has worked for a long time to decrease emissions and make its energy use more efficient. In combination with a shift from oil to electricity, among other things, this has entailed a substantial reduction of the specific use of oil in relation to production value (see figure 7 above). Following on from the sharp increases in output in Swedish industry, absolute emissions have, however, increased substantially despite the specific emissions of industry per produced unit being among the lowest in the world.

Figure 9 below shows the development of the specific emissions in terms of carbon dioxide per production value for Swedish installations in refineries, chemical industry, the iron and steel sector and the paper and pulp industry during the period 1990-2004. The comparison shows that the specific emissions in the refinery sector and the iron and steel sector have been relatively unchanged. This means that the development of the absolute emissions of carbon dioxide from these industries is closely associated with changes in the production value. There has been a downward trend in the pulp and paper industry and the chemical industry, which are characterised by a lower portion of raw-material related emissions than the other two industries, at least for development since the mid-1990s.

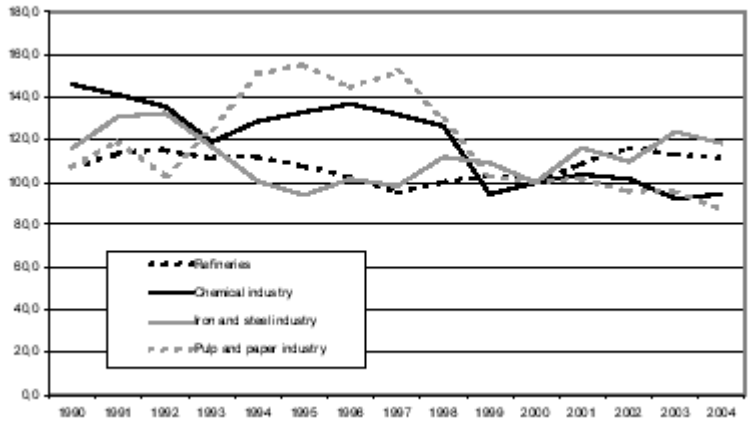

Figure 9 *Change of specific emissions in terms of carbon dioxide per production value for Swedish installations within some branches of industry sectors in the period 1990-2004. As a basis for this comparison, the relative development has been indexed against the value in year 2000 for all industries (index2000=100). Source: Swedish NAP II*

The average annual reduction of the emission intensity of industry as shown in the figure is considerably lower than the value shown for the link between emissions and economic development in the European Commission's further guidance. As a result of an already very low carbon dioxide intensity in the energy sector, industry accounts for a share of the Swedish emissions in the ETS sector which is higher than the corresponding share in many other Member States. The ETS sector's share of total emissions is not either constant but is increasing unlike the assumption made in the further guidance in connection with the

reasoning on how statistics of carbon dioxide use can be used to establish the total quantity of allowances to allocate.

The energy-intensive industry's relatively limited possibilities for achieving emission reductions without having a negative impact on the production value is confirmed by international comparisons, including a study of carbon dioxide decoupling in energy-intensive industries which has been carried out on behalf of the Nordic Council of Ministers. The empirical data analysed in this study indicates that only one of the four most energy intensive industries in Sweden can show signs of a decoupling of carbon dioxide emissions and value-added. This could be observed in the chemical industry, which is partly due to an increased recovery of the energy content of residual gases.

The Swedish industries covered by the emission allowance trading scheme are very export-oriented as shown by the summary in table 7 below. Since a considerable part of the output that is exported goes to countries outside EU-25, there is a risk that the competitiveness of these installations will deteriorate in the cases where the other installations which operate in this market are not subject to corresponding emission restriction. However, it should be noted that the share sold in the internal market is also exposed to competition from entities in countries which do not have the corresponding costs for emissions of greenhouse gases.

Table 7. *Export share of total production and share of export that went to countries outside EU-25 for various industrial sectors in Sweden in 2004 (Source: Statistics Sweden and author's calculations*

Industry	Share of export of total production (%)	Share of export that goes to non-EU countries (%)
Metal ore mines	37	37
Basic chemical industry	57	38
Steel and metal works	81	28
Pulp & paper industry	68	25
Petroleum refinery	61	34

The Swedish Institute for Growth Policy Studies (ITPS) notes in its report "Basic industry and Kyoto" that trade with allowances has considerable effects on the competitiveness of Swedish energy-intensive industry40. According to the calculations made by ITPS, manufacturers of cement and lime and petroleum refineries have been most affected. Since a relatively larger share of exports from the mineral industry goes to markets outside the EU and the industrial structure is sensitive to cost changes, the effects will be even greater for the cement and lime industry compared with the refinery sector, for instance. Sweden accounts for a substantial part of the EU's mining production (table 8). Output of iron ore is controlled wholly by demand in the steel industry and is therefore dependent on the development of this market. Around 80 per cent of the Swedish steel output is exported to other countries. In the world market, the Swedish installations only account for a limited share of the total output and the ability to influence the price level is therefore low. This means that the mines and the iron and steel industry are sensitive to cost changes at the same time as the latter accounts for the largest carbon dioxide emissions in Swedish industry. Some of the mining industry's foremost competitor countries outside the EU are Brazil, Australia and Canada.

