Ds 2005:55

Sweden's fourth national communication on climate change

Under the United Nations Framework Convention on Climate Change

REGERINGSKANSLIET

Ministry of
Sustainable Development
Sweden

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Foreword

Sweden's Fourth National Communication is formulated in accordance with the guidelines adopted by the parties to the Framework Convention on Climate Change. It presents basic facts about Swedish society and reviews the various sectors of society according to the classification commonly used in the context of climate. Emissions of different greenhouse gases are presented for each sector and as an aggregate figure for each year since 1990, along with the impact of various policies and measures on emissions.

The evaluations presented in the report show that Sweden has succeeded in severing the link between economic growth and greenhouse gas emissions. The policies and measures introduced have had a significant impact, and emissions have been decreasing with 2.3% since 1990. Over the same period, Sweden has enjoyed relatively high economic growth. The report also contains projections for emissions up to 2020. According to these projections, emissions will start to rise again unless more measures are taken.

The National Communication describes Sweden's vulnerability and what it is being done to adapt to climate change. Sweden's international efforts in the form of development assistance with relevance to climate change and other types of cooperation are described, as are research and development activities. Finally Sweden's education, training and public awareness efforts are described.

The material on which the national communication is based has been obtained through extensive activities undertaken by government agencies, led by the Swedish Environmental Protection Agency and the Swedish Energy Agency, with the participation of around ten other agencies. Most of the work on the fourth national communication was carried out during the period from the autumn of 2004 to the summer of 2005.

As the work on the national communication was, for the most part, completed during the summer of 2005, events that have occurred since then are not fully described in the report. It should be emphasised in particular that the projections for future Swedish greenhouse gas emissions do not take account of the decisions taken since the beginning of 2005. It is likely that the introduction of new policies and measures will contribute to lower emissions than are shown by the projections.

Decisions taken recently aimed at reducing greenhouse gas emissions include the adoption of the Government Budget Bill for 2006 (Government Bill 2005/06:1). According to this Bill, motor vehicle taxation will be differentiated with respect to carbon dioxide emissions in 2006. In addition, subsidies for wind power will be extended by five years from 2008. These subsidies amount to SEK 70 million a year. Resources earmarked for energy research will increase by SEK 270 million annually in 2006-07 and SEK 370 million in 2008. In addition, an investment subsidy is being introduced to encourage the change-over from oil-fired heating to more environmentally friendly energy sources such as district heating or individual heating based on biomass fuels, heat pumps or solar energy. The subsidies signify tax relief totalling SEK 400 million a year. The investment programmes providing subsidies for climate-related investments (KLIMP) are also to receive a boost of SEK 200 million in 2006 and SEK 320 million a year in 2007-2008.

In the government declaration dated September 2005, the Swedish Government raises its aspirations in the area of the environment and climate change. The proportion of electricity from renewable energy sources is to increase by 15 TWh up to 2015, that is to say by 5 TWh more than the target for the electricity certificate system has been to date. A national programme is to be created for

energy efficiency improvement and low-energy construction. There is a clear focus on the transport sector in greenhouse gas emissions. The target for state purchases of green cars is being raised to 35% and company-car taxation for gas-powered vehicles is being reduced. A new target to create the necessary conditions to sever Sweden's dependence on fossil fuels by 2020 is also to be established.

The Swedish Government has continued to work on the follow-up of national climate strategy in 2005. The underlying aim is to submit a bill to the Swedish parliament which deals with the future formulation of national climate targets, and documents existing and new efforts and policy instruments. The Government intends to introduce the bill in the Swedish parliament in the near future.

Stockholm, December 2005

Lena Sommestad
Minister for the Environment

Contents

1 Summary

This is Sweden's fourth national communication, which describes the national activities to comply with the commitments under the UN Framework Convention on Climate Change. Sweden ratified the Kyoto Protocol in 2002, and as the Kyoto Protocol came into force at the start of 2005, an account is also given in this report of national activities to fulfil the commitments under the Kyoto Protocol. The report summarises the trend in Swedish greenhouse gas emissions since 1990, national circumstances affecting these emissions and the political decisions Sweden has taken to reduce its impact on the global climate. These decisions contribute to achieving the ultimate objective of the UN Framework Convention on Climate Change – that the concentration of greenhouses gases in the atmosphere be stabilised at a level that prevents human impact on the climate system becoming dangerous.

The report also describes projections for national emissions and removals of greenhouse gases in the period up to 2020, national initiatives to increase awareness of the country's vulnerability to climate change, efforts in climate research and initiatives to provide financial support to developing countries and to spread knowledge on the cause, implications and consequences of human impact on the global climate.

1.1 National circumstances, energy use, greenhouse gas emissions

Geographical, population-related, economic, industrial and energy-related national circumstances are of great significance for a country's emissions and removals of greenhouses gases.

Sweden's system of government means that the most important political decisions, relating to climate policy and energy policy, are taken by the parliament (the Riksdag). The government implements parliamentary decisions and is assisted in doing so by national agencies which act as the government's expert bodies. The Swedish Environmental Protection Agency and the Swedish Energy Agency are the most important agencies for the implementation, monitoring and evaluation of the climate-policy decisions.

The proximity of Sweden to the northern Atlantic and the prevailing south-westerly winds result in a climate that is mild for the latitude during the winter months. Some climate change can be discerned in recent years. The average temperature rose by almost one degree over the period 1991-2004 compared with the period 1961-1990, with the greatest change taking place during the winter.

The Swedish population has increased slightly over the last 15 years, passing the 9 million mark in 2004. It is expected to rise to 9.7 million in 2020. Sweden's economic growth was very weak during the first part of the 1990s but since 1994 has been 2 to 4% per annum, with the highest increase in GDP occurring during the period 1998-2000.

Total energy use in Sweden has varied between 560 and 625 TWh per year since 1990, with a slight upward trend. Energy intensity (energy use per GDP) started to decline from 1995 onwards. Crude oil and oil products in 2003 accounted for a third of primary energy, nuclear fuel and hydropower together for 40% and biomass fuels for around 17%.

Total greenhouse gas emissions in Sweden decreased by 2.3% or approximately 1.7 million tonnes of carbon dioxide equivalent between 1990 and 2003. Intensity of emissions calculated per capita and per GDP was lower in 2003 than in 1990. Calculated in terms of carbon dioxide equivalent, Sweden's total emissions in 2003 were just under 70.6 million tonnes. The greatest decreases in emissions over the period 1990-2003 took place in the res-

Table 1-1 **Macroeconomic data for Sweden, fixed prices in 2000**

	1990	1995	2000	2003	2004	1990-2004 %/year	2001-2004 %/year
GDP (SEK billion)	1 802	1 871	2 195	2295	2381	2.01	2.39
GDP per capita (SEK)	210 545	211 977	247 450	256 232	264 766	1.65	2.02
GDP per capita (USD 2000 PPP)	22 910	23 066	26 926	27 882	28 810	1.65	2.02

idential and service, agriculture and waste sectors. Greenhouse gas emissions from the energy sector excluding transport[1] accounted for 46% of total emissions in 2003 and are dominated by carbon dioxide emissions. The transport sector accounts for just under 30% of greenhouse gas emissions. Agriculture for 12%, industrial processes for 8%, waste accounts for 3% and solvents for less than 1% of greenhouse gas emissions.

Greenhouse gas emissions by the energy sector[2] were just under 33 million tonnes of carbon dioxide equivalent in 2003, which is 6% lower than in 1990. Emissions from the sector vary with temperature, precipitation conditions and the economic situation. Hydropower production is of great significance for variations in energy supply and emissions between years. During years with low precipitation, such as 1996 and 2003, hydropower production is relatively low. This is principally offset by electricity imports and increased production of combined heat and power, resulting in higher emissions. Over the period 1990 to 2003 district heating production increased, while emissions did not, as the expansion took place primarily through increased use of biomass fuels. Average residential floor space per capita rose by 5% during the 1990s. Increased population and rising residential floor space per capita is forcing up the energy need for

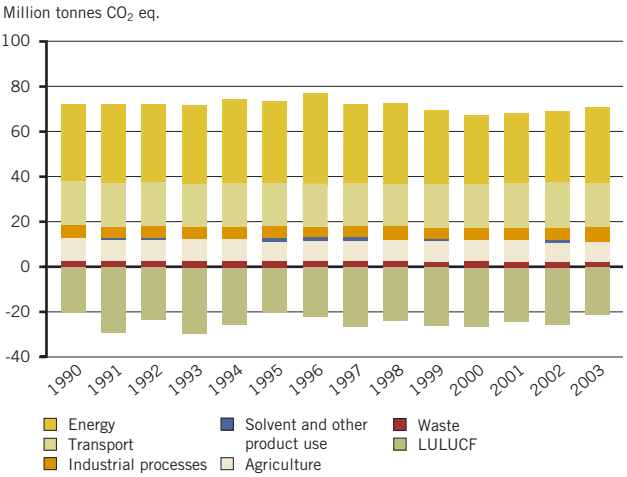
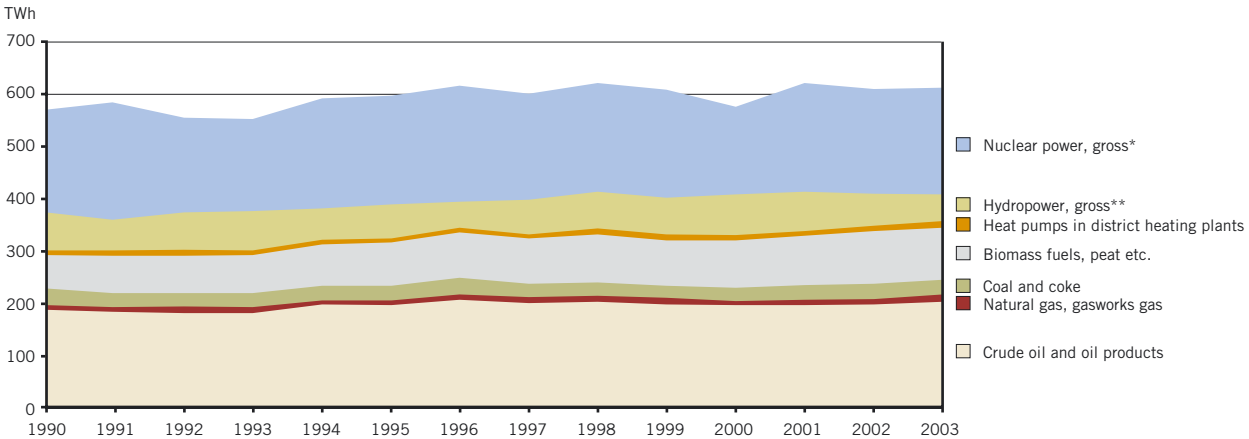


Figure 1-1 **Emissions and removals of greenhouse gases, calculated as carbon dioxide equivalent.**

heating. Despite this, emissions from heating in the residential and service sector have fallen on average by 2-3% a year and by a total of almost 40% since 1990, principally due to a change-over from oil to biomass fuel-based district heating and in recent years heat pumps and wood pellet-fired boilers. Only 10% of detached and semi-detached houses are now heated by oil.

The volume of transport and the energy use of the transport sector are increasing continuously. Greenhouse gas emissions from the sector increased by



* According to the method used by the UN/ECE for calculate supply from nuclear power, wich means that conversion losses are included.

** Including wind power up to 1996.

Figure 1-2 **Sweden's primary energy supply per energy carrier (excluding electricity imports and exports).**

[1] Energy sector emissions include emissions from electricity and district heating production, refineries, industrial combustion and residential and service, incl. combustion in agriculture, forestry and fisheries.

[2] Energy sector emissions include emissions from electricity and district heating production, refineries, industrial combustion and residential and service, incl. combustion in agriculture, forestry and fisheries.

10% over the period from 1990 to 2003. Domestic passenger transport increased by 12% and freight transport by just over 14% between 1990 and 2002. The increase for freight carried by road is 25%.This increase in freight transport is reflected in diesel consumption having increased by more than 50% since the early 1990s, with consequent increases in emissions. Emissions from passenger transport have increased at a lower rate because the national vehicle fleet has become more fuel-efficient than in 1990. Low admixture of ethanol in petrol has led to an increase in the use of ethanol as motor fuel of almost 600% between 2001 and 2004. However, in 2004, bioethanol still only accounted for 2% of the energy use of the transport sector. Carbon dioxide emissions from bunker fuels used for international shipping and aviation to and from Swedish ports in 2003 amounted to around 7.2 million tonnes, which represents a doubling since 1990.

Sweden's industrial structure is characterised firstly by activities in the forestry industry and metal production based on raw materials and energy. Secondly by knowledge-based activities in the chemical industry and the engineering industry. Development of production in the engineering industry and parts of the chemical industry has exceeded that of the rest of industry, resulting in a reduction of energy intensity for the whole industry sector. Carbon dioxide emissions from industrial combustion, however, have remained stable at around 11-12 million tonnes since 1990. Emissions from industrial processes originate principally from the use of coke in blast furnaces, the use of dolomite and limestone in the mineral industry and the use of coal in the reduction of copper. Emissions have varied with economic fluctuations in industry. Emissions in 2003 were just under 6 million tonnes of carbon dioxide equivalent, which is 4% higher than in 1990.

Emissions by the waste sector are dominated by methane emissions from landfills. The quantity of household waste has increased by around 2% a year over the last 10-year period, but the quantity deposited in landfills has decreased due to increased energy and material recovery. In addition, the collection of landfill gas is increasing, and in 2003 approximately 440 GWh energy equivalent was recovered from collected gas. This resulted altogether in 32% lower methane emissions from waste in 2003 than in 1990.

The economic significance of agriculture is limited. The value of Swedish agricultural products, including direct subsidies, was less than 1% of the country's GDP in 2003. The acreage under cultivation has decreased, and the number of dairy cows has decreased by around 15% over the last ten years, contributing to reduced methane emissions. Total emissions from agriculture have decreased by 9% since 1990. Agriculture is, however, still the largest source of methane and nitrous oxide emissions in Sweden.

A large proportion of Sweden's land area is forest. Felling increased sharply between 1990 and 2004, while the level of growth rose modestly, which meant that the rate of increase in forest stock that occurred decreased during the period. The carbon sink from the land use, land-use change and forestry (LULUCF) sector nevertheless amounted to 21.5 million tonnes of carbon dioxide in 2003.

1.2 Policies and measures

Sweden's climate strategy has emerged since the late 1980s as a result of the decisions taken in the context of environmental, energy and transport policy. Sweden's current climate strategy was adopted in 2002, when the Kyoto Protocol was also ratified by the Swedish government.

Sweden's climate strategy is based on a number of policy-related initiatives. Instruments of importance to Swedish greenhouse gas emissions have in many cases been introduced partly for purposes other than reducing emissions. It is therefore often difficult to evaluate these policy instruments. As well as the fact that the policies may be intended for more than one societal objective, separating the effects of individual policy instruments poses a great challenge, as the instruments often interact with each other as well as with other exogenous factors.

Cross-sectoral instruments

Several of the policy instruments in the Swedish climate strategy affect more than one sector. These include:

- the energy and carbon dioxide taxes
- the EU emissions trading scheme (EU ETS),
- government subsidies for local investment programmes (LIP, Klimp).

The energy and carbon dioxide taxes are discussed under the energy sector and transport sector. Sweden has been taking part in the EU emissions trading scheme since 1 January 2005. Other policy instruments affecting emissions from installations included in the trading sector only re-distribute emissions between these installations. Emissions from activities in Sweden included in the trading scheme in 2000 accounted for just under 30% of total Swedish greenhouse gas emissions. Sweden has based the

allocations to existing installations during the first period of the scheme (2005-2007) on average historical emissions over the period 1998-2001. Raw material-related emissions have, however, been allocated emission allowances equivalent to a projected increase in emissions from these sources. Altogether, Sweden will allocate around 23 million tonnes of emission allowances a year over the period 2005-2007. The national allocation plan for the next period 2008-2012 is due to be adopted in 2006.

LIP (the local investment programme for ecologically sustainable development) and Klimp (local investment programmes for climate measures) are two government subsidy programmes for municipalities that contribute to reducing greenhouse gas emissions. LIP grants, with up to one-third of the investment cost, were made over the period 1998-2002 and contained many measures aimed at reducing GHG emissions. In total, it is estimated that SEK 2.7 billion will be disbursed for climate-related measures within LIP. Altogether, LIP projects are estimated to reduce emissions by up to 1.5 million tonnes of carbon dioxide equivalent a year. From 2003 LIP was replaced by Klimp, which is dedicated to action programmes to limit climate change. The Klimp investments amount to just over SEK 1 billion and are estimated to lead to reductions in emissions of 0.5 million tonnes of carbon dioxide equivalent per year.

The energy sector excluding transport

A number of policy instruments have been introduced in the energy sector that lead to reduced carbon dioxide emissions. The instruments are principally aimed at increasing energy efficiency, reducing use of energy and increasing the proportion of renewable energy. The most important policy instruments include:

- energy and carbon dioxide taxes
- the electricity certificate system

The current system of energy taxes is based on a combination of a carbon dioxide tax, an energy tax on fuel, a nuclear power tax and a consumption tax on electricity. Tax on the use of energy and electricity has been in existence since the 1950s. Biomass fuels have not been taxed, and the energy tax system has thus encouraged the use of biomass fuels since before 1990. Carbon dioxide tax was introduced in 1991 and has since been successively raised. The level of the tax at present is 91 öre/kg CO_2. There are some exemptions. Changes in energy and carbon dioxide tax levels since 1990 have provided strong financial incentives for a substantial expansion in and increased use of biomass fuels for district heating production, as well as replacement of oil with biomass fuel, district heating and heat pumps in individual heating.

The electricity certificate system is a support system for renewable electricity production which was introduced in Sweden on 1 May 2003 and which is gradually replacing earlier investment subsidies. The aim is to increase renewable electricity production in Sweden between 2002 and 2010 by 10 TWh. During the first two years of the electricity certificate system, renewable electricity production increased by around 4 TWh, largely through conversions from fossil fuels to biomass fuels and increased use of existing electricity production capacity in biomass-based combined heat and power installations. On the other hand, no major new investments in production capacity have yet been generated.

Combined effect of economic instruments in the energy sector excluding transport

Many instruments interact directly or indirectly with other instruments. An evaluation has therefore been made of the combined effects of the economic instruments[3] introduced in the energy sector between 1990 and 2005 on carbon dioxide emissions in Sweden. The instruments introduced are estimated to reduce emissions by 10 million tonnes of carbon dioxide up to 2010 and by 38 million tonnes of carbon dioxide up to 2020 compared with a 1990 business as usual scenario (Figure 1-3). The sharp increase in emissions up to 2020 in the 1990 business as usual scenario is due to the assumption that nuclear power is phased out after 40 years of operation and is replaced principally by natural gas.

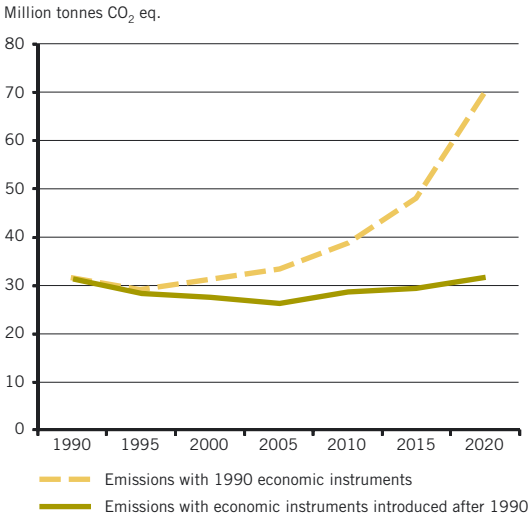


Figure 1-3 **Estimated trend in emissions in the Swedish energy sector excluding transport with introduced economic instruments compared with the scenario for 1990 instruments.**

[3] Economic instruments are understood in this case to mean taxes, investment and operating subsidies, the electricity certificate system and the EU emissions trading scheme. However, LIP and Klimp are not included.

Industrial processes

Few of the present-day instruments have an impact on emissions from industrial processes. A future EU-wide regulation to limit emissions of fluorinated greenhouse gases (F gases) is estimated to lead to reductions in Sweden of around 0.15 million tonnes of carbon dioxide equivalent a year up to 2010 and 0.4 million tonnes of carbon dioxide equivalent a year up to 2020. The provisions in the Environmental Code for permit examination of large installations also plays a role in reducing emissions from industrial processes. It is estimated that application of the Environmental Code will reduce emissions of PFCs from aluminium production by at least 0.2 million tonnes of carbon dioxide equivalent.

Transport

Increases in motor-fuel taxes in Sweden have limited the increase in emissions from transport. According to model calculations, tax increases from 1990 have reduced emissions of carbon dioxide from cars in 2005 between 1.5 and 3.2 million tonnes compared with motor-fuel tax at the 1990 nominal level.

Around 25% of sales of new vehicles in Sweden are accounted for by company cars, where the employer owns the car while the employee has the car at his or her disposal and pays tax on this benefit. These cars are, on average, heavier and have higher fuel consumption than the rest of the vehicle fleet. In 1997 a a tax on free fuel for individuals with company cars was introduced. This tax is estimated to have reduced carbon dioxide emissions by 0.2 million tonnes a year. A tax incentive for environmentally appropriate company cars was introduced in 2003.

Biofuels have been exempt from carbon dioxide tax and energy tax in Sweden since 2004. The tax exemption applies to the end of 2008. The result is that almost all petrol sold in Sweden now contains 5% ethanol. The use of biofuels has increased from 0.7% of total petrol and diesel use in 2002 to 2% in 2004 in terms of energy content, and the increase has continued in 2005. The total decrease in emissions is estimated to amount to around 0.6 million tonnes of carbon dioxide emissions a year up to 2005 and to remain at that level until 2010.

Waste

Landfilling of organic waste started to decrease from the mid-1990s after requirements on municipal waste planning and producer responsibility were introduced for a number of different groups of products, for example packaging, waste paper, office paper and tyres. A tax on waste sent to landfill was introduced in 2000, and a ban on the landfilling of separated combustible and organic material has subsequently been introduced. The collection of methane gas from landfills for energy recovery started at the end of the 1990s, aided by investment subsidies and the fact that measures in many cases proved cost-effective.

Landfilling of household waste has overall decreased by almost 60% since 1993. Large parts of this waste are instead incinerated with energy recovery. The extent to which biological treatment methods such as digestion and composting are applied has also increased. Introduced policy instruments in the area of waste are estimated to reduce methane release from landfills by 1.4 million tonnes of carbon dioxide equivalent emissions in 2010 and to amount to 1.9 million tonnes by 2020.

Agriculture

At present there are no policy instruments in the agricultural sector that are directly aimed at reducing emissions of methane and nitrous oxide. But the EU's Common Agricultural Policy has a significant bearing on the extent, orientation and profitability of agriculture. The present-day formulation of subsidies reduces greenhouse gas emissions from agriculture. The Swedish Board of Agriculture has been working on an action programme since 1980 to reduce losses of plant nutrients, which in turn reduces the release of methane and nitrous oxide from manure management and agricultural soil.

Land use, land-use change and forestry

There is legislation in forestry that has an indirect impact on forestry in the direction of increased carbon sequestration. Provisions on forest stewardship contribute to forestry methods that reduce greenhouse gas emissions. New forest reserves including voluntary set-asides contribute to increased carbon stock in forest biomass. The objective in Sweden is for a further 900 000 hectares of forest to be protected by 2010 in comparison with 2000, when total set-asides amounted to approximately 850 000 hectares of productive forest land.

The project-based flexible mechanisms under the Kyoto Protocol

Sweden has committed itself in work related to the flexible mechanisms of the Kyoto Protocol to bring about cost-effective emission reductions, gain early experience and contribute towards the mechanisms being developed into credible climate policy instruments.

The Swedish government takes part in two multilateral CDM/JI[4] funds, the Prototype Carbon Fund

[4] Clean Development Mechanism/Joint Implementation

(PCF) and Testing Ground Facility (TGF), and is committed to the SICLIP (Swedish International Climate Investment Programme), which is a CDM/JI programme. The total sums invested in the funds and in SICLIP are expected to lead to the acquisition of emission reduction units over the period 2008-2012 amounting to around 5 million tonnes of carbon dioxide equivalent, i.e. around 1 million tonnes of carbon dioxide equivalent a year.

1.3 Projections and the total effect of policies and measures

Projections

Projections of greenhouse gas emissions focusing on 2010 and 2020 have been produced. The projections are based on the instruments that have been adopted by the Swedish parliament up to 2004[5]. Total greenhouse gas emissions in 2010, excluding the land use, land-use change and forestry (LULUCF) sector are forecast to be 1% lower in 2010 than the 1990 level, which indicates that Sweden's commitments according to the Kyoto Protocol and EU burden sharing agreement can be fulfilled with policies and measures already adopted. If Sweden only reports emissions from land use, land-use change and forestry, according to the mandatory Article 3.3 of the Kyoto Protocol, an addition of emissions is obtained and net emissions according to the projections and specific calculations for the LULUCF sector end up in line with the country's commitment. If Sweden chooses additionally to report emissions and removals from forestry in accordance with Article 3.4 of the Kyoto Protocol, net emissions are estimated instead to end up substantially below the country's commitment.

Emissions are estimated to increase after 2010, principally due to the assumption that Swedish nuclear power plants are decommissioned after an operational life of 40 years and are principally replaced by natural gas based power plants. An expected increase in road transport using heavy goods vehicles also contributes to the increase in emissions.

The trend in emissions differs between different sectors of society. Figure 1-4 shows historical emissions, as well as the projections for greenhouse gas emissions from different sectors.

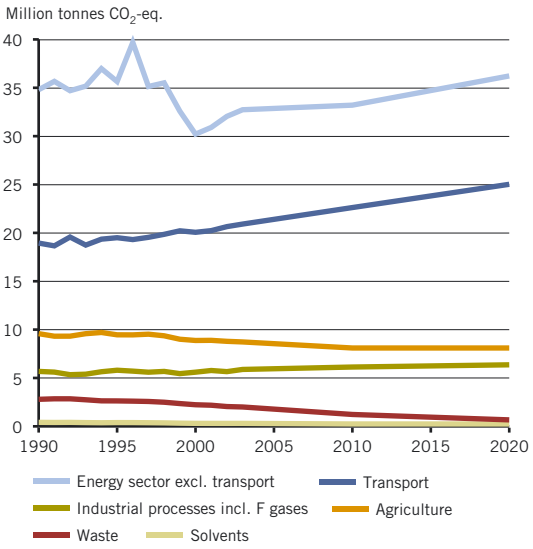


Figure 1-4 **Greenhouse gas emissions per sector over the period 1990 – 2020.**

Carbon dioxide is the greenhouse gas which, according to the projections, will increase most in absolute terms. At the same time emissions of methane and nitrous oxide are expected to decrease, which appreciably reduces the aggregate increase in emissions. Emissions of fluorinated greenhouse gases are estimated to increase over the period of the projections but these continue to account for a small proportion of total greenhouse gases.

Total greenhouse gas emissions from the **energy sector excluding transport** are estimated to decrease by around 5% between 1990 and 2010, but are expected to increase by around 4% by 2020 in comparison with 1990. Greenhouse gas emissions from the production of electricity and district heating including refineries are expected to increase by 36% up to 2010 and by 73% up to 2020 in comparison with the 1990 level of emissions. The greatest increase is expected to come after 2010 and is due to expected increased production in both combined heat and power plants and condensing plants based on natural gas. Emissions from electricity production are expected to more than double by 2010 and be three times higher in 2020 than in 1990, mainly due to nuclear power plants being assumed

Table 1-2 **Historical and projected greenhouse gas emissions from 1990 to 2020 per gas (million tonnes of CO_2 equivalent)**

Greenhouse gas/year	1990	2003	2005	2010	2015	2020	1990-2010	1990-2020
Carbon dioxide	56.3	56.0	56.6	58.3	60.0	63.7	4%	13%
Methane	6.5	5.5	5.2	4.5	4.1	3.8	-32%	-42%
Nitrous oxide	8.9	8.2	8.2	8.0	8.2	8.3	-9%	-7%
Fluorinated greenhouse gases	0.55	0.84	0.82	0.79	0.82	0.85	43%	53%
Total emissions (excl. LULUCF)	**72.2**	**70.6**	**70.8**	**71.5**	**73.1**	**76.6**	**-1%**	**6%**

[5] According to the UNFCCC definition, these projections constitute projections "with measures".

to be decommissioned after an operational life of 40 years and being expected to be replaced principally by natural gas based power plants. Emissions from refineries are expected to increase. Emissions from the residential and service sector are expected to decrease by 56% between 1990 and 2010. After 2010, emissions are expected to decrease more slowly, and in 2020 it is estimated that they will be around 70% below the 1990 level. Emissions from industrial combustion are estimated to increase by 8% up to 2010 and then stabilise.

Total emissions from **industrial processes including fluorinated gases** are estimated to increase by 8% up to 2010 and 12% up to 2020 in comparison with the 1990 level. It is principally carbon dioxide emissions that are expected to increase due to the assumption of high growth in the iron and steel industry. Emissions from the cement industry are also expected to increase.

Emissions from the **transport sector** are estimated in the projections to increase by just over 19% over the period 1990-2010 and by 32% between 1990 and 2020. The total increase in emissions is principally due to increased freight transport of heavy vehicles.

Greenhouse gas emissions from the **waste sector** are expected to continue to decrease to be 56% lower than the 1990 level in 2010. In 2020, emissions are expected to be 76% below the 1990 level. It is the reduced quantity of organic waste sent to landfill that is expected to lead to the reduction in emissions.

Emissions from the **agriculture sector** are forecast to continue to decrease, being 16% lower than the 1990 level in 2010. Methane is expected to decrease by 10% and nitrous oxide by 18%. Fewer cattle contribute to lower methane release. Reduced use of mineral fertiliser, smaller area of cultivated organogenic soils, reduced nitrogen leaching and a changeover to slurry management reduce emissions of nitrous oxide.

Emissions and removals from **land use, land-use change and forestry (LULUCF)** have been projected for 2005, 2010, 2015 and 2020 (see Table 1-3). Felling has increased sharply in recent years as a consequence of increasing demand for forestry industry products. Felling is estimated in the assumptions underlying the projections to be at the maximum of what is regarded as sustainable. Net removals of greenhouse gases therefore decrease over the period up to 2020.

Table 1-3 **Projection of emissions and removals of greenhouse gases in the LULUCF sector (million tonnes of carbon dioxide)**

	2005	2010	2015	2020
Removals in forest biomass	17.7	17.2	14.0	10.9
Emissions from agricultural soil	3.8	3.8	3.8	3.8
Net removals	13.9	13.4	10.2	7.1

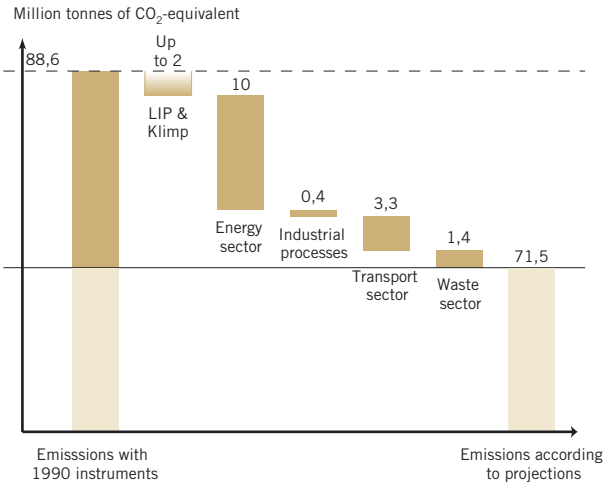


Figure 1-5 **Aggregate effects in 2010 of introduced instruments in comparison with 1990 instruments by sector.**

Total effect of policies and measures

Effects of individual instruments or groups of instruments in the energy sector, industrial processes, the transport sector and the waste sector have been analysed and quantified and are reported in Chapter 4. In addition to these sector-specific instruments and measures, estimates have been made of cross-sectoral instruments (LIP and Klimp). There may be a certain overlap between the effects of sector-specific and cross-sectoral instruments and measures (LIP and Klimp), but it has not been possible to quantify this.

Altogether, the quantitatively evaluated instruments are estimated to result in up to 17 million tonnes lower carbon dioxide equivalent for 2010 and 47 million tonnes lower for 2020 compared with a scenario in which 1990 instruments have been retained over the whole period. This is equivalent to a decrease in emissions of around 65%. The effects from each sector and the cross-sectoral instruments LIP and Klimp are shown in Figure 1-5.

1.4 Vulnerability assessment, climate-change impacts and adaptations

New climate scenarios build on some of the scenarios used by the IPCC have been developed since the previous national communication (2002). These describe conceivable climate change for Sweden from the period 1961-1990 to the period 2071-2100. In

the scenarios, Sweden's annual mean temperature increases by between 2.5 and 4.5°C. The length of the vegetation period is estimated to increase by between one and two months and in the far south by up to three months. Precipitation is expected to increase by between 5 and 25% over the next century, with the greatest increase occurring in northern Sweden during the winter. However, southern Sweden will have reduced precipitation during the summer months. The intensity of precipitation is expected to increase both where total precipitation increases and where precipitation decreases.

Variations in temperature are estimated to decrease in the winter, principally due to an expected sharp decrease in extremely cold periods. The converse situation applies in the summer, in that diurnal variability may increase somewhat, due to an increase in extremely warm periods.

Climate impacts and vulnerability assessment

Run-off, especially in the autumn and winter seasons, is expected to increase in Sweden as a whole, with an increased risk of flooding. Historically, the built environment has been situated in locations that were safe and with good climatic conditions. However, in recent years, less consideration has been given to these factors in siting new settlements. Buildings have been located in areas at risk of flooding, landslides and mudslides. This applies in particular to areas alongside lakes and watercourses.

The temperature increase reduces the need for energy for heating. As minimum temperatures for the year and 24-hour period are expected to rise, the need for peak capacity for particularly cold periods decrease. Swedish maximum consumption of electricity may be reduced by around 1500 MW (equivalent to two small nuclear reactors) if the most severe winter cold is mitigated by 4°C. Electricity production from hydropower is expected to increase and be more even over the year, but the altered pattern of run-off combined with possible changes in extreme weather increase the vulnerability of power station dams. Increased incidence of extreme weather increases the risk of severe disruption to the distribution of electricity but the consequences can be reduced with sturdier power lines and by burying cables.

The temperature increase projected for the end of the 21st century corresponds to a shift in vegetation zones of between 100 and 500 km. It is anticipated that the ecological impacts will be substantial. For forestry and agriculture the positive impacts may outweigh the negative ones as yield increases with a longer growing season and increased carbon dioxide level. It is difficult to estimate the extent of conceivable harmful impacts, but with suitable plant selection, choice of crop and type of tree cultivation and stewardship methods, it should be possible to prevent vulnerability and utilise positive consequences.

Virtually the whole country apart from the very highest mountain massifs will be below the tree line in the longer term, and the total area of bare mountain is becoming smaller than at any time since the last ice age. It is anticipated that this will have major consequences for ecosystems and for food supply for several species such as reindeer, lemmings and the Arctic fox, already an endangered species in Sweden.

Adaptation measures

It is essential to adapt society to a changed climate because even if massive measures to reduce emissions are taken now it is already too late to completely avert climate change. A state inquiry committee was established in the summer of 2005 to identify how Swedish society can prepare for future climate change. A number of other initiatives have also been taken. A strategy for forest tree breeding that takes account of expected climate change has been developed. Some municipalities have changed their regulations for physical planning and the built environment to take into account rise in water levels and expected flows in the future. A review of the ability of hydropower dams to cope with flooding that may occur as a result of climate change is in progress, and, where technically possible and economically feasible, the safety margins are further increased when reconstruction is carried out.

1.5 Financial resources and transfer of technology

The overall aim of Swedish development assistance policy is to combat poverty. Mitigating environmental impact and climate change and reducing their consequences is an integral part of this overall aim. Swedish development assistance as it relates to climate change is intended to contribute to measures that prevent or minimise greenhouse gas emissions, reduce the vulnerability of poor countries and people to climate change and put them in a better position to adapt to a changed climate. Earmarking of development assistance resources for specifically climate-related initiatives therefore occurs to a very small extent.

In December 2003, the Swedish parliament adopted a new policy for global development inspired in part by the UN's Millennium Declaration and by the environmental conferences in Stockholm, Rio de Janeiro and Johannesburg. According to this policy, Sweden is to strive for just and fair trade rules and contribute to the development of local industry and commerce in developing countries.

Sweden's total development assistance budget has increased over the last few years reaching 0.8% of GNI during the period 2000-2003, which is a high level in comparison with other OECD countries. The budget has since increased further, and for the year 2006 amounts to 1% of the calculated GNI. Sweden is one of the few countries to meet the 0.7% goal.

Around a third of Sweden's climate-related development assistance is channelled via multilateral organisations, primarily the Global Environment Facility (GEF), but also the fund for least developed countries (LDC fund). In December 2004, a decision was taken on a grant of 10 million Swedish kronor to the "Special Climate Change Fund" (SCCF), which is administered by the GEF. Sweden also provides financial support to the World Bank's consultancy funds, regional development banks and the UN Environmental Programme. In addition, Sweden makes contributions to a number of other organisations, including the Consultative Group for International Agriculture Research (CGIAR), the International Union for the Conservation of Nature (IUCN), the Asian Institute of Technology and the World Maritime University.

Swedish bilateral financial support for developing countries and countries with transitional economics is administered by the Swedish International Development Cooperation Agency (Sida), in dialogue with the partner country and on the basis of the country's needs and priorities and of its Poverty Reduction Strategy. When Sweden decides on the activity areas in a partner country, one of the major factors taken into consideration is the contribution to sustainable development. Swedish bilateral support is growing, but the proportion allocated to specific projects or programmes is declining. This trend reduces the opportunities to control how the resources are used and to assess what support is relevant from the point of view of climate. Swedish climate-related bilateral support over the period 2000-2003 amounted to just under SEK 7 billion, including loans of just under 1 billion. Around half the support went to mitigation measures, 30% to adaptation activities in general and capacity building in particular, and the remaining 20% to other activities that are generally relevant to the climate agenda, including support for the development of environmental legislation, and air quality issues. Approximately a third of bilateral support goes to the least developed countries (LDCs).

Several initiatives have been undertaken in Sweden to disseminate new and improved technology more widely and to provide opportunities for different actors to exchange experience and knowledge on how technologies can be used in different contexts. For example, Sweden finances the project Greenhouse Gas Emission Reduction from Industry in Asia and the Pacific (GERIAP) in cooperation with UNEP. The aim of the Swedish Export Credits Guarantee Board (EKN) is to contribute to sustainable development. As part of this work, the EKN introduced an environmental classification system in 2002 and requires an environmental impact assessment for all export projects where there may be a risk of adverse environmental impacts. Climate concerns are an important criterion in the evaluation. EKN's guarantees amount to approx. SEK 50-100 billion and new guarantees of SEK 20 billion were provided in 2004. A large proportion of the export deals to which the guarantees relate contribute directly or indirectly to attaining the goals of the Convention on Climate Change.

1.6 Research and systematic observation

The allocation of public funds to climate-related research over the period 2002-2005 amounts to just over SEK 400 million a year. This research is financed mainly through the government research councils and foundations, as well as by government agencies. The Swedish government underscored the importance of research related to the problem of climate change in the research bill presented in 2005. A social-science institute and a number of centres and research schools focusing on climate have been established as a result of collaboration and co-financing between universities and industry and commerce.

Climate-related research

Swedish climate-related research spans a broad area. Research related to climate processes and climate systems focuses on issues such as the Baltic Sea environment, the role of forests in the climate system and the montane ecosystem as an "early warning system" in a changed climate. Swedish climate modelling has been developed further to-

wards increasingly integrated models that take account of the hydrological cycle, vegetation changes, cloud cycles, radiation and so on.

Greater emphasis has been put on socio-economic research and research on measures. Socio-economic research relates, example, to the development of the climate-change issue and market-based instruments in the international arena, the attitudes of individuals and organisations and how they view measures and issues. Research on measures to reduce emissions is principally concerned with developing new technology to improve efficiency in and make use of renewable energy.

Two major initiatives came to an end during the period, the Swedish climate modelling programme SWECLIM and the EU-subsidised Environment and Space Institute, which funded part of the Swedish impact research in the far north of Sweden.

Systematic observation

Sweden has increased its contribution to the "Global Climate Observing Systems" (GCOS). This includes a number of new activities involving long-term observations and measurements of temperature, precipitation, wave height, ice formation, variations in glaciers and so on. It also contributes to the European Space Agency, which conducts observations with global, regional and national coverage with measurement from satellite-based systems. Sweden also actively participates in the "Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC".

1.7 Education, training and public awareness

The greenhouse effect is a familiar concept to the Swedish population and the level of awareness on the issue has increased. Nine out of ten people know that the burning of fossil fuels is a principal cause of the greenhouse effect. Attitudes towards taking individual action to address climate change are becoming more positive.

Awareness levels among the public peaked between 2002 and 2003, when a national information campaign on climate change was implemented. The campaign cost a total of SEK 60 million. Altogether more than 100 actors in government agencies, municipalities, non-governmental organisations and industry and commerce took part in the campaign activities,, which included advertising in the mass media and other public-relations activities. A special website was launched with more in-depth information on the issue of climate change. Brochures on the greenhouse effect were translated into English and the five major immigrant languages.

In order to maximise the involvement of all stakeholders in the municipalities, all government grants to local action programmes that reduce greenhouse emissions (Klimp) must encompass public education and information efforts.

The public can turn to a number of government agencies and institutions such as the Swedish Environmental Protection Agency, the Swedish Energy Agency, the Swedish Consumer Agency, the Swedish Council for Sustainable Development and the Swedish Meteorological and Hydrological Institute to obtain information on the causes and effects of climate change, research and ongoing work aimed at combating climate change.

2 National circumstances relevant to greenhouse gas emissions and removals

2.1 Government structure

Sweden is a representative democracy, with 349 members of parliament (the Riksdag) elected every four years. The tasks of the Swedish parliament include passing laws and taking decisions on budgets for areas of state responsibility. Sweden's system of government means that the most important political decisions, relating to climate policy and energy policy, are taken by the parliament.

The government has to implement parliamentary decisions, put new bills before parliament, direct state administrative activity and represent Sweden in the European Union. The government is assisted in governing Sweden by the Government Offices, which comprise the Prime Minister's Office, nine specialist departments, an administrative department and the EU representation in Brussels. With effect from 2005, responsibility for climate and energy issues is combined in a newly-formed Ministry of Sustainable Development.

Swedish administration is organised at three levels, central, regional and local. The central level consists of a large number of central agencies, whose task is to be the government's expert body for specific issues and to implement policy adopted by the parliament and the government. However, the agencies also have to monitor and evaluate the effects of political decisions. Responsibility for climate issues is shared between several central agencies, primarily the Swedish Environmental Protection Agency and the Swedish Energy Agency. The Swedish Environmental Protection Agency is responsible for monitoring the national environmental objective of reduced impact on climate, while the Swedish Energy Agency is responsible for implementing the majority of decisions on energy policy.

There are 21 county administrative boards and 290 municipalities for regional and local administration. Swedish municipalities have far-reaching self-government, The municipal administrative board and municipal council are elected by the citizens of the municipality in separate elections which are held at the same time as parliamentary elections.

The Government and parliament decide on how to implement the Framework Convention on Climate Change and the Kyoto Protocol. The county administrative boards and municipalities play a special role in climate policy by formulating and implementing local plans for land use, energy management, transport and waste. Swedish municipalities have been very active in local Agenda 21 work, and many people are also actively involved in action plans for climate-related measures.

No special institutional structures have been introduced as a consequence of the ratification of the Convention on Climate Change and the Kyoto Protocol. The existing national administrative structure has been found to work well in fulfilling the commitments.

2.2 Population profile

The population of Sweden passed the 9 million mark in 2004. It has increased by an average of 0.35% a year since 1990. It is estimated that the Swedish population will rise to 9.7 million by 2020. The population density averages 22 inhabitants per sq.km, but ranges between 3 inhabitants per sq.km in northern Sweden and 100 per sq.km in the south of the country.[1] Sweden's low population density results in long travel distances.

During the 20th century, there was a shift in population up to the mid-1980s from rural areas to the towns and cities. Today 84% of the population live in urban areas, a level that has been stable since 1990. The average household size in Sweden is two persons, which is low in comparison with other countries.

[1] Statistics Sweden BE 12 SM 0501

Table 2-1 **Sweden's population profile**

	1990	1995	2000	2001	2002	2003	2004	2005	2010	2015	2020
Population (million)	8.59	8.84	8.88	8.91	8.94	8.98	9.01	9.06	9.27	9.49	9.72
Aged 0-17 (% of population)	21.9	22.3	21.8	21.8	21.7	21.6	21.6				
Aged >65 (% of population)	17.8	17.5	17.2	17.2	17.2	17.2	17.2				
People per household	2.14		2.01								
Population density (people/sq.km)	20.9	21.5	21.6	21.7	21.8	21.8	21.9				

2.3 Geographic profile

Sweden is an elongated country running in a south-south-west/north-north-easterly direction and located between 55 and 69 degrees north in latitude and between 12 and 23 degrees east in longitude on the Scandinavian peninsula. Sweden is largely surrounded by sea. Over half the land surface is covered in forest. Water, rock, open bog and agriculture each account for around one tenth. Approximately 3% of the land area is covered by buildings. A large proportion of southern Sweden is low-lying, with agricultural land dominating in the far south. The only real mountain chain, with the highest peaks rising to just over 2000 metres above sea level, is in the north-west, along the Norwegian border.

Relatively large areas of land consist of a thin layer of soil on rock. The predominant type of soil is moraine which is suitable for forest production. The agricultural land is located on the marine deposits that are present. Over the last 50 years, 25% of agricultural land has gradually gone over to other land use, principally forestry.