Table 8 *Sweden's share of EU's mining output in 2002 (Source: Swedish Association of Mines, Minerals and Metal Producers Progress Report 17, July 2006 – www.mining.se)*

EU-25	(%)	
Iron	89	Ist
Gold	27	2nd after Finland
Zinc	24	2nd after Ireland
Silver	17	2nd after Poland
Lead	30	3rd after Ireland, Poland
Copper	11	3rd after Poland, Portugal

After Finland, the Swedish industry has the second greatest capacity for pulp and paper production in Europe and provides over a tenth of the EU's paper requirements. Sweden is the world's fourth largest exporter of paper and the third largest exporter of pulp. Brazil, North America, Indonesia and Chile are the foremost competitors as regards pulp production. For paper production, the United States (kraftliner) and Canada (newspaper) are some of the industry's largest competitor countries outside the EU-25.

Among the short-term effects for a number of the installations in basic industry are that a restrictive allocation entailing a need to purchase additional allowances can imply that they will face difficulties creating profitability in liaison with increases in output. Apace with more countries undertaking to limit their emissions of greenhouse gases, the risk decreases for a distortion of competition and moving out production which in the worst case can lead to carbon dioxide leakage and even an increase of global emissions.

6.3 Identification of the technology needs in targeted companies

The Swedish companies' highest need is within energy efficiency in the installations. To decrease the emissions the industry believes that energy efficiency in the installations is the most effective way to solve the problem in-house. To achieve this Good Practices and sector benchmarking will be used as methods to find the needed technology.

The industrial associations and the PFE program (Swedish Energy Agency) play a major role when it comes to present good practices and benchmarking. The need for energy mapping to find out the weak points in the installation to find the technology need is very efficient way to meet company need.

7. R&D priorities

7.1 General National aspects

Four Swedish organisations, The Swedish Energy Agency, the Swedish Environmental Protection Agency, the Foundation for Strategic Environmental Research and the Swedish Meteorological and Hydrological Institute, together fund climate policy research programmes of around 5 million Euro annually. The objective is to fund research that supports the Swedish climate strategy.

The organisations:

- The Swedish Energy Agency is a government agency for matters concerning the supply and use of energy in Sweden.
- The Swedish Environmental Protection Agency is a government agency for environmental issues.
- The Foundation for Strategic Environmental Research, support strategic and long-term environmental research.
- The Swedish Meteorological and Hydrological Institute is a government agency that manages and develops information on weather, water and climate that provides knowledge and advanced decision-making data for public services, the private sector and the general public.

7.2 Research related to Sustainable Energy Technologies

The programmes:

- The Swedish Climate Modelling Resource at the Rossby Centre develops advanced climate models and climate scenarios.
- The Land Use Strategies to Reduce Greenhouse Gas Emissions Programme, LUSTRA, aims at analysing different strategies for minimising greenhouse gases to the atmosphere from land use, especially forest soil.
- The CLIMATOOLS Programme, Adapting to climate change: tools and strategies for sectors and regions, is a five year multi-disciplinary research programme that started in late 2006. It will provide decision makers with guidelines and tools as helpers in their work on climate impacts and decisions on what and where to adapt.
- The International Climate Policy Research Programme will strengthen Swedish competence within research related to international processes on climate change and enhance Swedish participation in international networks.
- Mistra's Climate Policy Research Programme focuses on the knowledge in climate policy and international negotiation, and on the role of emissions trading in climate policy. Its Policy Forum will promote the dialogue between researchers and decision makers.

In 2001, the Swedish Energy Agency initiated a research programme on International Climate Policy. During 2001-2006, the programme had a budget of 40 million SEK. For the new period 2006-2010 the budget is 50 million SEK.

The objective of the programme is to broaden Swedish contacts internationally, to provide relevant inputs to the international climate policy process, and to enhance the Swedish research and development competence in the field of international climate policy. The programme will assist in establishing and supporting research groups capable of conducting long-term climate policy research.