Most of Sweden is subject to uplifting of land as a result of the last ice age, up to a maximum of 85-90 cm per 100 years in northern Sweden, while in the southernmost parts of the country the land level is falling, by about 5-10 cm per hundred years. This lowering of the land level is contributing to erosion along the coastline as the land here consists of easily eroded soils. The coastal erosion is exacerbated by the rise in sea level which is taking place as a result of increased atmospheric temperature.

Facts Geography

Total area:	450 295 sq.km
of which land area	410 335 sq.km
Distance north/south:	1572 km
Distance east/west:	499 km
Highest mountain:	Kebnekaise 2103 m above sea level
Lowest point:	-2.5 metres above sea level
Coast line:	Approx. 50 000 km
Land use:	Forest 52%, mountain 12%, lakes/watercourses 9%, bog 9%, agriculture 8%, other 10%

2.4 Climate profile

The proximity of Sweden to the northern Atlantic and the prevailing south-westerly to westerly winds result in a climate that is mild for the latitude during the winter months. Low pressures produce a climate with fairly abundant precipitation all year round. Long periods of dry weather may occur when high-pressure areas push depression fronts to the north and/or south of Sweden. Most of the country has a cold temperate climate with winters bringing heavy snowfalls.

The average temperature in January for the period 1961-1990 was 0°C in the far south, while the coldest valleys in inland areas of northern Sweden had an average temperature of -16 to -17°C. The average temperature in July reached a maximum of about 17°C, principally in south-eastern Sweden.

Precipitation falls throughout the year, but is heaviest in the summer and autumn. As most lows move in across the country from the west or south-west, the western parts of the country receive the heaviest precipitation. In the mountains close to the Norwegian border there are local annual precipitation levels of 1500-2000 mm. South-western Sweden contains the country's wettest inhabited areas, with a normal annual level of precipitation of 1000-1200 mm. Annual precipitation is otherwise generally 500-800 mm. The lowest annual precipitation occurs on smaller islands along the Baltic Sea and in enclosed valleys in mountain districts, at just under 400 mm.

Over the period 1991-2004 the average temperature rose by almost one degree compared with the period 1961-1990, with signs of a sharper increase in the eastern parts of the country. The increase is most pronounced for the winter period, at just over two degrees in the central and northern parts of the country. The increase is less noticeable for the autumn, with almost unchanged temperature locally, particularly in south-western Sweden.

Precipitation also increased over most of the country, in some places by 15-20%. However, there was almost no increase in the eastern part of central Sweden, indicating slightly different tracks for low-pressure areas over the last 14 years in comparison

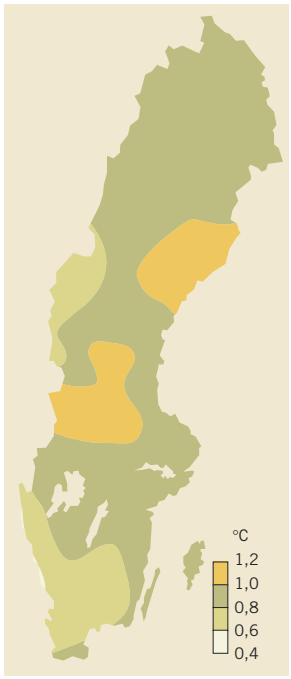


Figure 2-1 **Difference in annual mean temperature 1991-2004 compared with the period 1961-1990 (°C).**

Figure 2-2 **The relationship between annual mean precipitation in 1991-2004 and in the period 1961-1990 (%).**

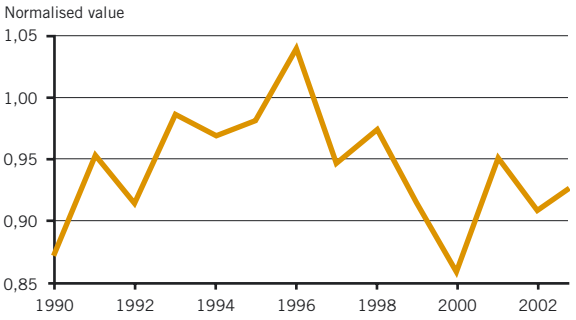


Figure 2-3 **Energy index in the period 1990-2003 for Sweden weighted according to the geographical distribution of the population**

with 1961-1990. Precipitation increased in all seasons apart from autumn, when it tended to decrease over most of the country.

Genuinely severe storms with very extensive uprooting of trees are rare, and it is difficult to identify trends for them. However, on 8-9 January 2005 a storm with hurricane-force winds occurred in southern Sweden with by far the greatest number of uprooted trees in the last hundred years. The period 1991-2004 did not, however, contain such severe storms as that between 1961 and 1990.

The energy required to heat buildings varies with outdoor temperature and wind conditions and fluctuated sharply over the period 1990-2003. This is illustrated in Figure 2-3 by an energy index[2] according to the geographical distribution of the population. 1990 and 2000 were very warm years with a requirement for heating which was 8 and 9% lower respectively than the average for the period 1966-1995. In 1996 the heating requirement was 4% above, resulting in increased fuel use and the highest carbon dioxide emissions over the whole period since 1990.

2.5 Economy

Sweden's economic growth was very weak during the first half of the 1990s, but annual growth since 1994 has been 2-4%. The most rapid increase in GDP took place over the period 1998-2000. Economic growth in 2004 stood at 3.5%, the highest figure in the first decade of the 21st century. Population growth since 1990 has been substantially lower than economic growth, which has led to a stable increase in prosperity measured as GDP per capita. Private consumption accounts for just under 50% of GDP and increased most sharply between 1996 and 2000, with annual growth of just under 3%. Household consumption on average has grown by 1.7% a year since 2000.

The shares of exports and imports in GDP have increased since 1990. Exports today account for just over 45% of Swedish GDP, which is an increase of almost 20 percentage points since 1990. The sharp growth in exports means that Sweden's foreign trade showed a surplus of 20% for the years following 1990. Investments today are equivalent to 16-

Table 2-2 **Macroeconomic data for Sweden, fixed prices in 2000 (billion kronor)[3]**

	1990	1995	2000	2001	2002	2003	2004	Increase 1990-2004 %/year	Increase 2001-2004 %/year
GDP	1 801.6	1 870.7	2 195.0	2 217.9	2 261.8	2 294.9	2 381.2	2.01	2.39
GDP per capita (SEK)	210 545	211 977	247 450	249 369	253 470	256 232	264 766	1.65	2.02
GDP per capita (USD 2000 PPP)	22 910	23 066	26 926	27 135	27 581	27 882	28 810	1.65	2.02
Private consumption	930.5	921.3	1 078.4	1 082.8	1 098.0	1 114.9	1 138.6	1.45	1.69
Public consumption	539.7	563.4	583.4	588.6	602.1	606.7	610.9	0.89	1.25
Exports	477.6	659.6	1 012.1	1 016.7	1 029.1	1 080.9	1 196.2	6.78	5.57
Imports	516.6	586.8	884.4	861.5	845.2	886.4	949.1	4.44	3.28
Gross investments	373.6	303.2	389.0	384.9	374.9	369.2	390.3	0.31	0.47

[2] Energy index weighs together the effects on the heating requirements of buildings during a year of hours of sunshine, wind conditions, temperatures and the energy properties, location and area of use of buildings.

[3] Statistics Sweden, National Accounts.

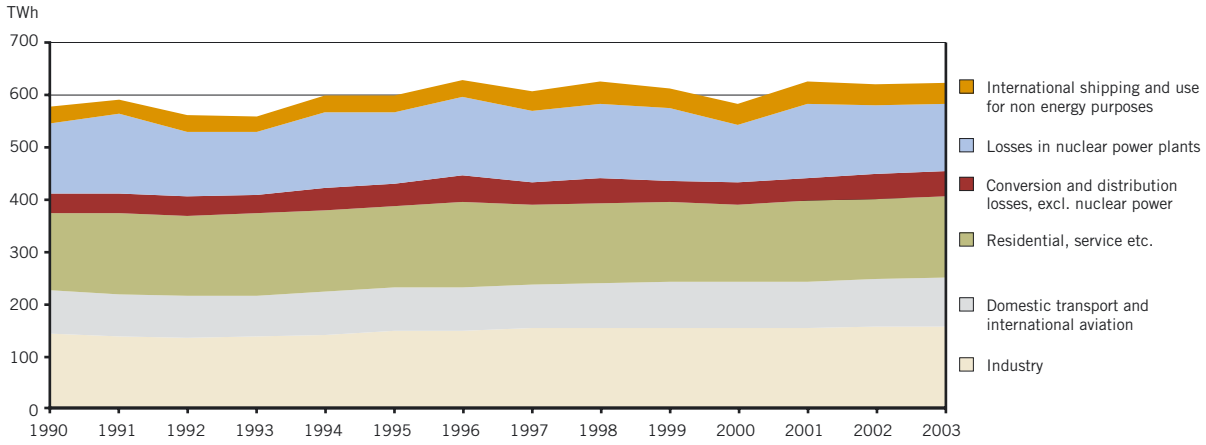


Figure 2-4 **Total energy use in Sweden by sector.**

Table 2-3 **Sweden's industrial structure as percentage shares of GDP (2002)[3]**

Sector	% of GDP
Manufacturing industry	20.8
of which:	
- Chemical industry	2.6
- Steel and metalworks	1.0
- Forestry industry	1.9
- Engineering industry	9.6

17% of GDP, which is lower than for many other industrialised countries. Investments increased in 2004 after three successive years of falls.

The international economy has become stronger in recent years, and demand is favourable for Swedish export industry, which is considered to enjoy competitiveness. It is anticipated that exports will continue to grow in the future, but at a lower rate than in recent years. The growth in GDP is expected to continue to be at a relatively high level.

Swedish manufacturing industry, which accounts for 20% of GDP, is capital-intensive and highly export-oriented. The engineering industry accounts for almost half the value of production.

2.6 Energy

2.6.1 Energy use

Total energy use in Sweden has fluctuated between 560 and 625 TWh since 1990, with a slight upward trend. Final energy use accounts for around 65% of total energy use, while the remainder is made up of conversion and distribution losses, bunker oils for international shipping and use for non-energy purposes[4].

Energy intensity, calculated as energy use in relation to GDP, was at a relatively stable level over the period 1990-1995. Energy intensity began to

[3] Statistics Sweden, National Accounts.

[4] Energy use for non-energy purposes consists for instance of use of oils for plastics production.

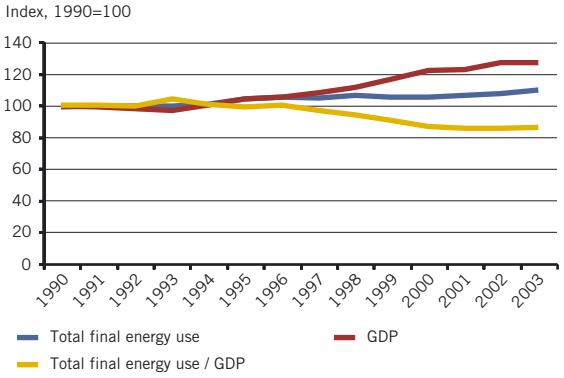


Figure 2-5 **Energy intensity, total energy supply and growth in GDP**

decline from 1995 on. GDP is thus increasing at a faster rate than energy use.

The residential and service sector accounts for nearly 40% of Sweden's total final energy use. Most of this (around 60%) energy is used for heating and hot water. Energy use has been relatively stable since 1990, but the breakdown between different energy carriers has changed. Use of oil products in the residential and service sector has declined from 40 to 25 TWh and has been replaced by heat pumps, district heating and biomass fuels. Household electricity has increased slightly, and electricity for lighting, ventilation and appliances in the service sector has increased by 45%.

Industry accounts for just under 40% of total final energy use in Sweden. The three most energy-intensive industry sectors[5] account for two-thirds of total energy use in the industrial sector. Electricity and biomass fuels dominate energy supply in the industrial sector with around 35% each in 2003. Use of biomass fuels has increased slightly. The share of oil averaged 15% between 1990 and 2003.

Energy use by the transport sector is entirely dominated by oil products. Domestic transport accounted for 23% of the country's total final energy use in 2003. The share of this sector in energy use

[5] The paper and pulp industry, iron and steel and the chemical industry.

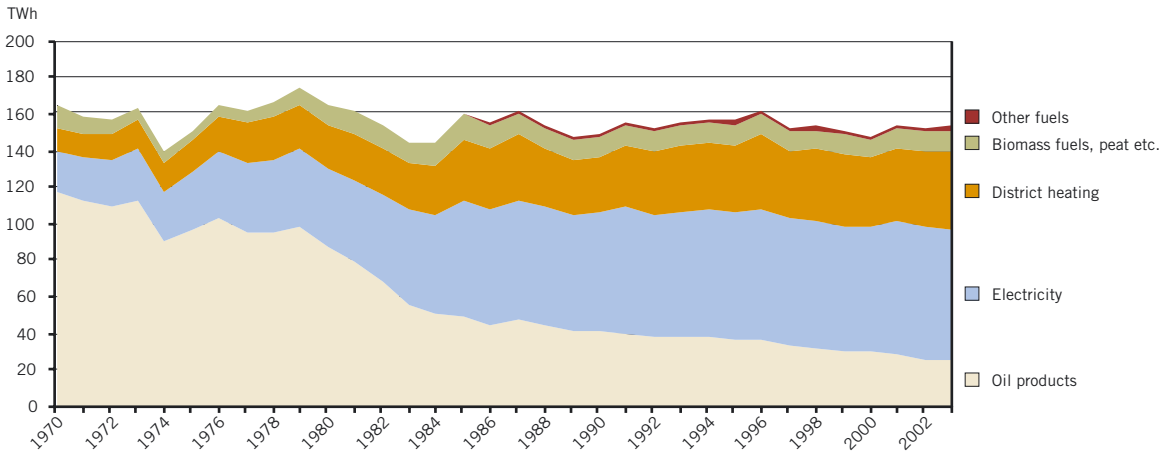


Figure 2-6 **Final energy use in the residential and service sector by energy carriers.**

has increased steadily since 1990, when it was just under 21%.

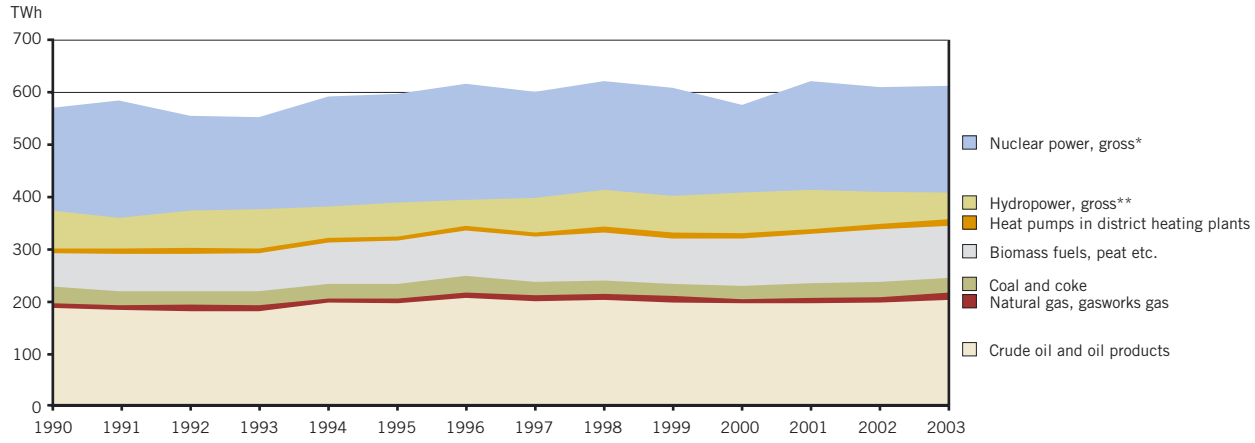
Production in Swedish refineries has increased by more than 10% over the last decade, but energy use has increased even more due to new environmental requirements to be met by the products which necessitate greater input of energy.

2.6.2 Energy supply

Crude oil and oil products account for around a third of the primary energy supply in Sweden. Nuclear fuel[6] and hydropower together account for 40%. The share of biomass fuels has increased and in 2003 amounted to around 17% of Sweden's primary energy supply, which is high by international standards. Infrastructure for natural gas at present only exists in south-western Sweden, and natural gas accounts for 2% of Sweden's primary energy supply.

Nuclear power on average accounted for 45% of Swedish electricity production and hydropower for an average of 47% between 1990 and 2003. The Barsebäck plant, one of Sweden's four nuclear power plants, has been phased out with the shutdown of the first reactor in 1999 and the second in May 2005. The shutdown of Barsebäck 2 signifies a loss of production of around 4 TWh. Remaining electricity production principally takes place in combined heat and power plants, and this accounted for an average of 7% of total energy production over the period 1990-2003. The fuels used are biomass fuels, oil, coal, coke and blast-furnace gas.

Transmission capacity for electricity between Sweden and neighbouring countries has increased as cables across the Baltic Sea have been expanded. Electricity trading in the Nordic region has increased since the Nordic electricity market was deregulated in 1996. Electricity production in the Nordic countries is partly based on different energy sources and is therefore affected to differing degrees by inflow to hydropower. The possibility of importing electricity from neighbouring countries represents a cost-effective way of utilising the combined production capacity of the different countries since electricity trading reduces



* According to the method used by the UN/ECE for calculate supply from nuclear power, wich means that conversion losses are included.
** Including wind power up to 1996.

Figure 2-7 **Sweden's primary energy supply per energy carrier (excluding electricity imports and exports).**

[6] Reported according to UN/ECE method, which means that energy-conversion losses in nuclear power plants are included.

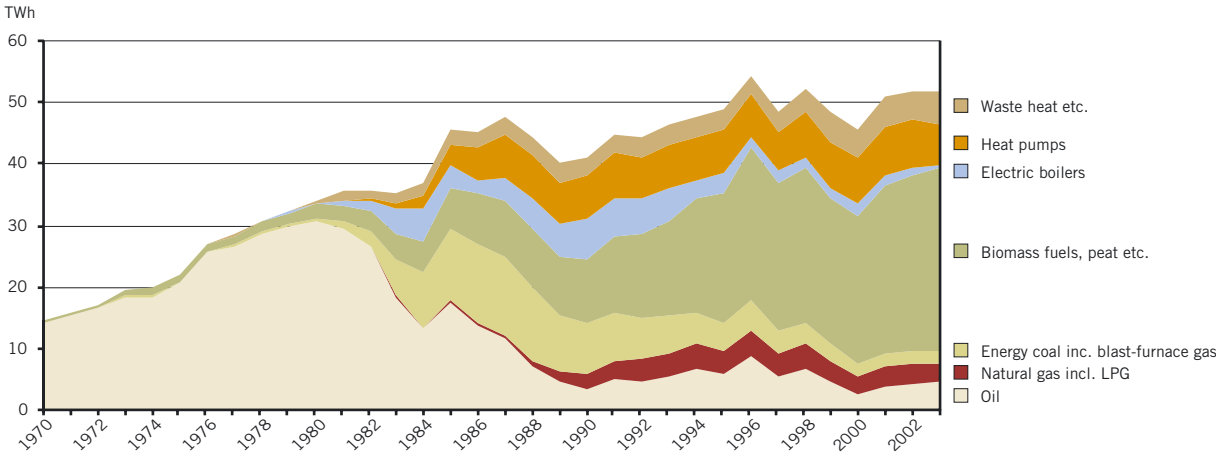


Figure 2-8 **Energy supplied for district-heating production.**

the need for production from power plants with the highest electricity production cost.

District heating accounts for just over 40% of heating supply and is available in 570 of the just under 2000 urban areas in Sweden[7]. Total energy supply in district heating amounted to 56 TWh in 2003, which is an increase of around 36% compared with 1990. Apartment buildings in Sweden have had central heating with water-borne heating distribution for many years. Oil was the dominant fuel in the 1980s, but biomass fuels[8] have taken over and in 2003 accounted for around 60% of fuel used for district-heating production. Logging residuals from the forestry industry are used to a great extent, but household waste also represents an important fuel. The proportion of district heating produced in combined heat and power plants was 30% during the 1990s and up to 2001 and then increased sharply to 40% for 2003.

2.7 Transport

The development of transport is affected primarily by economic development, population development and employment. Infrastructure development is also significant for transport. Increased access to high-speed transport has resulted in a decline in the proportion of people living in urban areas and increased commuting distance between work and home.

The Swedish road network has around 139 000 km of public roads. In addition, there are 285 000 km of smaller private roads which to a large extent are used for forestry purposes. Roads and streets occupy around 1% of the land area of Sweden, and are increasing by around 0.3% a year. The length of the Swedish rail network is around 17 000 km.

In the Swedish road-traffic system, total consumption of petrol in 2003 amounted to 5.2 million m^3 and for diesel to 2.6 million m^3. Consumption of petrol has decreased slightly since the early 1990s. Consumption of diesel, on the other hand, has increased by more than 50%, principally as a result of an increase in freight carried by heavy goods vehicles. Bioethanol has started to be used as a motor fuel in the 2000s, with an increase in volume of almost 600% between 2001 and 2003. Of the quantity of ethanol consumed, 85% is used as a low admixture (5%) in petrol. Use of RME (biodiesel) has also increased, but this fuel is used on a far smaller scale than bioethanol.

2.7.1 Passenger transport

Domestic passenger transport has increased by approximately 12% since 1990. Transport activity by road accounts for around 90% of total transport activity. Rail traffic has increased most in percentage terms since 1990.

International transport measured in passenger kilometres has increased by 80% since 1985. International journeys have increased in both number and length. Leisure journeys, which make up a quarter of international travel, account for the

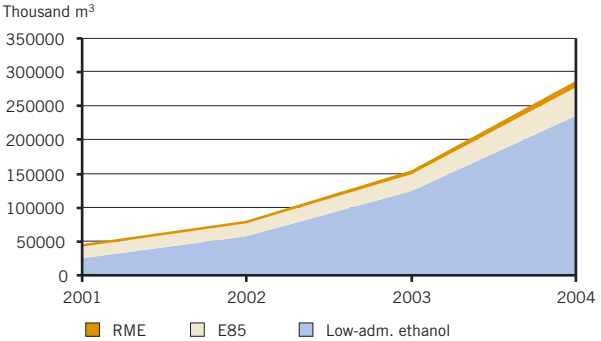


Figure 2-9 **Delivered quantity of ethanol and RME for vehicle operation[9].**

[7] Swedish District-Heating Association (Svensk Fjärrvärme)
[8] Includes waste but not peat
[9] Statistics Sweden, Monthly fuel, gas and inventory statistics

greatest increase. Most international journeys take place with aircraft as the principal mode of transport, with cars as the second most common mode of transport.

The weight and engine power of the Swedish vehicle population is steadily increasing. In 1990 more than 80% of passenger cars weighed less than 1 400 kg. In 2003 these cars accounted for less than 60%. The average engine power of newly registered cars today is 101 kW, compared with 81 kW in 1990. This has resulted in specific carbon dioxide emissions of new cars in Sweden (grams per km) not decreasing since 2000, despite more fuel-efficient engines.

The total number of what are known as 'green cars', which are powered entirely or partially by electricity, gas or ethanol, has increased sharply in recent years[10], a trend which is expected to continue. New additions in 2004 amounted to just under 7 000 cars, equivalent to 2.5% of new-car sales.

2.7.2 Freight transport

Swedish freight transport in terms of volume is dominated by imported raw materials and export products related to the mining industry and forestry. Types of freight with low added value are chiefly transported by rail or ship, as in the past. New transport flows, on the other hand, principally go by truck and also to a small but rapidly increasing extent by air. This has resulted in a decline in the relative significance of the railways and shipping over the course of time. Total freight transport activity in Sweden increased by just over 14% between 1990 and 2002. The increase for freight carried by road is 25%. The reason for the sharp increase in freight transport by road is that the freight is transported over ever longer distances. This is driven by geographical spread of the goods production and a globalised consumer market. One explanation for this may be that the cost of transporting goods by road represents an ever smaller proportion of the value of the transported goods.

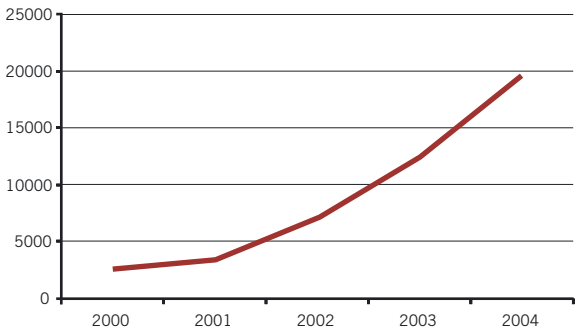


Figure 2-10 **Number of green cars in Sweden in 2000-2004**

[10] Electric, hybrid, gas-powered and ethanol-powered vehicles, www.miljofordon.se

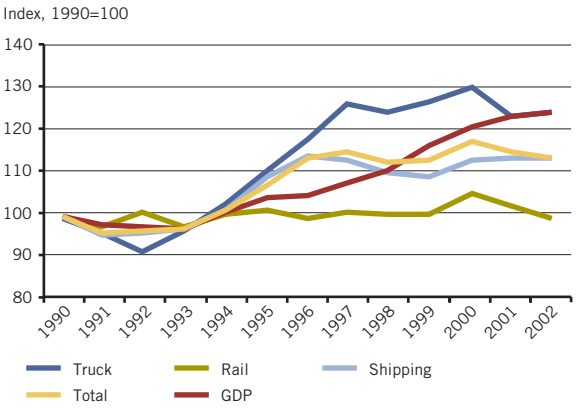


Figure 2-11 **Comparison between development of GDP and freight transport.**

International freight transport is dominated by shipping. More than 80% of the total goods flow in tonnes arrives or departs by cargo ship. On the other hand, in terms of value, truck traffic is the most important mode of transport for international trade. Between 50 and 60% of international trade measured in Swedish kronor is carried by truck.

2.8 Industry

The Swedish industrial structure is characterised firstly by activities in the forestry industry and metal production based on raw materials and energy and secondly by knowledge-based activities in the chemical industry and the engineering industry.

Constant structural transformation is taking place in trade and industry. An increased degree of structural change towards more knowledge-intensive production has taken place since the mid-1990s. The relatively rapid development of production in knowledge-intensive industry has been principally due to strong demand for products from the telecommunications and pharmaceutical industries. Manufacturing industry, the agricultural and forestry sectors, fisheries and electricity, gas, heating plants and water works accounted for 33% of total production in trade and industry in 2002. The remaining 67% originates from the rest of trade and industry, which primarily produces services.

The energy-intensive sectors[11], which to a great extent are capital-intensive, have been affected by change within the structure. In the pulp and paper industry and the iron and steel industry, production has been concentrated on fewer but larger and more efficient production units. In addition, more and more value has been added to the products. A significant proportion of the production of the pulp and paper industry and the iron and steel industry is exported.

[11] Mining industry, pulp and paper industry, non-metallic mineral products industry, iron and steel industry and metalworks

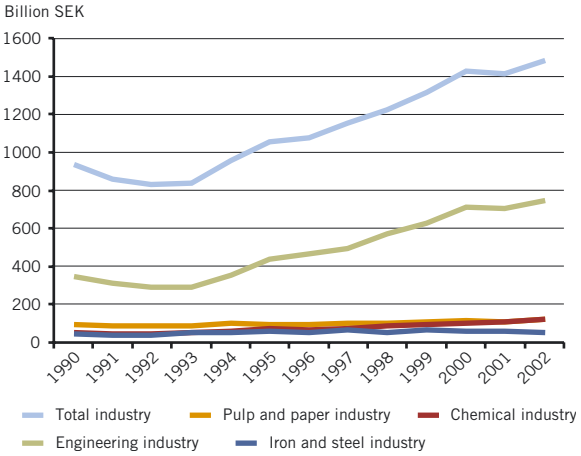


Figure 2-12 **Industry production value 1990-2002 (year 2000 price levels).**

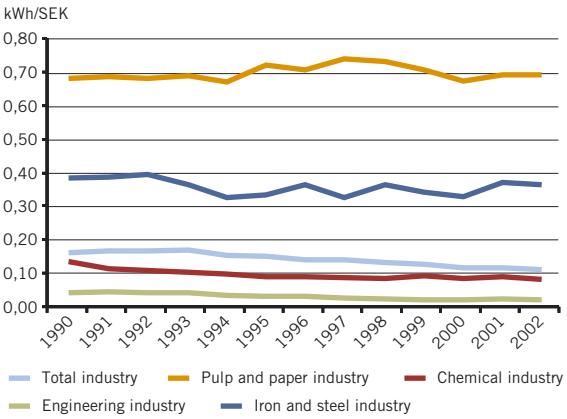


Figure 2-13 **Specific energy use per SEK of production value (year 2000 price levels).**

There was a significant increase in productivity in manufacturing industry in the 1990s, particularly for the engineering industry. The increase in productivity is due in particular to information and communication technology in the engineering industry.

The high rate of growth for engineering products compared with energy-intensive basic industry since the end of the 1990s, principally due to increased export demand, has led to a structural transformation towards somewhat reduced energy intensity in the manufacturing industry.

2.9 Building stock and urban structure

The total heated area of buildings in 2003 amounted to 686 million sq.m. There were 1 985 000 detached and semi-detached houses and 2 365 000 apartments in apartment buildings.[12] The number of apartments increased by 7% between 1990 and 2002. Most dwellings were built at the start of the period. As well as dwellings gradually increasing in number, they are gradually becoming larger. This is driving up the energy requirement for heating. The average residential floor space for all detached and semi-detached houses in 2003 was 110 sq.m. The average for newly-built detached and semi-detached houses was 122 sq.m, which represents an increase of 12% in 10 years. The average residential floor space per capita in the 1990s rose from 41 sq.m to just over 43 sq.m.

Table 2-4 **Average residential floor space for detached and semi-detached houses by year of construction[13]**

Year of construction	Residential floor space (sq.m)
2000-2003	122
1995-1999	111
1990-1994	109

Of the current housing stock, 80% was built before 1980. In 2003 there were around 88 000 industrial buildings in Sweden, together making up a total floor space of 120.5 million sq.m. Of this figure, 14.5 million sq.m was added during the period 1990-99. In 2003 there was also 160 million sq.m of other premises[14], of which 6.8 million sq.m was added over the period from 2002 to 2004[15].

2.9.1 Energy use in buildings

Energy for heating dominates energy use in buildings in Sweden. Household electricity etc. is also significant, however. The use of household electricity has increased over the period since 1990 despite technical development which has led to improvements in the efficiency of domestic appliances.

Changes in the form of energy for heating detached and semi-detached houses were small over the period 1990-2002. Heating is based solely on electricity in more than a third of detached and semi-detached houses. Oil use decreased over the period and has been principally replaced by biomass fuels, ground and geothermal heat pumps and district heating.

District heating has dominated the heating of apartment buildings in the last 20 years, and the proportion increased from 67% in 1990 to 77% in 2002. Commercial premises were heated to 58% by district heating in 2002.

The average energy efficiency[16] for newly-built detached and semi-detached houses has improved by around 20% over the past two decades. An average of 129 kWh/m^2 is used in detached and semi-detached houses built over the period 1996-2001, compared with 146 kWh/m^2 in detached and semi-

[12] Statistics Sweden, Housing and building statistics yearbook

[13] Source: General assessment of real estate in 2003 (www.scb.se)
[14] Statistics Sweden EN 16 SM 0404
[15] Statistics Sweden BO 14 SM 0501
[16] Includes energy used per sq.m for heating, hot tap water and building electricity

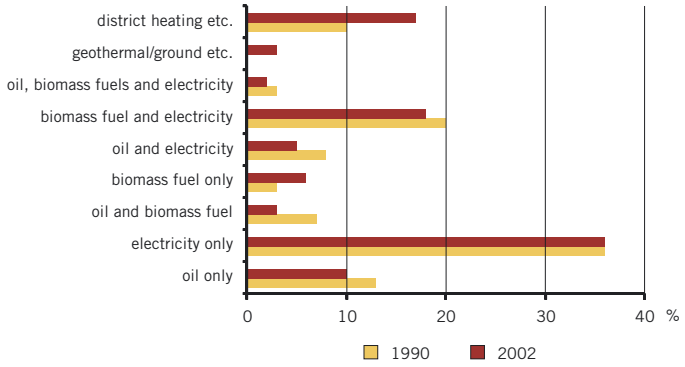


Figure 2-14 **Energy use for heating in houses in 1990 and 2002[17].**

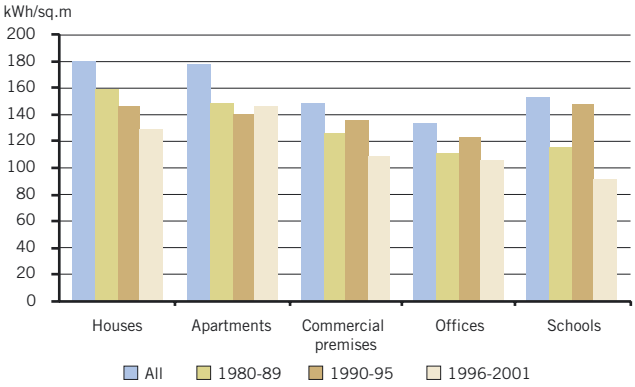


Figure 2-16 **Energy use in 2002 in residential and commercial buildings constructed 1980-89, 1990-95, 1996-2001 and in all buildings of the various categories[19].**

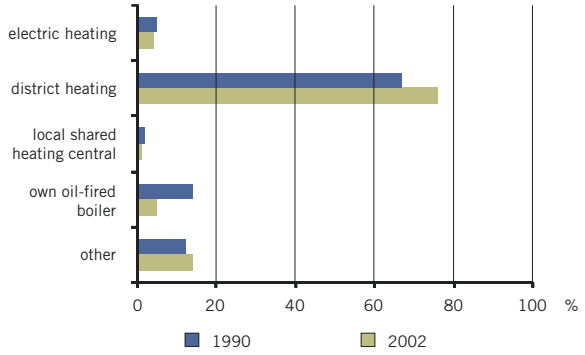


Figure 2-15 **Energy use for heating in apartment buildings in 1990 and 2002.**

detached houses built in 1990-95 and 159 kWh/m² in detached and semi-detached houses built in 1980-89. On the other hand, just as much energy per sq.m is used for heating in new apartment buildings as in blocks built during the 1980s and 1990s.

2.9.2 Urban structure

Urban areas have expanded by over 50% in the last 40 years, while the population over the same period has increased by 37%[18]. This means that more land per person is being used for homes, infrastructure and services. The rate of expansion of urban areas declined between 1990 and 2000, with an increase of 3.7% while the population increased by 4.2%. A structural change now in progress in urban areas is the opening of out-of-town shopping centres. The share of out-of-town trading in retail sales has increased sharply since 1990, and new shopping centres are constantly being added, while many local food stores are being closed down. These changes in the urban structure may increase the need for ever longer journeys in everyday life.

2.10 Waste

Sweden's waste policy is aimed at preventing waste from arising, increasing re-use and recycling, reducing landfilling and reducing the environmental impact of various forms of waste management.

The quantity of household waste in Sweden in 2003 amounted to a total of 4.2 million tonnes, which is equivalent to around 470 kg per person. Household waste consists to just over 40% of food waste, just over 20% packaging, 8% newspapers and magazines, 7% garden waste, 5% nappies, 4% other combustible waste, 2% textiles and 9% other waste[20]. Most of this goes for incineration or material recovery. The quantity of household waste has increased 2% a year over the last 10-year period, but the quantity sent to landfills has decreased.

The quantity of waste in manufacturing industry amounted to around 19 million tonnes in 2002 and in the mining industry to around 54 million tonnes.

Table 2-5 **Quantity and treatment of waste in Sweden in 2002[21]**

TREATED QUANTITIES OF WASTE IN 2002 (ktonnes)	Household waste (excl. household hazardous waste)	Hazardous waste	Other waste	Total
Material recovered	1 295	171	2 906	4 372
Incinerated	3.5	60	31	95
Incinerated with energy recovery	1 675	12	6 296	7 984
Landfilled	825	299	55 517	56 641
Bunded	0	1.5	0	1.5
Biologically treated	354	13	816	1 184
TOTAL	**4 153**	**572**	**65 567**	**70 292**

[17] Statistics Sweden Bostads- och byggnadsstatistisk årsbok (Housing and building statistics yearbook). In addition to district heating, the item of district heating etc. includes gas and other combinations of forms of heating not indicated in the diagram, such as combinations with heat pumps.

[18] Statistics Sweden, Markanvändningen i Sverige (Land use in Sweden), 2004

[19] Statistics Sweden Bostads- och byggnadsstatistisk årsbok (Housing and building statistics yearbook)

[20] Swedish Association of Waste Management, Utveckling 2005:5

[21] Internationell rapportering av avfallsdata 2004 (International reporting of waste data in 2004, Swedish Environmental Protection Agency

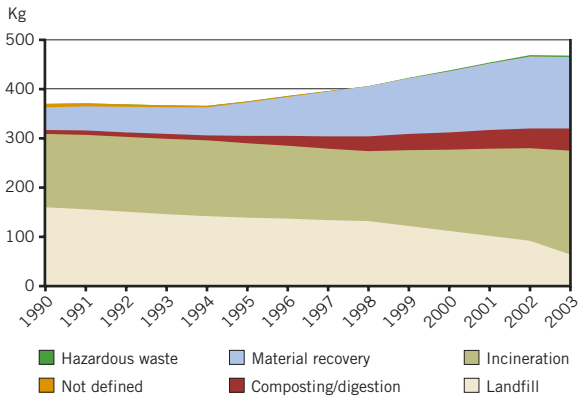


Figure 2-17 **Treated quantity of household waste per person in Sweden 1990-2003[22].**

Just over 40% of manufacturing industry waste went for material recovery and just under 40% to incineration with energy recovery.

The landfilling of combustible and organic waste has decreased substantially while recycling has increased. In Sweden, the heat from all installations that incinerate waste is utilised in the local district-heating networks. Landfill gas for energy recovery equivalent to around 440 GWh was collected in 2003, while around 65 GWh was destroyed.

2.11 Agriculture

Cultivated land amounts to around 2.7 million hectares, just over 6.5% of the total land area of the country. The conditions for agriculture vary widely. The growing period in the south is nearly 100 days longer than in the north.

Structural development in agriculture over recent decades has resulted in fewer but larger farms. As investments in technology have steadily risen, many farmers have specialised in areas such as cereals, milk production and pig rearing. The value of Swedish agricultural products, including direct subsidies, amounted to around SEK 44 billion in 2003, equivalent to less than 1% of the country's GDP.

The value of crop production is estimated to have amounted to SEK 19.3 billion in 2003, in which the value of cereals and fodder crops accounted for SEK 7.5 and 5.3 billion respectively. The value of livestock production is estimated to have amounted to SEK 21.1 billion, in which milk, beef cattle and pigs accounted for SEK 9.9, 4.5 and 3.3 billion respectively.

Swedish arable farming is dominated by the cultivation of cereals, principally barley, wheat and oats, and by the growing of forage crops. Cereals are grown on 42% of the arable acreage. The differing climatic conditions in the various parts of the country affect the distribution of crops across the country. In the north, the principal crops grown are forage crops, green fodder and fodder seed. Production of wheat, barley and rye is concentrated on the plains of central and southern Sweden. The acreage under cultivation has decreased, and among the soils taken out of production there are organogenic humus soils, which reduces the release of carbon dioxide from the land.

There were around 1.6 million cattle in Sweden in 2004, of which 404 000 were dairy cows. Restructuring in milk production has led to a decrease of around 15% in the number of dairy cows over the last ten years, but the average yield per cow has greatly increased at the same time. This trend is expected to continue over the next few years. The decline in the number of dairy cows has created scope for specialised rearing of beef cattle, which has increased.

Table 2-6 **Number of farms by arable acreage[23]**

Acreage (hectares)	1990	2000	2004
2.1–5.0	14 957	11 784	9 176
5.1–10.0	19 020	14 110	11 224
10.1–20.0	20 832	15 453	12 926
20.1–30.0	12 177	8 717	7 386
30.1–50.0	14 223	10 624	9 054
50.1–100.0	11 348	10 652	9 906
100.1–	4 003	5 458	6 129
Total	**96 560**	**76 798**	**65 801**

Table 2-7 **Distribution of arable acreage by crops, thousands of hectares[24]**

	1990	2000	2004
Cereals, total	1 336	1 229	1 126
Legumes	33	37	43
Oil-seed crops	168	48	84
Forage[1]	970	921	971
Potatoes	36	33	32
Sugar beet	50	56	48
Set-aside	176	248	268
Whole arable acreage	**2 845**	**2 706**	**2 572**

[1)]Incl. silage crops.

Table 2-8 **Number of livestock, thousands[25]**

	1990	2000	2004
Cows for milk production	576	428	404
Cows for rearing of calves	75	166	172
Total cows	**651**	**595**	**575**
Heifers, bulls and steers 1 year and over	543	589	539
Calves below 1 year	524	500	514
Total cattle	**1 718**	**1 684**	**1 628**
Ewes and rams	162	198	220
Lambs	244	234	246
Total sheep	**406**	**432**	**466**
Sows and gilts	221	202	195
Other pigs, 20 kg and over	1 025	1 146	1 095
Other pigs, 20 kg and over	1 009	566	528
Total pigs	**2 254**	**1 914**	**1 818**

[22] Swedish Waste Management Association (Svensk Avfallshantering) 1998, 2002 and 2003

[23] Swedish Board of Agriculture JO 10 SM 0501
[24] Swedish Board of Agriculture JO 20 SM 0402
[25] Swedish Board of Agriculture 2004

2.12 Forestry

The total forest area in Sweden is 27.4 million hectares[26], which is equivalent to 67% of the land area of the country according to the FAO definition. This land area also includes bogland etc. The forest area has not changed significantly since 1990. Half the area of forest is owned by private individuals, up to 20% by private forest companies and up to 30% by the state and municipalities. The proportion of "managed forest land" out of the whole area of forest is 83% (22.7 million hectares). It has decreased somewhat (by around 0.2 million hectares) since 1990, principally as a result of setting aside for reserves. Of the total area of forest, 3-4% was under complete protection in 2000, mostly montane forests in national parks or nature reserves, while 13-14% is not managed because the Forestry Act does not permit forestry on low-productivity land.

The total stock of timber in 1990 was around 2.9 billion sq.m on managed forest land. Increased demand from the forestry industry meant that felling increased sharply between 1990 and 2003, while the level of growth rose modestly. The increase in the stock of timber consequently declined over the same period. The Swedish forestry industry at present imports 10-15% of its raw-material needs.

The total use of biomass fuels from the forests has increased by nearly 30 TWh since 1990 and now accounts for almost 95 TWh. Around a tenth of the biomass fuels used are imported. The area of land on which logging residuals are harvested for biomass fuel purposes was small at the start of the 1990s. It has since grown steadily, and in 2000-2002 logging residuals were harvested on around 25 000 hectares a year, which was around 15% of the felled land area. Ash is returned with the aim of counteracting the acidifying and nutrient-depleting effect in the ground of the harvesting of logging residuals. Ash was returned to 5 000 hectares in 2004.

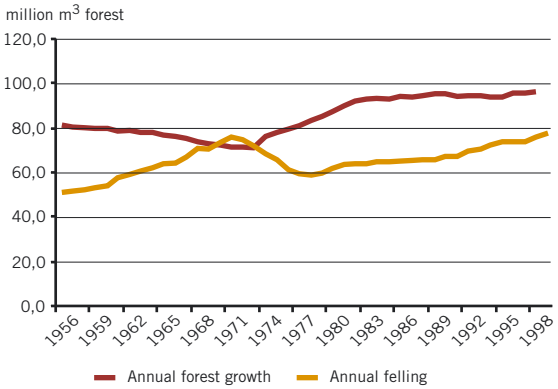


Figure 2-18 **Estimated annual forest growth and felling in Sweden[27].**

[26] Definition according to the UN Food and Agriculture Organisation. If differs from the national definition of forest, which gives 57% forest in the land area and 52% of the total area.

[27] National Board of Forestry: National Forest Survey

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3 Greenhouse gas inventory information

3.1 Total emissions and removals of greenhouse gases

Total greenhouse gas emissions in Sweden,[1] calculated as carbon dioxide equivalent, were just under 70.6 million tonnes in 2003. Emissions decreased by 2.3% or around 1.7 million tonnes between 1990 and 2003. Total greenhouse gas emissions over the period 1999-2003 were below the 1990 level in all cases.

Carbon dioxide removals in forest biomass amounted to 25.3 million tonnes in 2003[2] and emissions from agricultural land were around 3.8 million tonnes of carbon dioxide, which resulted in a sink for the land use, land-use change and forestry sector (LULUCF) of 21.5 million tonnes of carbon dioxide. This is an increase of around 1.2 million tonnes compared with 1990, but the size of the sink varied over the period 1990-2003.

Growth in GDP averaged 1.9% a year over the period 1990-2003[3]. GDP fell during the early nineties and since 1994 has increased by an average of 3% a year. Total emissions of greenhouse gases have not increased as a result of the growth of the Swedish economy during the period, instead emissions overall have been decoupled from growth. Emissions per capita were lower in 2003 than in 1990.

Emissions of greenhouse gases from different sectors of society developed in different directions over the period from 1990 to 2003. The greatest reduc-

Table 3-1 **Emissions of carbon dioxide and greenhouse gas emissions per capita and GDP***

	1990	1995	2000	2001	2002	2003
CO_2 per capita (tonnes)	6.58	6.53	5.91	6.01	6.14	6.25
CO_2 eq per capita (tonnes)	8.44	8.32	7.59	7.68	7.79	7.88
CO_2/GDP (kg/SEK)	0.031	0.031	0.024	0.024	0.024	0.024
CO_2 eq/GDP (kg/SEK)	0.040	0.039	0.031	0.031	0.031	0.031

* GDP in fixed prices, reference year 2000.