Among the areas of particular interest to this programme, are global climate change policy processes as well as the question of future commitments, for example, the definition of quantitative goals, the role of technology development and transfer, the cost-effectiveness of policies and measures as well as the role of project based mechanisms in the European emissions trading scheme and in the future commitment period of the Kyoto process.

The Swedish Energy Agency research programme *General energy system studies* has a socio-technical profile and plays an important part in the Swedish energy research portfolio.

The programme augments the technically oriented research, development and demonstration activities funded by the Swedish Energy Agency. The aim of the programme is to produce high quality research results and develop competence within the fields of energy policy analysis, energy system modelling, energy economics, energy market studies, innovation studies, and behavioural science.

The purpose of the programme is to establish and develop Swedish research groups within these areas, including international co-operation, and to disseminate and incorporate results from the research into energy policy analyses, energy technology analyses, energy forecasts, etc. The government, national, regional and local administrations, energy companies, energy users/customers benefit from results from the programme that can be used in their decision making processes. Through dissemination of results general knowledge about energy systems, energy policy and energy markets also increase.

The first programme period that ended in June 30, 2005 and included research within the following areas:

- History of technology studies related to the reform of the the Swedish electricity market
- Political science studies of energy policy guidence measures
- Economic studies of the power market
- Energy technology innovations studies, including experience curve analyses
- Energy system modelling development
- Forecast studies related to the transport sector

Energy-related R&D and demonstration work is characterised by a system-based approach. One goal is to further reduce the use of oil and electricity for heating purposes and another is to improve the efficiency of use of operational and household electricity in properties. The work aims to reduce the energy needs of buildings and replace fossil fuels with renewable alternatives. In its role as the public agency for the sector, the Swedish Energy Agency has principal and coordinating responsibility for energy-related building research. The Agency finances projects in this sector together with the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning. The Swedish Consumer Agency, the Swedish National Board of Housing, Building and Planning and the Swedish Environmental Protection Agency also have energy-related undertakings in the building sector.

The goal of research into buildings as climate shells is to boost the efficiency of energy consumption for heating, hot water and operational electricity by 50 per cent over 40–50 years.

Energy consumption in industry has remained relatively constant since the early 1970s, with increased production volume compensated by improved energy efficiency. Oil consumption has fallen while electricity consumption has risen. Industry accounts for about 25 per cent of Sweden’s energy consumption and about 25 per cent of greenhouse gas emissions. Energy efficiency and more efficient use of resources can be boosted by greater cooperation between different industries and between industry and the rest of society. Hence, The Swedish Energy Agency works to improve cooperation between the research sector and trade and industry. Industrial organisations and research institutes have an important role to play in this context. The Swedish government supports research, development and demonstration work in industry through the Energy Agency, and research grants are supported by various policy instruments to help achieve energy policy goals and drive developments in Swedish trade and industry.

Studies show that there is major potential to further reduce energy losses and to utilise biofuels more efficiently in energy-intensive industry. The paper, pulp, iron, steel and chemicals industries are the most energy-intensive sectors, accounting for almost 70 per cent of the energy consumption of the entire industrial sector. The main priority therefore is energy efficiency improvement in fields where there is cooperation between research institutes and trade and industry.

This includes electricity production from the renewable energy sources of solar, wind, hydro and wave power as well as technology for the transmission, distribution and storage of electricity.

The climate issue is the main impetus for boosting the proportion of renewable electricity production in the power system. Security of supply, economy and commercial potential are highly significant in determining what research is given priority.
For hydro power, the goal is to accumulate and maintain the knowledge and expertise necessary to ensure that efficient and reliable hydro power production remains an important part of Sweden's energy supply. This area also includes assured safety in dam operation.

In wind power, the priority is large-scale technology, preferably sea-based (off-shore) systems. R&D is ongoing to cut the costs of wind power and to increase the contribution of wind power to the overall power system. R&D covering solar cells aims to produce more efficient solar cells at lower cost. It also covers solar cell systems as an energy source and as a building component.

R&D covering the overall power system is required in order to create more secure and higher quality transmission and distribution systems adapting it for use in new applications. A robust power system is a prerequisite for the introduction of a large proportion of electricity production from intermittent sources in Sweden

R&D on power systems area covers new conversion techniques such as electricity from underwater currents and wave power.

The Swedish Energy Agency funds research and development aiming at increased cell and module efficiency and lower production costs as well as system studies of PV as an energy source and as a building component. The two largest research installations are:

- Ångström Solar Center that includes research on thin film CIGS cells
- Grätzel solar cells

The Swedish Energy Agency also participates in PV-ERA-NET, which is a European network aiming at increased collaboration and coordination between national PV RTD programmes. Sweden also participates in the International Energy Agency's Photovoltaic Power Systems Programme.