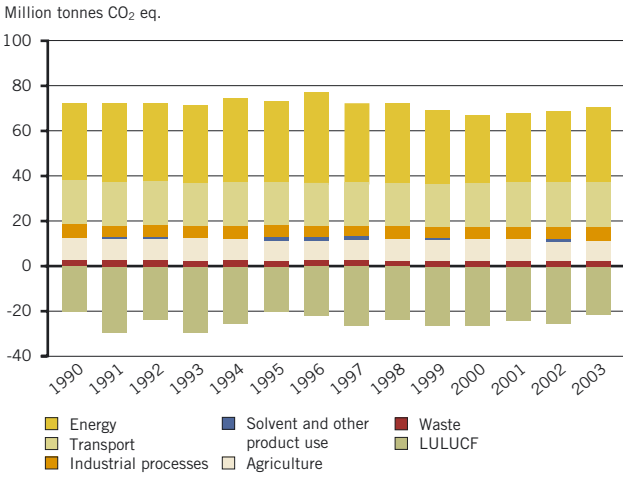

Figure 3-1 **Emissions and removals of greenhouse gases from different sectors.**

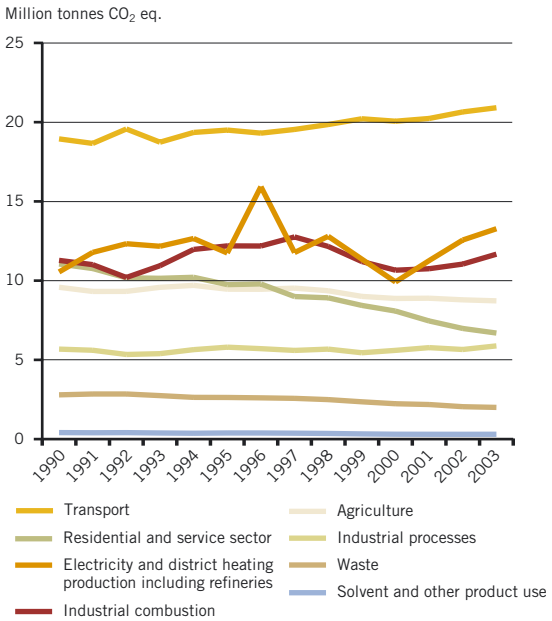

Figure 3–2 **Greenhouse gas emissions from different sectors.**

[1] Swedish Environmental Protection Agency Sweden's National Inventory Report 2005

[2] A new method for calculating the sink will be used with effect from 2006 reporting. The values for the period 1990-2003 will then be recalculated.

[3] Statistics Sweden, 2005 National Accounts.

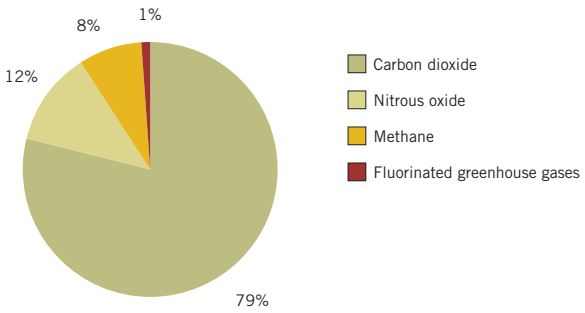

Figure 3-3 **Greenhouse gas emissions broken down by gas, 2003.**

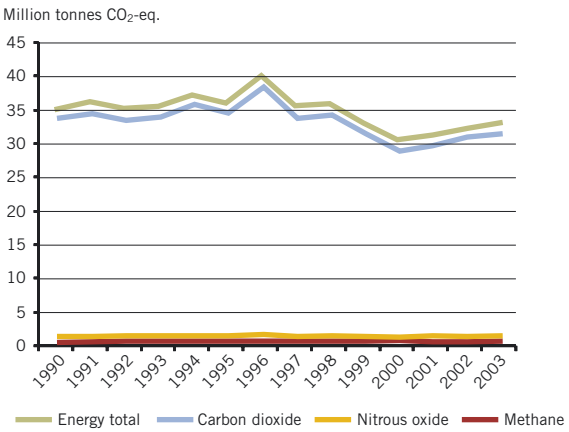

Figure 3-4 **Emissions from the energy sector excluding transport, total and broken down by gas.**

tions in emissions over the period 1990-2003 took place in the residential and service sector, agriculture and waste. Increases in emissions occurred principally in the transport sector.

In 2003, emissions of carbon dioxide were around 56 million tonnes, which is equivalent to around 79% of total greenhouse gas emissions. Emissions of methane were 5.5 million tonnes of carbon dioxide equivalent and account for 8% of emissions, while emissions of nitrous oxide were 8.2 million tonnes, equivalent to around 12%. Only 1% or 0.8 million tonnes of carbon dioxide equivalent out of total greenhouse gas emissions were emissions of fluorinated greenhouse gases. The breakdown between the different greenhouses gas was roughly the same over the period 1990-2003.

3.2 Emissions and removals of greenhouse gases per sector

3.2.1 Energy excluding transport

Emissions of greenhouse gases by the energy sector[4] amounted to just under 33 million tonnes of carbon dioxide equivalent in 2003, which represents 46% of total emissions. Carbon dioxide emissions dominate with 95% of emissions by the energy sector, while emissions of methane and nitrous oxide are small. Emissions by the energy sector vary depending on temperature and precipitation and the state of the economy, but the trend over the period 1990-2003 was a slight reduction in emissions. In comparison with 1990, emissions were 6% lower in 2003 and the decrease is principally due to the use of oil for heating in the residential and service sector having declined.

Calculated in terms of carbon dioxide equivalent, total emissions from electricity and district heating production amounted to 10.6 million tonnes, from refineries to 2.7 million tonnes and from industrial combustion to 11.7 million tonnes in 2003. The emissions of the residential and service sector of 6.7 million tonnes include combustion in the sector and combustion in agriculture, forestry and fisheries. Fugitive emissions from fuels come, for instance, from flaring and amounted to just under 0.8 million tonnes in 2003. Emissions from "other" amounted to 0.3 million tonnes in 2003 and consisted principally of emissions from military transport.

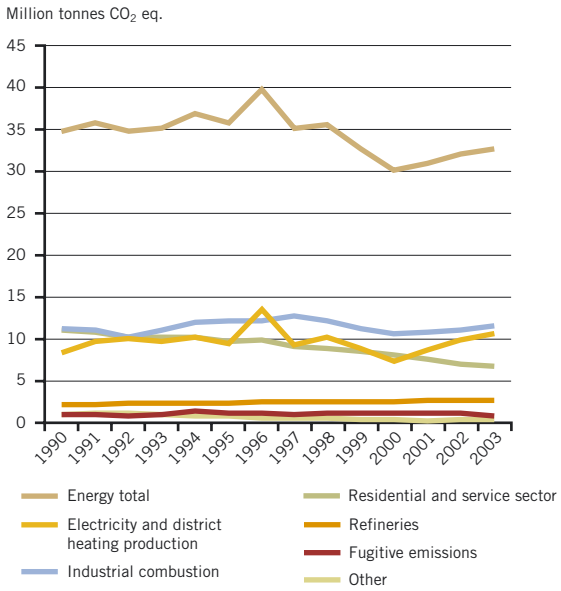

Figure 3-5 **Emissions from the energy sector, total and broken down by sub-sector.**

Carbon dioxide emissions

Production of electricity and district heating

Emissions of carbon dioxide from the production of electricity and district heating amounted to 9.8 million tonnes in 2003. Emissions in 1990 were 7.6 million tonnes, but over the period 1990-2003 emissions varied.

Temperature and precipitation, which vary be-

[4] Emissions in the energy sector include emissions from the production of electricity and district heating, including refineries, industrial combustion and residential and service, including combustion in agriculture, forestry and fisheries

tween years, have an impact on hydropower production and heating needs and thus lead to a variation in emissions from year to year. This is clearly illustrated by the high emissions in 1996, which was a cold and dry year, and by the low emissions in 2000, which was a warm year with heavy precipitation and thus good availability of hydropower. Emissions are also affected by what energy source is used when there is a shortage of hydropower. The deficient production of hydropower in 1996 was principally offset by increased oil-condensing production. In 2003, which was another year of low hydropower production, the shortage of hydropower was largely offset by importing electricity.

District heating production increased from 41.1 TWh in 1990 to 56.2 TWh in 2003[5]. On the other hand, emissions have not increased significantly as the expansion has principally taken place through increased use of biomass fuel. Use of biomass fuel in 1990, including peat and waste, amounted to 10.7 TWh and rose to 35.6 TWh in 2003. The positive trend is principally due to the energy and carbon dioxide taxes but also to investment grants for connection to the district heating network (see Chapter 4). Use of coal has decreased, and the coal has been replaced by biomass fuels. On the other hand, the use of oil was relatively stable between 1990 and 2003, but with some variation due to different temperature conditions between years.

Emissions of carbon dioxide from electricity production come from the combustion of fossil fuels in combined heat and power plants, and in some years also from condensing power plants, for example when little hydropower is available. These emissions varied over the period, chiefly depending on availability of hydropower. Some increase in emissions from electricity production in combined heat and power plants has taken place as a result of increased production with biomass fuel and coal, coke and blast-furnace gas, as well as oil.

Production of refined products increased in Sweden during the period, leading to an increase in carbon dioxide emissions from the refineries from 2.1 million tonnes in 1990 to 2.7 million tonnes in 2003 or almost 25%.

Residential and service sector

Emissions of carbon dioxide in 2003 were 6.2 million tonnes in the residential and service sector, which is a decrease of 39% or 4.3 million tonnes compared with 1990. The decrease is principally due to a change-over from oil to district heating and in recent years also to heat pumps and wood pellet boilers. Total use of fossil fuels decreased from around 40 TWh in 1990 to approximately 30 TWh in 2003, or by 25%. Only 10% of detached and semi-detached houses are now heated by oil alone, while the proportion of detached and semi-detached houses with combined heating systems, for example oil/electricity, is just under 30%. Energy and carbon dioxide taxes have contributed to this trend.

Industrial combustion

Emissions of carbon dioxide from industrial combustion were 11.1 million tonnes in 2003. Emissions varied around approximately the same level over the period 1990-2003, principally due to fluctuations in the economic climate. A small number of energy-intensive industries account for the bulk of carbon dioxide emissions in the sector. The pulp and paper industry accounts for around 20% of emissions, followed by the chemical industry with around 15% and the iron and steel industry with around 10%.

Viewed over a longer period from 1970 on, industry has reduced its use of oil and increased its use of electricity. However, use of fossil fuels increased by almost 5 TWh between 1992 and 2003. Contributory factors have included increased production and lower energy and carbon dioxide taxes. Use of oil has, however, increased less than production volume due to some improvement in energy efficiency. The specific use of oil (kWh per production value at 1991 prices) decreased by 29% and specific use of electricity by just under 38% over the period 1992-2003[6].

Methane and nitrous oxide emissions

Only a small proportion of emissions from the energy sector are emissions of methane and nitrous oxide. Approximately 4% of emissions from the energy sector are emissions of nitrous oxide, and approximately 1% are emissions of methane. Methane and nitrous oxide emissions increased slightly between 1990 and 2003. This trend is in proportion to combustion in the production of electricity and district heating, industry and the residential and service sector.

3.2.2 Industrial processes

Emissions from industrial processes come in particular from the production of iron and steel and from the cement and lime industries. Some examples of emission sources are the use of coke in blast furnaces, the use of dolomite and limestone in production in the mineral industry and the use of coal in the reduction of copper. There are also emissions of fluor-

[5] Swedish Energy Agency, Energiläget 2004 (Energy in Sweden 2004).

[6] Swedish Energy Agency, Energiläget 2004 (Energy in Sweden 2004).

inated greenhouse gases in this sector. Total emissions from the industrial processes sector amounted to just under 5.9 million tonnes of carbon dioxide equivalent in 2003, which corresponds to 8% of total emissions. Carbon dioxide emissions are dominant at around 77%, followed by fluorinated greenhouse gases with approximately 14%, nitrous oxide with approximately 9% and methane with 0.1%.

Total emissions in this sector have varied somewhat since 1990, chiefly due to the fact that production volumes vary with economic fluctuations. In 2003 emissions were 3.6% higher than in 1990 (5.7 million tonnes). Emissions increased by 229 000 tonnes or 4% between 2002 and 2003, partly due to an increase in carbon dioxide emissions resulting from increased production of steel. The increase in production is a consequence of higher demand on the world market.

Emissions of fluorinated greenhouse gases

Fluorinated greenhouse gases[7] (F gases) have a number of uses. The majority of emissions of fluorinated greenhouse gases in Sweden today come from primary aluminium production, refrigeration and air-conditioning systems, foam plastic manufacturing and foam plastic products. Total emissions of F gases in 2003 amounted to around 0.84 million tonnes calculated as carbon dioxide equivalent accounting for just over 1% of total emissions. Emissions of F gases increased by 52% between 1990 and 2003, principally due to a sharp increase in HFC emissions. This is due to HFCs having in many cases replaced the ozone-depleting substances CFCs and HCFCs. [8]

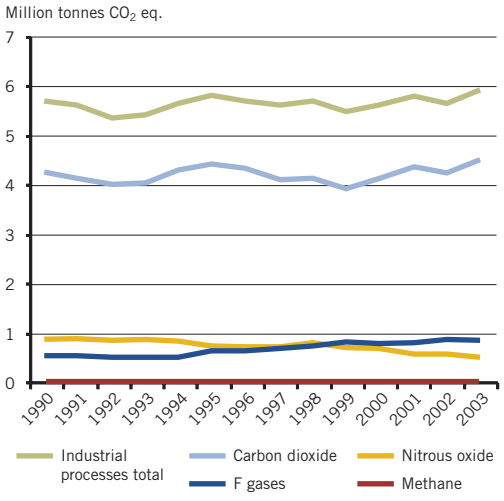

Figure 3-6 **Emissions from the industrial processes sector, total and broken down by gas.**

3.2.3 Transport

Emissions from the transport sector amounted to around 21 million tonnes of carbon dioxide equivalent in 2003, which is equivalent to a share of just under 30% in total greenhouse gas emissions. Emissions of greenhouse gases for the transport sector as a whole increased by 10% over the period from 1990 to 2003.

Carbon dioxide emissions

Road traffic is the largest single source of greenhouse gas emissions in Sweden and accounts for 92% of emissions by the transport sector. Carbon dioxide is the greenhouse gas which, in turn, dominates emissions from the transport sector. The trend in transport activity follows the economic trend, and use of fossil fuels in road traffic is steadily increasing.

Emissions of carbon dioxide from petrol-engined vehicles varied over the period. Emissions increased in the early 1990s but have since decreased and in 2003 were 5% lower than in 1990. One reason for the decrease is a change-over from petrol to diesel in passenger cars and light commercial vehicles. The total proportion of diesel-engined passenger cars is, however, still relatively small. In 2004, 5% of the Swedish car population was powered by diesel. Another reason for the decrease is that the present-day vehicle has lower average fuel consumption than was the case in 1990, while some use of biofuels has started in the last few years. Almost all petrol sold in Sweden contains 5% ethanol, for example.

Use of diesel for road transport, which is less sensitive to price than petrol consumption, has steadily increased in recent years, by a total of 53% between 1990 and 2003. Most of the increase is due to in-

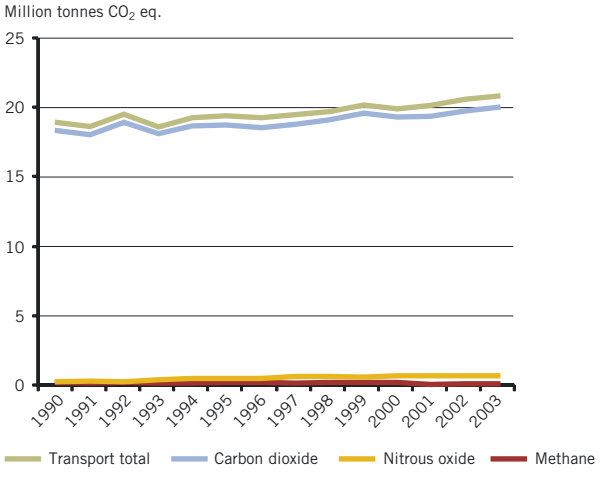

Figure 3-7 **Emissions from transport, total and broken down by gas.**

[7] Fluorinated greenhouse gases can be divided into three groups of substances: incompletely halogenated fluorocarbons (HFCs), completely halogenated fluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

[8] Swedish Environmental Protection Agency, Report 5311, 2003

creased transport activity with heavy trucks (over 16 tonnes). This increased transport activity is primarily due to the structural transformation in society towards more specialisation, centralisation and globalisation, which means that goods are transported ever longer distances[9]. In relation to the total cost of production of an item of goods, transport costs account for a very small proportion, particularly with regard to high-value goods.

For domestic air travel, carbon dioxide emissions are estimated at 0.58 million tonnes in 2003. The trend towards decreasing national carbon dioxide emissions for domestic air travel which started in 2002 has continued and the level is now over 13% lower than in 1990.

Carbon dioxide emissions from domestic shipping amounted to 0.75 million tonnes in 2003, a 14% increase in comparison with 1990. The fluctuations in use of fuel for international transport between different years is heavily dependent on the price of fuel in Sweden compared with the price in other countries.

Carbon dioxide emissions from rail traffic have decreased by 37% since 1990 and account for a marginal share of 0.3% in the emissions of the transport sector.

Methane and nitrous oxide emissions

Only around 4% of transport sector emissions are emissions of methane and nitrous oxide. Emissions of nitrous oxide in the transport sector doubled between 1990 and 2003, as vehicles fitted with catalytic converters emit more nitrous oxide per vehicle kilometre than other vehicles. Emissions of methane, on the other hand, have fallen by half as a result of better exhaust emission control.

3.2.4 Agriculture

Agriculture is the largest source of methane and nitrous oxide emissions. Emissions expressed as carbon dioxide equivalent in 2003 amounted to 8.7 million tonnes, of which approximately 60% was made up of nitrous oxide and 40% of methane. Emissions decreased by 3.1% over the period 2000 – 2003, and total agricultural emissions of greenhouse gases have been reduced by 8.9% since 1990.

Emissions of methane

Methane emissions come principally from the digestion and manure of cattle, while other types of animals are of relatively little significance. The most important reason for the reduced emissions is reduced livestock farming. The number of dairy cows decreased from 576 000 in 1990 to 403 000 in 2003. The greatest reduction took place between 1990 and 1991, when a large number of farms abandoned milk production. Some of these changed over to extensive meat production with the aid of government conversion grants, and the number of beef cattle therefore increased during the early 1990s. After Sweden joined the EU in 1995, the grant systems and livestock quotas in the EU's Common Agricultural Policy (CAP) led to some stabilisation in livestock numbers, but the trend is towards a gradual decrease, particularly with regard to the number of dairy cows. This has reduced emissions of methane from both the livestock and their manure, despite the fact that methane emissions per dairy cow have increased as a result of increased milk yield, greater quantity of manure and a larger proportion of slurry management.

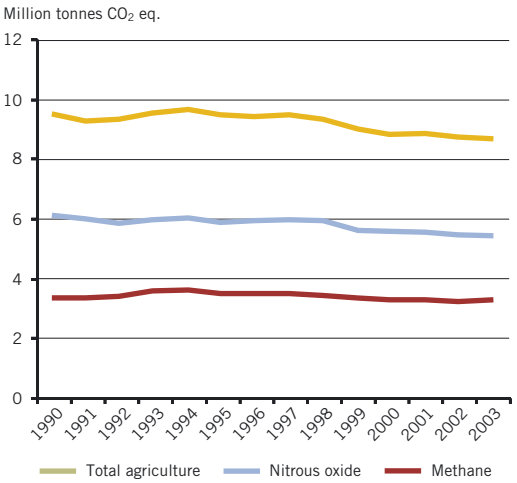

Figure 3-8 **Emissions from the agricultural sector, total and broken down by gas.**

Emissions of nitrous oxide

Nitrous oxide emissions come principally from conversion of nitrogen in soil. This is affected by the use of farmyard manure and commercial fertiliser and the cultivation of nitrogen-fixing crops. Discharges from cultivated peat soils, known as organogenic soils, are also significant, as is the formation of nitrous oxide from nitrogen leaching to lakes and watercourses. The reduced emissions since 1990 are due to the use of both commercial fertiliser and farmyard manure having decreased. The quantity of farmyard manure is declining principally as a consequence of the decreasing number of dairy cows. The action programme which has been implemented to lower nitrogen losses from agriculture has to some extent reduced indirect emissions of nitrous oxide from leached nitrogen and ammonia deposition. Changes in the way manure is handled for

[9] Swedish Environmental Protection Agency, Report 5370, 2004

pigs and dairy cows have also reduced emissions of nitrous oxide, as nitrous oxide emissions from new slurry systems are considerably lower than from traditional solid manure handling techniques.

3.2.5 Waste

Total emissions from the waste sector in 2003 amounted to 2 million tonnes of carbon dioxide emissions or just under 3% of total greenhouse gas emissions. Waste sector emissions are dominated by methane emissions with around 87%, while nitrous oxide emissions account for around 7% and carbon dioxide emissions for around 6%. Methane emissions come from landfills, while nitrous oxide emissions come from wastewater and carbon dioxide is emitted in the incineration of hazardous waste where the production of electricity and heating is not possible.

Landfills are the largest source for the emission of methane gas, after livestock farming, as methane is formed when organic waste is placed in landfills. Methane emissions are showing a downward trend and decreased by 32% between 1990 and 2003. The reduction is partly due to the collection of landfill gas, which leads to a decrease in emissions from material already placed in landfills, and partly to a reduced quantity of landfilled material as a consequence of the prohibition of landfilling, landfill tax and waste plans.

A measure which has started to have an impact in the form of reduced emissions but will particularly affect emissions in the future is the ban on sending combustible material to landfill which was introduced in 2002 and the ban on sending organic material to landfill with effect from 2005.

Landfill tax was introduced in 2000 to steer waste away from landfilling to other, environmentally better methods of disposal. This tax has led to a decrease in the quantity of waste sent to landfill since 2000. Waste plans for how the quantity and hazardousness of waste is to be reduced have helped the municipalities in persuading their citizens to assist towards better waste management. Sorting at source is an important factor here.

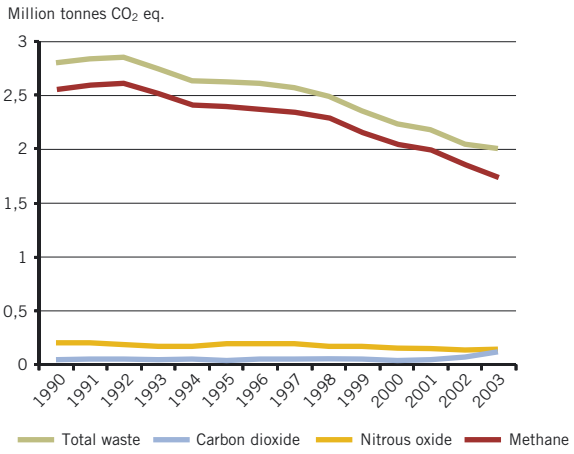

Figure 3-9 **Emissions from the waste sector, total and broken down by gas.**

3.2.6 Solvent and other product use

The use of solvents principally gives rise to emissions of volatile organic compounds, and the carbon content of these emissions is assumed to be oxidised to carbon dioxide. The use of other products, such as spray cans, also leads to emissions of nitrous oxide. Emissions of carbon dioxide and nitrous oxide calculated as carbon dioxide equivalent in 2003 amounted to around 0.3 million tonnes, which is approximately 0.4% of total emissions. In comparison with 1990, emissions have decreased by 26%. Around a third of carbon dioxide emissions come from paints, but these emissions have been reduced by a change-over to water-based paints.

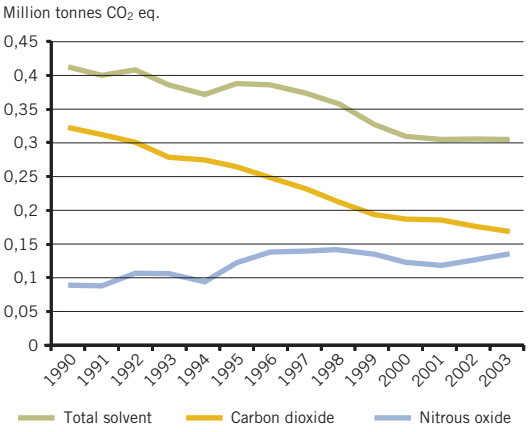

Figure 3-10 **Emissions from solvent and other product use, total and broken down by gas.**

3.2.7 Land use, land-use change and forestry (LULUCF)

The forests contributed to a removal of carbon dioxide in Sweden over the period 1990-2003, and carbon dioxide removal in forest biomass in 2003 amounted to 25.3 million tonnes. For the years 1990-2000 removal of carbon dioxide were calculated according to change in stock. For the years 2001 to 2003 the removal is calculated as growth in forest biomass above and below ground, minus felling and natural loss. With effect from 2006 reporting, a new method will be used according to IPCC Good Practice Guidance for reporting to the Kyoto Protocol. The values for the period 1990-2003 will then be recalculated. The size of the sink varied over the period 1990-2003, the variations being

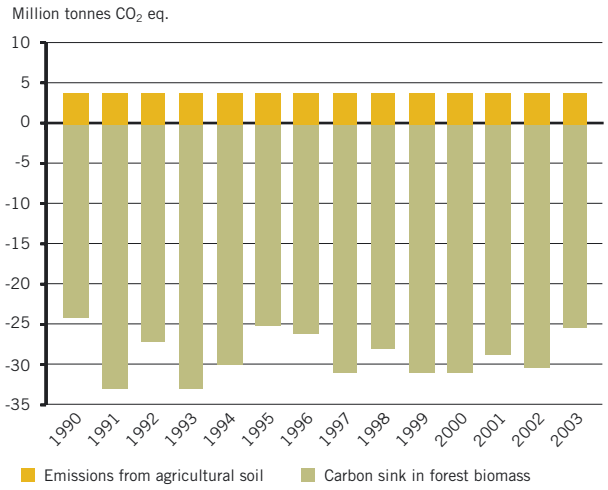

Figure 3-11 **Emissions and removals of carbon dioxide from land use, land-use change and forestry.**

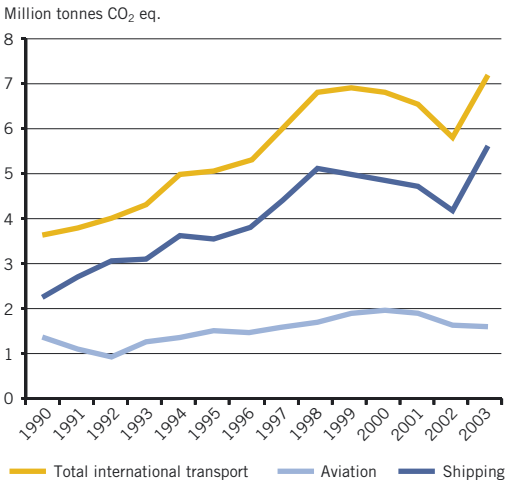

Figure 3-12 **Emissions from international transport, total and broken down by mode of transport.**

principally due to variations in annual felling. According to National Board of Forestry statistics, felling ranged between 64 million m^3 and 83.4 million m^3 over the period 1990-2003[10].

Carbon dioxide emissions from cultivated agricultural land amounted to just under 3.8 million tonnes of carbon dioxide in 2003 and were of the same order of magnitude over the period 1990-2003. Differences are due to minor changes in land area and the use of lime in agriculture. Emissions and removals of carbon dioxide from the land use, land-use change and forestry sector resulted in a sink for the sector of around 21.5 million tonnes of carbon dioxide in 2003.

3.2.8 International transport

Emissions from use of bunker fuels for international transport amounted to around 7.2 million tonnes of carbon dioxide equivalent in 2003. This includes fuel used by vessels in international shipping and international aviation, and emissions from this fuel are not included in the reporting of total emissions from Sweden. Use of bunker fuels is substantially greater than the domestic use of fuel in shipping and aviation.

Emissions from international shipping amounted to 5.6 million tonnes of carbon dioxide equivalent in 2003 and more than doubled over the period 1990-2003. Part of the explanation is that freight transport activity abroad has increased.

Emissions from international aviation amounted to 1.6 million tonnes of carbon dioxide equivalent in 2003, an increase of 0.2 million tonnes or 17% in comparison with 1990. The emissions peaked in 1999 and 2000 but have decreased since.

[10] National Board of Forestry, Skogsstatistisk årsbok 2004 (Forest statistics yearbook 2004)

3.3 Methodology in calculating emissions and removals of greenhouse gases[11]

The energy sector including transport

The energy sector is divided into stationary combustion and transport. A description of how activity data are collected for sub-sectors of stationary combustion is given below.

- Production of electricity, heating and fuels: Data come from a total survey for official statistics where collected figures are available at installation level and per type of fuel.
- Industrial combustion: Calculated on the basis of a sample survey for official statistics scaled up to a total level. Data are collected at installation level and per type of fuel.
- Residential and service sector: Data used are taken from official statistics at national level, broken down by type of fuel.

The calculations of emissions from transport are based on activity data on total quantities of fuels at national level and per type of fuel. These figures are supplemented by information and calculations from responsible government agencies regarding road transport, rail transport, use in the armed forces, shipping and aviation, after which allocation to the various sub-sectors takes place.

Activity data are multiplied by calorific values and emission factors to obtain resultant emissions. National calorific values and emission factors are principally used for calculations in the energy sector in Sweden. A model which has been developed to reflect national conditions is used for calculations of emissions from road transport.

[11] Extract from Sweden's National Inventory report 2005

Emissions from international aviation and shipping are not included in the national combined emissions and are reported separately. For emissions to be attributed to this category, according to the IPCC guidelines and Swedish methodology the fuel has to be purchased in Sweden and used for transport from a Swedish sea port or airport to a foreign destination.

Industrial processes and use of fluorinated greenhouse gases

Emissions from industrial processes and the use of fluorinated greenhouse gases are predominantly calculated on the basis of figures from two types of information sources:

- Environmental reports or other information direct from companies.
- Official statistics or other information at national level, for example from industry organisations.

Under Swedish environmental legislation, companies that undertake environmentally hazardous operations for which a permit is required have to present an account of their operations in an environmental report. Figures relating to emissions presented in environmental reports are principally based on measurements, mass balances or calculations using installation-specific or nationally developed emission factors.

In some industries, environmental reports are not sufficiently wide-ranging to be able to provide a basis for calculations of emissions. This applies for example when a substantial proportion of the emissions from an industry originates from small installations which are not covered by the requirement to compile environmental reports. In such cases emissions are wholly or partially calculated on the basis of activity data at national level combined with nationally developed emission factors, often based on figures from representative installations in the same industry. International standard values are only used to a minor extent.

Carbon dioxide emissions from industrial processes are calculated on the basis of activity data relating to the use of raw materials or alternatively production. In cases where fuels are used as a raw material in industrial processes, activity data are obtained from national energy statistics.

Solvent and other product use

In the sector of solvent and other product use, the emission calculations are based on information from several different types of data sources. Activity data at national level from industry associations, the product register of the Swedish Chemicals Inspectorate or experts who are active in the sub-sector concerned is often used, together with nationally developed emission factors. Figures taken from companies' environmental reports are used to some extent for industrial operations.

Agricultural sector

Emissions of nitrous oxide and methane from agriculture are calculated on the basis of activity data at national level and nationally developed emission factors or standard values proposed by IPCC. Activity data are made up of agricultural statistics, which include figures on livestock numbers, areas under cultivation, harvests, manure management, harvest residues and specific dung/nitrogen production. Supplementary information is obtained from industry organisations and research institutes.

Land use, land-use change and forestry

Land use in Sweden has not changed significantly since 1990. Change is understood here to mean conversion of land areas to other types of land use or farmed land which has been set aside. As the net changes in areas of land use are small, they have been reported to date as zero.

Nationally developed methodology is used to calculate the removal of carbon dioxide in forest biomass. This removal is estimated for the years 2001-2003 as annual growth minus annual loss. Growth calculations are based on field measurements in the framework of the Swedish National Forest Survey. All living trees more than 1.3 m in height are included in the estimates. Forest biomass both above and below ground is estimated from stem diameter at chest height. Loss of carbon dioxide is calculated from statistics on felling volumes and figures relating to natural loss (trees which die standing or are felled by wind).

Carbon dioxide emissions from organogenic soils are calculated by multiplying a nationally developed emission factor by the area of organogenic soils in Sweden. Emissions of carbon dioxide due to the liming of agricultural land are calculated by multiplying activity data from sales statistics at national level in the form of quantities of limestone and dolomite sold by emission factors (international standard values).

Waste sector

Activity data for the waste sector consist among other things of the quantity of waste sent to landfill, landfill gas recovery and emissions of nitrogen from wastewater treatment. Data on emissions from the

incineration of hazardous waste are compiled from the environmental reports of the installations concerned. The emission factors used are for the most part international standard values.

Swedish methodology for data gathering and calculation of emissions is described in more detail for each reporting sector in the yearly inventory reports to the UN, Sweden's National Inventory Report.

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4 Policies and measures

4.1 Swedish climate strategy

Swedish climate strategy has developed steadily since the late 1980s through decisions taken primarily in the areas of environmental, energy and transport policy.

The UN Framework Convention on Climate Change and the Kyoto Protocol, which Sweden has ratified, are central to the Swedish strategy.

Sweden's efforts on climate change are also affected by its membership of the European Union (EU). The fifteen member states which made up the European Union at the time when the Kyoto Protocol was negotiated, according to their commitment under the protocol, are together to limit their emissions to no more than 92% of 1990 emissions of the six greenhouse gases which the protocol covers. In 1998 a decision was taken on internal burden sharing between these countries.

When the Swedish parliament decided to ratify the Kyoto Protocol in 2002, Sweden's internationally binding commitment under the Kyoto Protocol and the EU burden sharing agreement was that emissions for Sweden were not to exceed 104% of 1990 emissions over the period 2008 – 2012.

Current Swedish strategy[1] with national short-term and long-term objectives was adopted at the same time. The short-term national climate objective means that Swedish emissions of greenhouse gases over the period 2008 - 2012 are to be at least four per cent lower than 1990 emissions. This objective is to be achieved without any compensation for removals in carbon sinks or with flexible mechanisms. The long-term climate objective means that Sweden is to act towards the concentration in the atmosphere of the six greenhouse gases included in the Kyoto Protocol being stabilised at a level below 550 ppm carbon dioxide equivalent. Sweden will work internationally for global efforts to be focused on this objective. By 2050, total Swedish emissions should therefore be lower than 4.5 tonnes of carbon dioxide equivalent per year and per capita, and then decrease further. Attainment of the objective depends crucially on international cooperation and efforts in all countries. Swedish efforts in relation to climate change and the national objectives are to be continuously monitored and evaluated. Checkpoints were established for 2004 and 2008.

Central parliamentary decisions on Swedish climate policy are presented in Facts 4.1.

Most policy instruments in Swedish climate policy have been introduced and tightened up successively since the start of the 1990s. Some of the policy

Facts 4.1. **Parliamentary decisions of importance to Swedish climate policy**

- The first climate-policy objective for Sweden was adopted in 1988. The objective only covered carbon dioxide and meant that emissions were to be stabilised at the "present-day level".
- An addition was made to the 1988 objective in 1991. The new objective covered all greenhouse gases and all sectors.
- In 1993 a national climate strategy was adopted in line with the objective in the Framework Convention on Climate Change to stabilise emissions in developed countries. The new national target stated that carbon dioxide emissions from fossil fuels were to be stabilised at the 1990 level by 2000 and then to decrease.
- The energy-policy guidelines from 1997 included a climate strategy for the energy sector.
- The objective of carbon dioxide emissions from transport having to be stabilised at 1990 levels in 2010 was adopted in the decision on transport policy in 1997.
- In 1999 the parliament decided to introduce a system of 15 environmental quality objectives, one of which was an objective concerned with the greenhouse effect: the environmental objective of *"Reduced impact on climate"*.
- In 2002 the current Swedish climate policy was adopted.
- In 2002 the parliament decided on a further development of the system of environmental quality objectives, relating among other things to the responsibilities of various actors to attain the objectives.
- The 2002 energy-policy decision included a related climate strategy.

[1] Government Bill 2001/02:55, "Sveriges klimatstrategi" (Swedish climate strategy).

instruments that have an impact on greenhouse gases were introduced partly with other objectives in mind. The 2002 decision on climate policy is partly based on instruments that had been introduced earlier, but also comprises instruments more specifically oriented towards the climate in the form of funds for information on the climate and investment grants for climate measures. In recent years national climate-change policy has been increasingly influenced by the development of EU-wide instruments, principally the emissions trading scheme. A selection of the most important decisions on instruments for Swedish climate policy is presented in overview form in Facts 4.2.

The principle of *sector integration*, i.e. environmentally-driven work, including efforts to limit impact on the climate, being integrated into all sectors of society and covered by all actors, has long been central to Swedish environmental policy. Government authorities such as the Swedish Energy Agency and the National Road Administration also have *sector responsibility* for the implementation of environmental policy in their areas. When the system of environmental quality objectives was introduced in Sweden, sector responsibility for authorities, municipalities and county administrative boards was clarified and these actors were allocated separate responsibilities for the environmental quality objectives to be attained. This means that the environmental objective of limiting impact on the climate, one of the 15 environmental quality objectives, has to permeate work in many different areas of activity in society, for example in work on physical planning, infrastructure development, municipal action etc. Together with the instruments emphasised in the Swedish climate strategy, this sharing of responsibilities in itself also has to contribute to a cost-effective reduction in total emissions.[2]

Swedish climate-change efforts are also affected by its EU membership, for instance by the member states of the EU regularly developing their common climate strategy. An important element in this is the European Climate Change Programme (ECCP), an action programme in which the most important instrument for reducing total emissions within the Union is a system for emissions trading together with a directive which links this system to the project-based mechanisms of the Kyoto Protocol. Other important instruments in the EU strategy include, for example, the directive for the promotion of biofuels in the transport sector, the directive on the promotion of electricity production from renewable sources and the directive on the energy performance of buildings.

Facts 4.2. **Important policy instruments for Swedish climate strategy introduced over the period 1990-2005:**

Energy and carbon dioxide taxes. The first carbon dioxide tax was introduced in 1991 and has since been raised in several steps while tax-relief rules have been introduced for sectors subject to competition. In 2000 a strategy was adopted for a green tax shift, in which raised carbon dioxide taxes are offset by reduced tax on labour.

Support for electricity production from renewable energy. There have been several schemes since the early 1990s to support electricity production from renewable energy. The 1997 energy-policy decision included subsidies of this type.

Support for more efficient energy use, 1998-2002. The 1997 energy policy decision also meant that funds were earmarked for information, technology procurement, municipal energy advisers and labelling of energy-demanding equipment. The decision also covered grants to reduce energy use, including grants for the expansion of district heating, conversion of electrically heated properties and investments in solar heating.

Grants to local investment programmes. The LIP programme was the subject of a decision in 1996 and started in 1998, and meant that municipalities can obtain subsidies for local efforts to improve the environment and boost employment.

Legislation and economic instruments in the area of waste. In 1997 the parliament decided that a ban on the landfilling of sorted combustible waste should be introduced in 2002 and a ban on the landfilling of organic waste in 2005. In 1999 a decision was also passed for a tax on the landfilling of waste from 2000.

Tax relief for green cars and for biofuels was adopted in the 2002 climate-policy decision and has since been introduced. Carbon dioxide-neutral motor fuels have been exempt from tax in Sweden since 2004.

A climate information campaign was introduced as part of Sweden's climate-change strategy in 2002 and was implemented in 2003 with the aim of increasing knowledge on the subject of climate change.

Support for climate investment programmes (Klimp), with an opportunity for municipalities and companies, among others, to apply for grants for measures that reduce greenhouse gas emissions was also introduced in the Swedish climate-change strategy in 2002 and the scheme started in 2003.

The electricity certificate system was included in the 2002 energy-policy decision and the system was introduced in 2003. The system replaces the previous investment support for electricity production from renewable energy.

New support for more efficient energy use over the period 2002-2007. A new five-year programme was also introduced in the 2002 energy-policy decision with support for information, training and market launch of energy-efficient technology.

Work relating to the flexible mechanisms of the Kyoto Protocol. Under the 1997 energy-policy decision, funds were earmarked for international climate-policy initiatives.

The parliament passed decisions in 2004 and 2005 on the national regulations required for the *EU Emissions Trading Scheme* to be implemented in Sweden, including decisions on implementation of the *Linking Directive* which links the flexible mechanisms of the Kyoto Protocol to the EU trading scheme.

A *programme for energy efficiency* in industry was introduced in 2004 to improve the efficiency of electricity use in energy-intensive industry.

[2] Government Bill 2001/02:55, "Sveriges klimatstrategi" (Swedish climate strategy).

International cooperation on climate-change issues, under the UN Framework Convention on Climate Change, however, has a decisive bearing on the prospects of stabilising greenhouse gas concentrations in the atmosphere and consequently avoiding dangerous human impact on the climate system. In accordance with the provisions of the convention and the Kyoto Protocol, Sweden contributes with funding, capacity building and technology transfer to non-Annex I countries (see also Chapter 7). Sweden also works to make it possible for greenhouse gas emissions globally to be reduced at the lowest possible cost. The climate strategy therefore also includes work towards developing the flexible mechanisms of the Kyoto Protocol. Through international cooperation under CDM, Sweden is additionally working to ensure that climate measures contribute to sustainable development in developing countries.

4.2 Policy instruments in the Swedish climate strategy and their effects

A description is given below of a selection of Swedish instruments in the area of climate change and some results that indicate the effects of these instruments on greenhouse gas emissions. Out of the instruments presented in the previous national communication, NC3, key instruments and some other instruments whose effects it has been possible to quantify have been selected for presentation in this national communication.

4.2.1 Background

The Swedish climate strategy is based on a number of policy-related initiatives. As mentioned previously, these instruments have been introduced in several policy areas. The objectives of the instruments are therefore often multi-faceted, and it may be difficult to assess whether the objectives are attained.

Perhaps the greatest challenge in the work of evaluation is to differentiate the effects of individual instruments, as the instruments are often applied in parallel, and interact with one another. The task of distinguishing the effects of policy instruments from other changes that have an impact on development is also complex.

Another difficulty arises when instruments that contribute to reduced use of electricity or addition of new electricity production have to be evaluated, as there is significant electricity trading across borders. Capacity for the transmission of electricity between Sweden and neighbouring countries has increased as cables across the Baltic Sea have been extended (see 2.6.2), and electricity trading in the Nordic region has increased since the Nordic electricity market was deregulated in 1996. Since 2000, the Nordic electricity market has been a fully integrated market. Power consumption in the Nordic region is also partially met by power generated in nearby countries, principally Russia, Poland and Germany.

Changes in electricity supply and electricity use primarily have an impact on the production with the highest cost, known as marginal electricity. In the next few years, over the period 2008-2012, it is judged that electricity from coal-fired condensing power plants will constitute marginal electricity on the Nordic electricity market.[3] It is therefore assumed that reduced use of electricity or an addition of new electricity production over the next few years will mean a decrease in production in coal-fired condensing power plants in the Nordic electricity system which are located outside Sweden. After 2012, it is estimated that electricity use in the Nordic region will have increased so that new investments in production capacity will be needed. Additional production is expected to come from natural gas-fired combined-cycle power plants in or outside Sweden. Instruments which lead to increased efficiency of electricity or additional electricity production capacity therefore only have a certain effect on carbon dioxide emissions in Sweden.

However, there is experience in Sweden of evaluating policy instruments, which is of great benefit in evaluating climate-policy instruments, see Facts 4.3.

4.2.2 Cross-sectoral instruments

Several of the most important instruments in Swedish climate strategy affect more than one sector. The most important instruments and some overall evaluation results are described below.

The EU emissions trading scheme

The EU's joint emissions trading scheme – EU ETS – started on 1 January 2005. The first period of trading runs from 2005 to 2007 and is an initial phase in the run-up to the international emissions trading which begins in 2008 under the Kyoto Protocol. European emissions trading covers power and heating plants, oil refineries, installations which produce and process iron, steel, glass and glass fibre, cement and ceramics and installations which produce paper and pulp. Trading is restricted to carbon dioxide during the first period. Emissions from Swedish in-

[3] Swedish Energy Agency, ER 14:2002.

Facts 4.3. **Evaluation of climate-policy instruments in Sweden**

Climate-policy instruments are evaluated in Sweden as follows:

1. Various authorities are responsible for evaluating climate-policy instruments in their own areas. Affected agencies include the Swedish Environmental Protection Agency, the Swedish Energy Agency, the National Board of Housing, Building and Planning, the Swedish Institute for Transport and Communications Analysis (SIKA), the National Road Administration etc. Coordination takes place between these agencies.
2. Relevant statistics and information for follow-up and assessment of climate-policy efforts are gathered by the authorities responsible for statistics. Efforts to gather statistics on energy use in the built environment were stepped up in 2004.
3. Different climate-policy instruments are evaluated by different methods. Climate-policy objectives are not always the primary objective of the instrument concerned, which is of vital significance for the method chosen. In some cases supplementary methods of evaluation are employed, both quantitative and qualitative methods.
4. Swedish evaluation activity includes both ex-ante evaluations and follow-ups and ex-post evaluations, albeit to a differing extent. The collected results from follow-ups and evaluations of efforts in relation to climate policy are reported at particular checkpoints (in 2004 and 2008).
5. Indicators are used for the follow-up of efforts in relation to climate change, such as carbon dioxide emissions, emissions of other greenhouse gases, energy use per sector, proportion of energy from fossil fuels, proportion of energy from renewable sources etc. Follow-up of the climate indicators is coordinated with the follow-up of indications relating to energy, transport and the environment.

stallations which are affected, the "trading sector", accounted for just under 30% of total greenhouse gas emissions in Sweden in 2000.

Swedish principles of allocation

The EC directive on emissions trading sets certain frameworks for the initial allocation of emission allowances but permits various methods for allocating emission allowances to the installations covered by the scheme. The basic allocation to existing installations during the period 2005-2007 is based on average historical emissions over the period 1998-2001. Some adjustments have been made to the basic principle for emissions related to raw materials, i.e. emissions where carbon dioxide is formed from carbon bound in the raw material that is to be refined or where carbon is used to remove an unwanted component from the raw material. Emission allowances equivalent to the forecast increase in production are granted for emissions of this type as the prospects of implementing restrictions on emissions are judged to be limited in this sector, at least in the shorter term.