A development platform covering power systems (UPKraft) was launched in 2005. The platform was intended to drive technical developments in the area using a well-prepared and established strategy. About ten people from the Swedish Energy Agency and roughly the same number of representatives of power companies, other industry and public agencies participated in UPKraft. Its overall goal was to help shift the power system in a sustainable direction, i.e. towards the energy policy goals adopted by the Swedish Riksdag (Parliament) and the Swedish government. These goals are to be realised within the framework of the platform. The platform began by formulating visions and goals for the power system area and

thereafter looked to identify energy-related research, development and demonstration measures that need to be undertaken to achieve the goals.

Simultaneous production of electricity and heat is efficient in terms of resources and environmental benefit. Hence, Combined Heat and Power (CHP) is one of the Swedish Energy Agency's priority areas. The Agency's measures are focused on:

- Research into and development of existing technology, as well as demonstration, with the focus on fuel flexibility, performance, cost-effectiveness and low emissions.
- R&D and demonstration of new (not yet launched) technology, with the aim of increasing electrical efficiency while retaining or improving environmental data at a competitive price

The transport sector's share of Sweden's total CO_2 emissions amounts to about 45 per cent and continues to rise. Despite the fact that the energy efficiency of vehicles has been improving over a long period of time, overall fuel consumption in the transport sector is not falling. This is partly due to the increasing size and power of vehicles and partly because the volume of transport has increased.

The Swedish Energy Agency supports technical research and development in issues related to road vehicles and the production of renewable fuels. This work is focused on improving energy efficiency and replacing today's fossil fuels. In the long term, biofuels will be able to meet a significant part of the country's transport sector needs, but this approach has to be supplemented by the development of more energy-efficient vehicles.

Several important projects are under way to improve energy and environmental performance in vehicles. Hybrid vehicles are now available on the market, and marketing of fuel cells for road vehicles is likely to start around 2010. This is why the main priority is system and component issues in the hybrid drive train. The development of batteries, electric engines, fuel cells and combustion engines tailored to hybrid vehicles is becoming increasingly important. The Swedish Energy Agency is contributing to long-term knowledge-building in these new areas through its research programme Energisystem i vägfordon (Energy systems in road vehicles).

The Agency is also focusing broadly on the development of production technology for several biobased fuels and other renewable fuels. Prioritised work includes pilot plants for making ethanol from forestry raw materials, black liquor gasification and biomass gasification. Work in the last two areas aims to develop the manufacture of fuels such as dimethylether (DME), methanol, synthetic petrol, synthetic diesel and hydrogen gas.

8. Links to relevant and related websites

Government official site: http://www.regeringen.se/sb/d/5745/a/21787

NAP II for Sweden: http://www.sweden.gov.se/sb/d/574/a/69778

The one-stop shop for emission trading in Sweden:
http://www.utslappshandel.se/eng/index.html

Swedish Energy Agency:
http://www.swedishenergyagency.se/WEB/STEMEx01Eng.nsf/F_PreGen01?ReadForm&MenuSelect=0650E42872736D32C1256E780028DE47

Swedish Environmental Protection Agency: http://www.naturvardsverket.se/en/In-English/Menu/Climate-change/Climate-policy/Swedens-climate-policy/

ETS in Sweden: http://www.utslappshandel.se/eng/index.html

EU ETS in Sweden:
http://www.swedishenergyagency.se/WEB/STEMEx01Eng.nsf/F_PreGen01?ReadForm&MenuSelect=291F011FFD55CA71C1256FF7003DD740

The Swedish EIA centre: http://mkb.slu.se/eiacentre/

Swedish Research (Energy):
http://www.swedishenergyagency.se/WEB/STEMFe01e.nsf/V_Media00/C12570D10037720FC1257130004123F7/$file/Swedish%20Research.pdf

The Swedish Private Equity & Venture Capital Association (SVCA):
http://www.svca.se/home/index.asp?sid=337&mid=1

EU & NAP I: http://ec.europa.eu/environment/climat/emission/emission_plans.htm
EU & NAP II: http://ec.europa.eu/environment/climat/emission/2nd_phase_ep.htm
EU-ETS : http://ec.europa.eu/environment/climat/emission/index_en.htm
United Nations Framework Convention on Climate Change: http://unfccc.int/2860.php
CDM, JI, etc. http://cdm.unfccc.int/index.html http://ji.unfccc.int/index.html