Industry subject to competition has been allocated relatively greater emission allowances in the initial allocation in comparison with combustion installations in the energy sector. A scale-down factor of 0.8 has been applied to the latter type of installations. The basic principle applicable to new installations is that the distribution is based on benchmarks or best available technology. A certain quantity of emission allowances have been earmarked for new installations. If this is not sufficient, the company may purchase emission allowances to cover emissions in the new installation.

Altogether, Sweden will allocate emission allowances equivalent to around 23 million tonnes of carbon dioxide a year over the period 2005-2007. The national allocation plan for the period 2008-2012 is due to be adopted in 2006.

Impact on carbon dioxide emissions

The EU emissions trading scheme has recently started, and it is therefore difficult to say what impact trading will have on Swedish emissions in the long term. The effect of the instrument transcends the EU. The combined allocation of emission allowances in the scheme limits total emissions in the EU from the whole of the trading sector. Trading may result in increased emissions in one country while emissions decrease in another.

The effect in an individual country depends, among other things, on the price established on the market for emission allowances, companies' assessment of future price levels and, in addition, national circumstances, such as the existence of supplementary instruments and what the costs of measures and the potential for emissions reductions are like.

Account has been taken of the EU trading scheme in the latest Swedish projections of emissions, presented in Chapter 5. It has been assumed that an average emission allowance price of 10 euros per tonne will apply throughout the period covered by the forecast. In comparison with development to date a relatively low price. The forecast is otherwise based on instruments which exist at present, including carbon dioxide tax, continuing to apply in the trading sector. According to this projection, emissions in the trading sector in Sweden will amount to 26.5 million tonnes in 2010, which signifies an increase in emissions for the sector.

However, the evaluation made of the combined effects of the economic instruments in the energy sector in Sweden, presented in 4.2.3, shows that the EU emissions trading system together with the electricity certificate system and energy and carbon dioxide taxes are expected to be the most important instruments from the point of view of limiting emissions from the energy sector in the future.

The Environmental Code

Overall legislation in the area of the environment has been brought together in the Environmental Code since 1 January 1999. The overarching aim of the Environmental Code is to promote sustainable development. The environmental quality objectives are to serve as a guide for the application of the Code. The Code contains, among other things, general consideration rules which are to be observed in all activities and measures. Among these, it may be mentioned that best possible technology has to be applied in professional activity, and that everyone who undertakes an activity or takes a measure has to make sparing use of raw materials and energy and utilise opportunities for re-use and recycling. Renewable energy sources are primarily to be used. These rules on consideration apply insofar as it cannot be regarded as unreasonable to fulfil them.

Major environmentally hazardous activities are covered by an obligation to obtain a permit. Greenhouse gas emissions form part of the permit examination procedure. However, these parts of the Environmental Code no longer apply in full to those installations that are covered by the emissions trading scheme. With effect from 2005 it is no longer permissible to establish emission limits for carbon dioxide or to limit the use of fossil fuels from such installations.

Measures in the area of physical planning principally have an impact on emission trends in the longer term and may be of great significance from this point of view. It is mandatory to obtain a permit for major infrastructure projects under the rules set forth in the Environmental Code. The Environmental Code lays down requirements for environmental impacts to be thoroughly described at an early stage in a project. Physical planning measures are otherwise principally governed by the Planning and Building Act (PBL). A review is currently in progress to ascertain how this act can make a better contribution to endeavours to attain the environmental quality objectives.

The Environmental Code also includes the special legislation applicable to the area of waste and rules that limit emissions of certain fluorinated greenhouse gases, principally from fire-extinguishing equipment and cooling systems. Quantitative assessments of effects on greenhouse gas emissions have been made in these areas. The results are described in the appropriate sector-related sections below.

Local Investment Programme (LIP) and Climate Investment Programme (Klimp)

LIP (the Local Investment Programme for ecologically sustainable development) was launched in the autumn of 1996. The principal aim of LIP was an improved environment, but also increased employment. The first grants were made in 1998 and the last grant was awarded in 2002. A total of 6.2 billion Swedish kronor has been issued in grants, and 4.7 billion kronor of this sum will probably have been paid out when 211 investment programmes in 161 municipalities and 2 municipal associations have been completed. The grant recipients at the same time are responsible for around three times as much of the investment costs.

Of the total of SEK 4.7 billion which it is estimated will be paid out in LIP grants, just over half will go to projects with a climate orientation. Figure 4-1 shows how grants to these projects, and the projects' estimated emission reductions, are broken down between sectors.

Around a third of the total funds in LIPs have gone on investments in the energy sector. A very large pro-

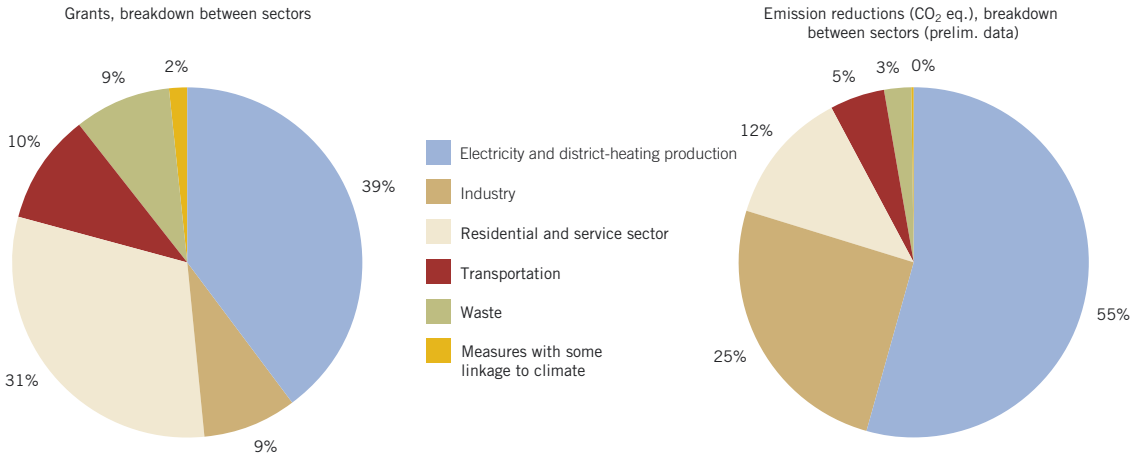

Figure 4-1 **LIP projects with a climate orientation, grants and estimated reductions in greenhouse gas emissions, broken down by sector. The data also include projects not yet the subject of final reporting.**

portion (around 92%) of the estimated reductions in emissions originate from measures taken in this sector. A smaller proportion, 5% and 6% respectively, of the total grant sum has gone on measures with a climate orientation in the waste and transport sectors. The projects altogether are estimated to reduce national greenhouse gas emissions by up to 1.5 million tonnes of carbon dioxide emissions a year.[4] Final reporting of all projects has not yet been completed. At present around 115 LIP programmes have been settled, that is to say slightly more than half.

It is difficult to assess to what extent the projects would have been carried out without grants or whether they have been brought forward as a result of the grant. In an evaluation[5] made of district and local heating measures it was judged that for *new construction and conversion of large heating units* the grant has meant that investments in some cases have come earlier than would have been the case if the grant had not been available. C*onnection of industry to the district-heating network* may also have come about earlier as a result of the grant. The grant is judged to have been of great significance for expansion of the district-heating network for *connection of detached and semi-detached houses* and for new establishment of *local heating and small-scale district heating*. According to those municipalities which have implemented *waste-heat projects*, only a few of these projects would have been implemented without grants.[6] In an evaluation of some large LIP projects implemented in the *pulp and paper industry*, it is also judged that these projects would not have happened without grants.[7]

With effect from 2003, government investment grants are paid to local climate investment programmes (Klimp), which are a successor to LIP. Stricter reporting requirements are laid down in comparison with LIP, which means that the effects of the programme can be calculated with greater certainty. Moreover, grants may not be paid to projects which are already profitable. It is estimated that the Klimp appropriation of SEK 1040 million will lead to reduced emissions of up to 0.5 million tonnes of carbon dioxide per year.[8] Grants from the Klimp appropriation have also, to a great extent, been given to projects in the area of energy (56% of grant funds). The proportion of grants made to transport projects and waste projects is higher than under LIP (21% against 10%).

In the autumn of 2005 the government proposed that the climate investment programme should be extended and that the funding of the programme should be increased by a total of SEK 840 million for the period 2006-2008.

In addition, the work on LIP and Klimp applications is judged to have strengthened environmental activity in municipal organisations and increased awareness of the climate-change issue among important actors in the municipalities and the knowledge of potential local environmental measures and their effects[9].

Information on climate change

Information is an important component of the Swedish climate strategy from 2002. During the period 2002-2003, a sum of SEK 60 million was invested in a national information campaign on climate change. Information is judged to boost the effect of and increase acceptance of the introduction of other instruments.

The principal purpose of the information campaign on climate change was not to bring about direct reductions in emissions but to increase knowledge among the public and businesses of the climate change issue and understanding of the adjustments that will be necessary in the longer term for sustainable development. The results of the campaign were followed up through interviews before and after the campaign was implemented. The interviews show that the knowledge and attitudes of the Swedish population on the issue of climate change altered during the year the campaign was in progress. According to an evaluation[10] , the campaign has, for example, contributed to improved knowledge of the climate-change issue.

4.2.3 The energy sector excluding transport

The energy sector excluding transport includes production of electricity and district heating, refineries, and combustion in industry and the residential and service sectors. This sector accounts for just under half of all greenhouse gas emissions in Sweden.

The trend for the sector points in the direction of reduced emissions in comparison with 1990. The reduced emissions are principally due to the fact that use of biomass fuel-based district heating has expanded greatly over the period and has principally replaced oil in the residential and service sector. According to the forecast presented in Chapter 5, however, emissions from the energy sector excluding transport will increase in comparison with emissions in recent years despite present-day instruments.

Emissions from the sub-sector of *production of electricity and district heating* do not show any in-

[4] The investment grant works together with other instruments such as energy and carbon dioxide taxes, electricity certificate schemes etc. The decrease in emissions therefore cannot be ascribed solely to the grant. The assessment includes assumptions that not all the remaining projects will be fully implemented.

[5] Swedish Environmental Protection Agency, Report 5372.

[6] Swedish Environmental Protection Agency, Report 5373.

[7] Margrethe Forssman. Pulling the pulp and paper industries into profitable investments.

[8] The estimate does not take account of how this investment subsidy interacts with other instruments.

[9] Swedish Environmental Protection Agency, Report 5382.

[10] Swedish Environmental Protection Agency, Report 5365.

creasing trend over the period 1990-2003 despite the increasing production in particular of district heating. Carbon dioxide emissions in connection with production of electricity in Sweden mainly originate from combustion in combined heat and power plants and, in some years, also condensing power plants, and these emissions vary depending on the amount of electricity produced in individual years. Development in the sub-sector of electricity and district-heating production has been affected primarily by energy and carbon dioxide taxes and the availability of investment grants. It is anticipated that the electricity certificate system and the emissions trading scheme will also be of great significance in the future.

Emissions from *combustion in industry* were also at approximately the same level over the period 1990-2003. The variations follow changes in the economic climate and price ratios between electricity and oil. The electricity certificate system, energy taxes and the trading scheme taken together are expected to be of great significance to the trend in emissions.

Emissions from combustion in the *residential and service sector* fell sharply over the period 1990-2003. The decrease in 2003 amounted to a total of around 4.3 million tonnes of carbon dioxide equivalent. The decrease is mainly due to increased use of biomass fuel-based district heating. The use of heat pumps and wood pellet boilers has also increased in recent years. Energy and carbon dioxide taxes are the instruments that principally affect emissions from burning in the housing sector but grants have also encouraged the trend in this sector.

In addition, a large number of instruments directed towards increased energy efficiency improvement and reduced use of energy have had an impact in the energy sector. These instruments take the form of investment and subsidy programmes, building regulations, energy labelling, information and technology procurement.

Facts 4.4

A carbon dioxide tax was introduced in 1991 and was raised from 25 öre/kg carbon dioxide to 91 öre/kg in 2005. Manufacturing industry, agriculture, co-generation plants, forestry and aquaculture pay a lower proportion of the general level. In addition, there are special rules for further tax relief for energy-intensive industry. In the autumn of 2005, the government proposed that operations covered by EU ETS should also be covered by special tax relief, exemption regulations with regard to the CO_2 tax.

Tax on energy has existed in Sweden since the 1950s. The tax initially covered oil and coal. A tax on petrol was introduced as long ago as the 1920s. The level of energy tax has changed over the years and also varies between different fuels. In 2005, energy tax on natural gas amounted to 2.2 öre/kWh, on coal to 4.3 öre/kWh and on fuel oil to 7.4 öre/kWh. However, biomass fuels are completely exempt from energy tax. Manufacturing industry and fuels for production in CHP plants are not subject to any energy tax. Fuels used in the production of electricity are exempt from both energy and carbon dioxide tax.

Energy and carbon dioxide taxes

The current system of energy tax is based on a combination of carbon dioxide taxes, energy tax on fuel, nuclear power tax and consumption tax on electricity. Energy tax and carbon dioxide tax affect fossil fuels. A brief review of the formulation of the carbon dioxide and energy taxes is presented in Facts 4.4.

Figures 4-2 and 4-3 show the trend in combined energy and carbon dioxide tax on oil and coal re-

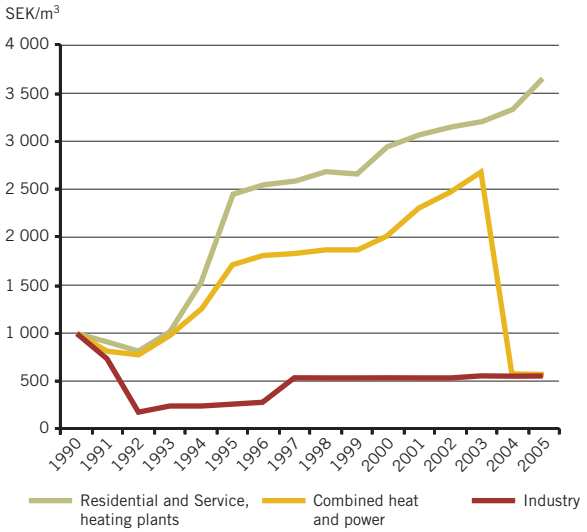

Figure 4-2 **Total tax (energy tax + carbon dioxide tax) for use of oil in different sectors 1990-2005, SEK/m³.**
(Source: National Tax Board)

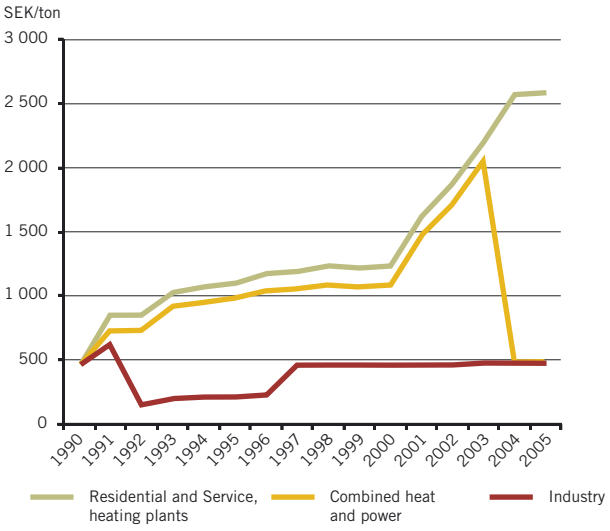

Figure 4-3 **Total tax (energy tax + carbon dioxide tax) for coal in different sectors 1990-2005, SEK/tonne.**
(Source: National Tax Board)

spectively in Sweden in different sectors since 1990.

The increases in energy and carbon dioxide taxes in recent years form part of the green tax shift which was initiated in the autumn of 2000[11]. The tax shift means that tax on environmentally harmful activities is raised, while tax on labour is lowered. In order to avoid altering the relative competitiveness of electricity and fossil fuels, the tax on electricity use has also been raised to the same extent as the carbon dioxide tax.

The extent to which taxes have affected emissions varies between sectors depending on the level of the tax in the sector concerned. It is important to remember that actors in society face the combined tax, that is to say both energy and carbon dioxide tax. Households additionally pay value-added tax.

An evaluation based on a model calculation[12] shows that the levels of energy and carbon dioxide taxes that have applied between 1990 and the present have provided stronger financial incentives towards increased use of biomass fuels in the production of district heating compared with the energy tax which was in place in 1990.

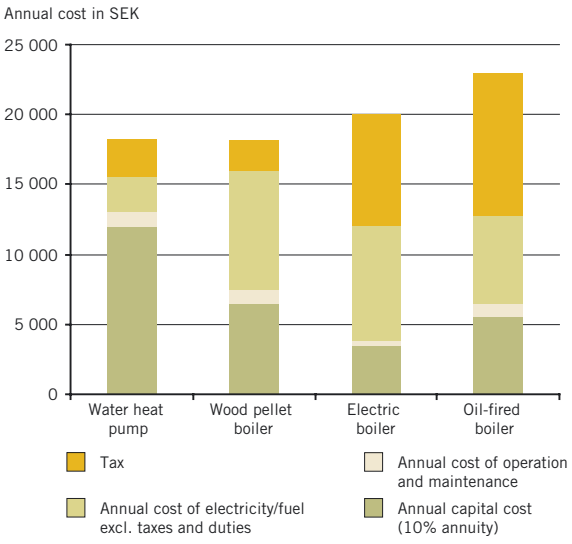

Figure 4-4 **Total costs broken down by cost item for investment in a new heating system in an average Swedish detached or semi-detached house.[13]**

The taxes have also had a substantial impact on the costs of various alternative forms of heating in apartment blocks and in detached and semi-detached houses, the latter being illustrated in Figure 4-4. The figure shows the annual costs assuming that an investment is made in a new heating system in an average Swedish detached or semi-detached house. The figure shows that energy and carbon dioxide taxes affect cost levels and provide financial incentives to install a heat pump or wood pellet-fired boiler for heating instead of an oil-fired boiler when the old heating system is due to be replaced. Without taxes the electric boiler and oil-fired boiler are the cheapest alternatives, but at 2004 levels of tax it is more economically advantageous to install a heat pump or wood pellet-fired boiler.

Grants towards investments in electricity production from renewable energy sources, 1998-2002

From the start of the 1990s to the present there have been several different schemes to subsidise electricity production from renewable energy sources. For example, there was an initiative under the 1997 energy policy decision to increase production of renewable electricity over the period 1998-2002. A number of grants towards investments in biomass fuel-based combined heat and power, wind power and small-scale hydropower were introduced in order to attain the programme target of 1.5 TWh of new electricity production from renewable energy sources. The effect of some of the measures is shown in Table 4-1.

Electricity certificate system

A new support system for electricity from renewable energy was introduced on 1 May 2003, an electricity certificate system that is gradually replacing previous investment subsidies. The system means that electricity producers receive an electricity certificate for each MWh of renewable electricity produced.[15] The certificates are then sold to electricity users who, by law, are obliged to purchase electricity certificates equivalent to a particular percentage of their use. This quota is successively increased year by year. The aim of the system is to contribute to the change-over of the energy system to a

Table 4-1 **Outcome of grants towards investments in electricity production from renewable energy sources in 1998-2002[14]**

Measure	Target (TWh)	Allocation (SEK million)	Increased electricity production from renewable energy sources (TWh/year)
Biomass fuel-based combined heat and power	+0.75	450	+0.88
Wind power	+0.5	472[1]	+0.96[2]
Hydropower	+0.25	472[1]	0.04

[1] Net appropriation for wind power and small-scale hydropower combined. The original appropriation was SEK 300 million for wind power and SEK 150 million for small-scale hydropower. As a result of redistribution between appropriations, funds in excess of the original amounts have been made available for investments in wind power.

[2] The figure for production from wind power includes some capacity not yet commissioned.

[11] Government Bill 2000/2001:1, "2001 Budget Proposal".

[12] The calculation, and a description of the model used (the Markal model) can be found in the Swedish Energy Agency report "Ekonomiska styrmedel i Energisektorn – en utvärdering av utvecklingen sedan 1990" (Economic instruments in the energy sector – an evaluation of trends since 1990).

[13] Swedpower, 2005.

[14] Swedish Energy Agency, ER2005:25.

[15] To be eligible for certification, electricity must have been produced with wind power, solar energy, geothermal energy, certain types of biomass fuels, wave energy, new or small-scale hydropower or peat.

higher proportion of renewable electricity production. As a result, lower greenhouse gas emissions are achieved through increased use of renewable fuels. The objective behind the system is for renewable electricity production in Sweden to increase by 10 TWh between 2002 and 2010. If the target for the system is attained, reductions in emissions will be achieved in the Nordic electricity system.

Electricity production from renewable energy sources increased more than required by the quota introduced during the first two years of the electricity certificate system, and at 31 March 2005 amounted to a total of 11.5 TWh. The increase in renewable electricity production of around 4 TWh since 2003 has largely taken place through conversions from fossil fuel to biomass fuels and increased use of existing electricity production capacity in biomass combined heat and power plants. On the other hand, the system has not generated any major new investments in production capacity, which, according to an evaluation carried out[16], is largely due to uncertainty among the actors involved as to whether the system will continue after 2010.

Combined effect of economic instruments in the energy sector

An evaluation[17] has been made to estimate the aggregate effect on carbon dioxide emissions of economic instruments introduced into the Swedish energy sector between 1990 and 2005. The evaluation relates to emissions in Sweden. Instruments included in the analysis consist of taxes, investment and operating support, the electricity certificate system and the EU emissions trading scheme. The calculations do not include grants awarded to projects in the energy sector under the LIP and Klimp programmes. A separate evaluation has been made of these programmes.

The evaluation is based on calculations made using the MARKAL-Nordic optimisation model.[18] The development of the energy system with the economic instruments introduced since 1990[19] (solid line in Figure 4-5) was simulated in a calculation. A limitation of the possibility of investing in coal-fired electricity and heat production plants has been introduced in this case. This limitation is justified by the judgement that new investment in coal-fired electricity and heat production plants is not a plausible alternative with the policy that is being conducted. Nor have any such investments been made in practice. In a second calculation, the development of the energy system is simulated on the assumption that Swedish instruments have not changed since 1990 (dashed line in Figure 4-5). In this calculation no limitation has been introduced into the model for investments in new coal-based electricity and heat production. In 1990 there was no clear policy that aimed to limit carbon dioxide emissions and development with investments in new coal-based electricity and heat production is judged to have been possible at that time.

As can be seen in Figure 4-5, the result of the evaluation shows that the introduced economic instruments provide stronger economic incentives for reduced carbon dioxide emissions in the energy sector than if the instruments had been unchanged since 1990.

In addition, a sensitivity analysis based on alternative assumptions has been conducted. In a third calculation the energy system is simulated on the assumption that Swedish instruments have not changed since 1990, but with a limitation introduced with regard to investments in new coal-based electricity and heat production. Table 4-2 shows the result of the calculations carried out, firstly in the form of a comparison between the case with introduced instruments after 1990 and the case with instruments that existed in 1990 without a coal limitation and secondly in the form of a comparison between the case with introduced instruments after 1990 and the case with 1990 instruments with a carbon limitation. The outcome of the calculation shows a substantially smaller effect for introduced instruments if carbon limitation is assumed in the case with 1990 instru-

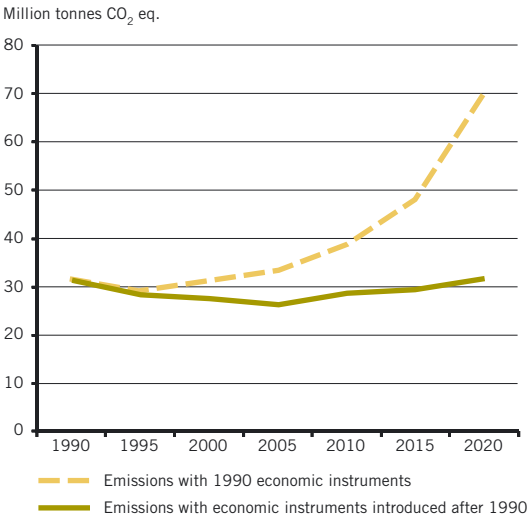

Figure 4-5 **Estimated trend in emissions in the Swedish energy sector (excluding transport) for a scenario with introduced economic instruments after 1990 and a scenario with 1990 economic instruments.**

[16] Swedish Energy Agency, ER 2005:09.

[17] Swedish Energy Agency report "Ekonomiska styrmedel i energisektorn – en utvärdering av utvecklingen sedan 1990" ("Economic instruments in the energy sector – an assessment of the development since 1990").

[18] A description of the MARKAL model is given in the Swedish Energy Agency Report "Ekonomiska styrmedel i Energisektorn – en utvärdering av utvecklingen sedan 1990" ("Economic instruments in the energy sector – an assessment of the development since 1990").

[19] The instruments have, as far as possible, been introduced into the model at the time when they have been introduced in reality.

Table 4-2 **Estimated total effects on emissions in Sweden in a comparison between current economic instruments in the energy sector (excluding transport) and two alternative reference cases with 1990 instruments**

	2005	2010	2015	2020
Reference case 1990 economic instruments without coal limitation	7	10	19	38
Reference case 1990 economic instruments with coal limitation	2	5	5	5

ments. Note, however, that the latter case cannot be regarded as providing a fair picture of the situation in Sweden in 1990.

The reason why emissions increase so sharply in 2020 in the calculation with 1990 instruments without a limitation of investment in coal-based electricity and heat production is that it is assumed that nuclear power plants are phased out after 2015[20]. Electricity production based on nuclear power is largely replaced by production in new coal-fired condensing power plants, which leads to very large increases in emissions.

Finally some observations can be made at the sector level from the model calculation. For the production of district heating, the 1990 energy tax already provided clear financial incentives for the use of biomass fuels and, consequently, reduced carbon dioxide emissions.

For the *electricity and district-heating sector* as a whole, it is the combination of the EU trading scheme, the electricity certificate system and energy and carbon dioxide taxes in particular that explain the future effect of introduced economic instruments indicating lower emissions than 1990 instruments. The reduction of the carbon dioxide tax on combined heat and power which came into effect on 1 January 2004 is thus counterbalanced by the controlling effect of the electricity certificate system and the EU trading scheme, while the competitiveness of energy-efficient combined heat and power production has simultaneously been strengthened.

For the sub-sector of *industrial combustion*, the calculation shows that the economic incentives for the part of industry covered by the EU trading scheme are stronger with current instruments. For the part of industry outside the trading sector, however, the 1990 energy tax provided stronger incentives for reduced emissions than the instruments that are in place today.

Energy and carbon dioxide taxes are the instruments which have provided the greatest individual effect on emissions in the *residential and service sector* and are also expected to do so in the future.

Beyond this analysis of the combined effect of the most important instruments in the energy sector (excluding transport) presented here, several separate assessments of the effects of individual instruments have been made. If the results of these separate assessments are added together, they show a substantially greater effect compared with the joint analysis of the effects of instruments. This is partly due to the instruments interacting with each other but also to the fact that the separate assessments of the effects of the individual instruments cover effects in the Nordic electricity system. Overall, it is reasonable to assume that the results presented here underestimate the aggregate effect of the instruments on emissions as the results only relate to effects in Sweden.

Instruments for increased energy efficiency and reduced energy use

Instruments described in this section are not included in the assessment of the combined effects of economic instruments in the energy sector as described earlier.

Grants for reduced electricity use in 1998-2002

Under the 1997 energy-policy decision there was also an initiative to reduce electricity use over the period 1998-2002. With a view to attaining the target of reducing electricity use by 1.5 TWh, grants were awarded to promote the expansion of district heating and support the conversion of electrically heated properties to district heating. In addition, grants were awarded for power-reducing measures in

Table 4-3 **Outcome of grants to reduce electricity use over the period 1998-2002 as well as effects on carbon dioxide emissions in the Nordic electricity system**

Measure	Granted funds (SEK million)[1]	Reduced electricity use (TWh/year)[1]	Reduction in emissions (million tonnes CO_2/year)[2]
Measures to promote district heating	510	1.62	0.6/1.3
Measures to reduce electricity use in the residential sector	150	0.03	0.05/0.12
Conversion to biomass fuel firing	350	0.32	0.1/0.3
Installation of solar heating	50	0.02	0.02/0.04
Total	**1510**	**1.99**	**0.77/1.76**

[1] Swedish Energy Agency, ER 2005:25.

[2] In the judgement of the Swedish Energy Agency, reduced electricity use up to 2012 is expected to lead to reduced electricity production from coal-condensing power stations within the Nordic electricity system, although outside Sweden. After 2012 it is judged that electricity use within the Nordic electricity system will reach the volume of production and that new investments then made will be in natural gas-fired combined-cycle power stations in or outside Sweden. Two alternative values are therefore presented for emission reductions.

[20] With the assumption of a 40-year operational life.

the residential sector, individual biomass fuel firing where district heating was not cost-effective, measures to reduce electricity use in residential and commercial premises and investments in solar heating.

Programmes for support of more efficient energy use in 1998-2002 and 2003-2007

Under the 1997 energy-policy, a decision was also taken on subsidies for technology procurement, testing, labelling and certification, as well as information on energy-demanding equipment (energy labelling) and grants for information, for instance in the form of municipal energy advisors, with the aim of encouraging more efficient use of energy. The 2002 energy-policy decision contained a new five-year programme for more efficient energy use with support for information and training, testing, labelling and certification of energy-demanding equipment, technology procurement and market introduction of energy-efficient technology. The effects of the various measures are described below.

Technology procurement – SEK 377 million was paid out over the period 1998-2002 for procurements in the energy sector. Around 30 new technologies have been introduced onto the market due to this type of support.[21] The procurement have led, for instance, to more energy-efficient heat pumps, refrigerators, washing machines and control systems for direct electric heating. In an attempt to estimate the potential in current and ongoing technology procurements, the technical potential for reduced energy use in the residential and service sector is estimated to amount to at least 12 TWh. However, it is judged that less than 25% of the potential[22] can be achieved over the next ten years.

Mandatory energy labelling of domestic appliances has existed in the EU since 1995. The labelling covers lamps, ovens, refrigerators, freezers, washing machines, tumble-dryers and dishwashers. The Swedish Consumer Agency estimates that this labelling has contributed to a 25-35% drop in the average energy consumption of new domestic appliances since it was introduced. The labelling has also contributed towards the worst appliances from the point of view of energy performance having disappeared from the market.

Information initiatives primarily relate to municipal energy advice. The aim is to disseminate objective information concerning environmentally friendly energy supply and more efficient energy use to the public and to businesses. Since 1998, government support has been provided for municipalities which provide energy advice, and by 2004 a sum of SEK 386 million had been paid out for municipal energy advice. There has been some form of energy advice in all Swedish municipalities since 2003.

The programme for energy efficiency improvement (PFE)

On 1 July 2004 an energy tax on electricity of 0.5 öre/kWh for manufacturing industry was introduced in line with EU minimum tax rates under the Energy Tax Directive (2003/96/EC). At the same time, a possibility was introduced of lowering the tax if an industry takes part in the programme for more efficient energy use (PFE). Under PFE, a participating industry makes a commitment to introduce energy management systems and continuously perform energy analyses, as well as implementing certain electricity efficiency improvement measures in exchange for avoiding having to pay tax on the electricity used. Around 130 companies with a total electricity use at minimum tax rate of around 35 TWh have applied for and been granted participation in PFE. It is difficult to assess the effect the programme may have. However, evaluations of a similar programme in Finland indicate that an efficiency improvement of 2%[23] may be achieved among participants in the programme.

Building regulations

Building regulations have been used in Sweden since the 1960s to influence energy efficiency in new buildings. Previous evaluations[24] have shown that the standards have contributed to increased awareness and knowledge and reduced the specific energy requirement for heating. More recent studies[25] show, however, that the specific energy requirement for heating in new buildings is no longer decreasing. This is due to incomplete supervision and checks on compliance with building regulations. Revision of the Planning and Building Act and the building regulations of the National Board of Housing, Building and Planning is in progress.

Support of investments in energy efficiency improvement measures

Certain investment grants for energy efficiency improvement measures have also been introduced in recent years, for example in the form of tax relief for investments in more energy-efficient windows in an ROT (Renovation, Refurbishment and Extension) deduction for investments in energy efficiency improvement measures in public buildings. Both forms of subsidy were introduced in 2004.

In the budget bill of 2005 the government also proposes tax relief for conversion from direct electric heating in buildings.

[21] Swedish Energy Agency.
[22] Swedish Energy Agency, ER 2005:01.
[23] Ulla Suomi, Motiva. Personal communication.
[24] Swedish Council for Building Research, 1984.
[25] Nässén J. and Holmberg J., 2005.

Energy Performance of Buildings Directive

In 2002 a decision was taken in the EU in favour of a directive on the energy performance of buildings, which is judged capable of contributing to large total reductions in emissions within the Union. In Sweden it is expected that the directive will be significant in the longer term as buildings have a long life and overall energy efficiency may increase when refurbishment and extension work is carried out. The Swedish government intends to submit proposals for implementation of the directive in 2005.

4.2.4 Industrial processes (including emissions of fluorinated greenhouse gases)

Industrial process emissions and emissions of fluorinated gases in 2003 amounted to 5.9 million tonnes, which is around 4% higher than the 1990 level. Combined process emissions from industry have fluctuated from year to year depending on economic development, transformation of industrial structure and how the use of *fluorinated* gases has developed. The principal instruments which may affect emissions from the sector are the EU emissions trading scheme, a future EU regulation on certain emissions of fluorinated gases and application of the Environmental Code.

Emissions of methane, nitrous oxide and fluorinated gases from industrial processes are covered by the *general rules of consideration in the Environmental Code*. These are particularly relevant to emissions of PFCs from aluminium production. It is estimated PFC emissions will be reduced by at least 0.2 million tonnes of carbon dioxide equivalent a year as a result of application of the rules contained in the Environmental Code in permit examination[26].

In the summer of 2003, the Commission presented a proposal for a *regulation on certain fluorinated greenhouse gases, COM (2003) 492 final*. The Council adopted a common position on the proposal in October 2004. The second reading in the European parliament has been completed and reconciliation awaits. In addition to the regulation, a directive governing the use of HFCs in mobile air conditioners has also been drawn up. In a previous study[27] based on the Commission's proposal for a regulation, it was estimated that implementation in Sweden would lead to reductions in annual emissions of around 0.15 million tonnes of carbon dioxide equivalent a year by 2010 and 0.4 million tonnes of carbon dioxide equivalent a year by 2020.

4.2.5 Transport

The transport sector accounts for just under 30% of total greenhouse gas emissions in Sweden. Emissions from the sector have increased by around 10% since 1990. Carbon dioxide emissions from road traffic are dominant, and it is primarily emissions from heavy goods vehicles that are increasing. However, the increase in emissions historically is not as great in Sweden as in the majority of the other EU member states, where both truck traffic and car traffic have increased substantially more. According to the projections presented in Chapter 5, emissions from the transport sector are expected to increase.

Increases in motor-fuel taxes in Sweden have had the effect of mitigating the increase in emissions. The use of renewable motor fuels has increased in Sweden since they were made exempt from motor-fuel taxes in 2004. A number of incentives introduced to promote the introduction of what are known as green cars can contribute to increasing the proportion of biomass vehicle fuels in the future. The principal instruments directly aimed at promoting more fuel-efficient vehicles are a requirement for information on the fuel consumption of new vehicles and the automotive industry's EU-wide voluntary commitment to reduce carbon dioxide emissions from new vehicles. It is additionally planned that a carbon dioxide-related vehicle tax will be introduced during 2006.[28]

The government has also proposed the introduction of a special tax relief for new diesel-run cars equipped with particulate filters.

Motor-fuel taxes

Petrol and diesel are subject to energy tax, carbon dioxide tax and value-added tax (VAT). Carbon dioxide tax applies in full to these fuels, but increases in the tax rate up to the present level have been offset to some extent by a simultaneous reduction in energy tax. The greatest increase in tax on petrol was made in 1993. Energy tax on diesel was increased in the mid-1990s at the same time as a kilometre tax was removed. Tax on petrol and diesel has been indexed in line with the consumer price index since the end of the 1990s.

The impact on vehicles' fuel consumption and carbon dioxide emissions of the total tax increases implemented on petrol and diesel from 1990 to 2005 has been calculated, see Figures 4-6, 4-7[29]. Future effects for 2010, 2015 and 2020 have also been estimated. The calculations have been made with an economic vehicle-use model which is based on statistical correlations regarding how demand for vehicle fuels is affected by increases in petrol and diesel prices, known as price elasticities. As the basis for assessing this type of correlation is uncer-

[26] IVL 2004.
[27] IVL 2004.
[28] Government Bill 2005/2006:1, "2006 Budget Proposal".
[29] SIKA PM 2005:NC 4.

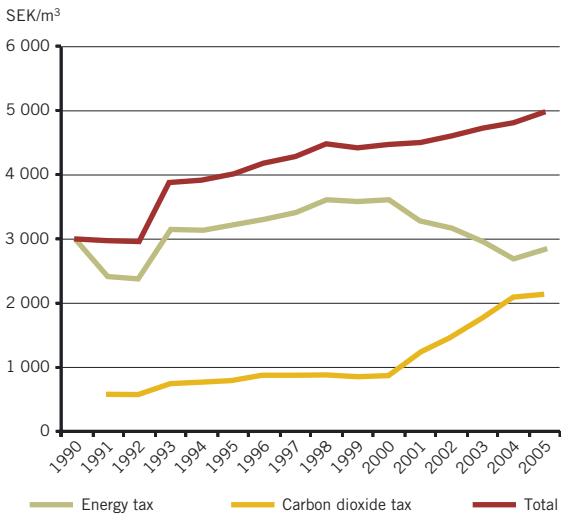

Figure 4-6 **Energy tax and carbon dioxide tax on petrol 1990-2005. In addition, there is value-added tax of 23.45% in 1990 and 1991 and 25% from 1992 on.**
(Source: National Tax Board)

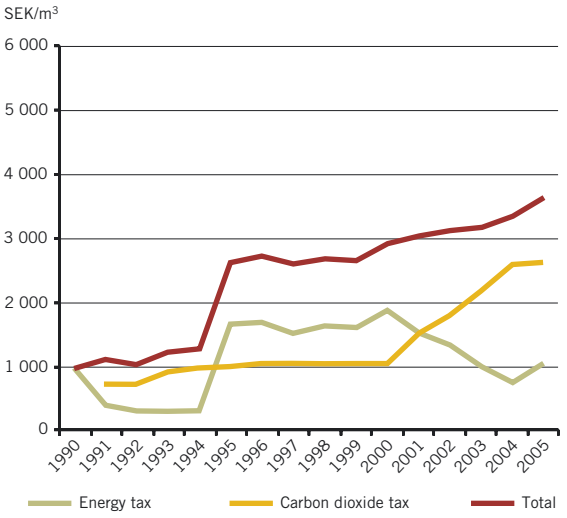

Figure 4-7 **Energy tax and carbon dioxide tax on diesel (MK 2 until 1996 and then MK1) 1990-2005.**
(Source: National Tax Board)

Table 4-4 **Calculated effects on emissions in Sweden of present-day levels of motor-fuel taxes compared with 1990 nominal levels, with two different price elasticities (million tonnes CO_2)**

	2005	2010	2015	2020
Calculated effort with lower and higher price elasticity respectively	1.5-3.2	1.6-3.4	1.7-3.5	1.8-3.8

tain, two sets of elasticities have been applied.[30]

The result of the calculation indicates that carbon dioxide emissions from vehicles in 2005 end up 1.5-3.2 million tonnes a year[31] lower due to the tax increases on motor fuels that have been implemented since 1990 than if motor-fuel tax had been retained at the nominal level in 1990. The average results of the calculations with higher and lower elasticity are shown in Figure 4-8.

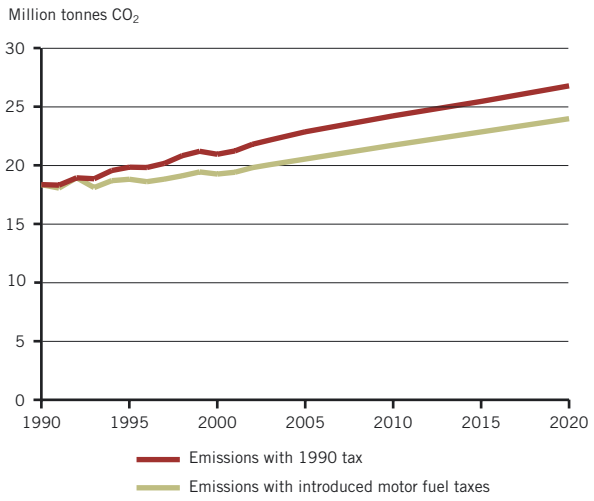

Figure 4-8 **Calculated and projected effects on carbon dioxide emissions from transport with and without implemented increases in motor-fuel tax 1990-2005. The reference case is the nominal tax level in 1990.**

[30] Price elasticities -0.8 for petrol and -0.2 for diesel and -0.4 for petrol and -0.1 for diesel, respectively. In other words, a price increase of 1% is expected to lead to a reduction in consumption of 0.8, 0.4, 0.2 and 0.1%, respectively, depending on the elasticity adopted. Total price elasticity includes an expected effect in the short and long terms in reduced distance driven and increased energy efficiency in the vehicle population.

EU strategy for reducing carbon dioxide emissions from new vehicles

The EU ministers of the environment adopted a strategy to reduce carbon dioxide emissions from new cars in 1996. The strategy is primarily based on a voluntary commitment by the car-industry organisation from 1998 to reduce emissions by 25% by 2008 in comparison with 1995. The commitment applies to an average on the whole EU market and need not be fulfilled in each individual member state, but follow-up of trends is also done at member-state level.

The effect of the commitment interacts with the effects of other instruments, mainly the level of motor-fuel taxes, and is influenced by economic development in society, petrol and diesel price trends, trends in new vehicle prices and so on. The trend in household disposable income and the proportion of company cars in sales of new vehicles are factors that influence the carbon dioxide emissions of new vehicles in Sweden.[32]

Average carbon dioxide emissions of new vehicles in Sweden decreased by 11% between 1995 and 2004. The decrease is in line with the trend at EU level. New fuel-efficient engine technology was introduced during the second half of the 1990s which led to reduced fuel consumption among new vehicles in Sweden at a more rapid rate than the trend

[31] With price elasticity of -0.4 and -0.1 for petrol and diesel respectively, the effect is 1.5 million tonnes lower CO_2 emissions, and with the higher price elasticity of -0.8/-0.2 the effect is 3.2 million tonnes lower emissions.

[32] Swedish Energy Agency/Swedish Environmental Protection Agency "Utvärdering av styrmedel i klimatpolitiken" (Evaluation of instruments in climate-change policy).

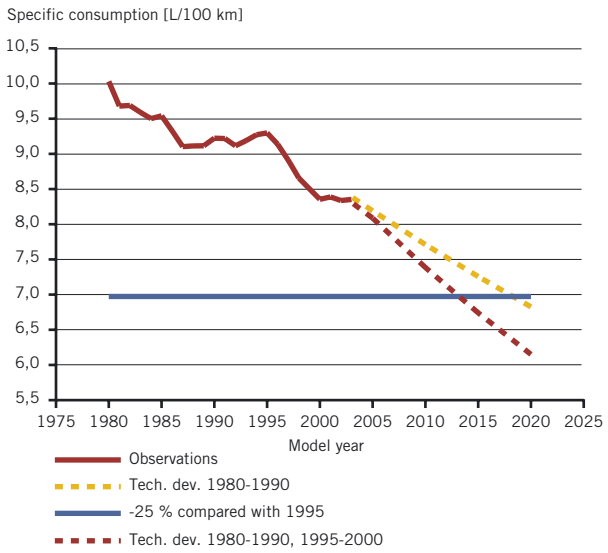

Figure 4-9 **Trend in specific consumption in new cars in Sweden since 1980. Two scenario alternatives up to 2020.**

over the previous 15 years. However, this trend has come to a halt since 2000. One reason for this is a sharp increase in the weight and engine capacity of new vehicles. The trend in average fuel consumption for new cars in Sweden from 1980 is shown in Figure 4-9, together with two alternative scenarios[33] for the future trend, one which agrees with the trend in the 1980s and an alternative which is an average of the trend during the 1980s and the second half of the 1990s. The two scenarios are equally feasible, and in both cases the 2008 average ends up significantly higher than the level required for a Swedish 25% reduction compared to 1990. It can be noted that both alternatives signify a more rapid rate of efficiency improvement than in the period 1980-1994, when average specific consumption of new vehicles overall only decreased by 8%.

Tax rules for company cars

Around 25% of sales of new vehicles in Sweden are accounted for by company cars. On average, these are heavier and have higher fuel consumption than the rest of the vehicle population. Current rules on company cars were amended in 1997 and 2002. The purpose of the 1997 amendment was that those in benefit of company cars should pay for fuel for private driving. This objective has only been fulfilled to 50%. An evaluation of the amendment shows, however, that the decision to introduce a tax on free fuel has had a significant effect in the form of a reduction in distance driven. Carbon dioxide emissions are estimated to have fallen by 0.2 million tonnes a year as a result of this amendment to the rules.

[33] SIKA, PM 2005 NC4.

Biofuel strategy for Sweden

The 2002 climate-change bill presented a strategy for biofuels and the introduction of what are known as 'green cars', with the principal aim of increasing the use of biofuels. The strategy comprises two main elements, tax exemption for biofuels and instruments and encouragement of vehicles that can use fuels other than petrol and diesel. The parliament subsequently (in the autumn of 2004) adopted the target of 3% of energy used as fuels in the transport sector having to consist of biofuels in 2005, and the government[34] has also expressed the aspiration that the 5.75% target stated in the EU Biofuels Directive should be attained by 2010.

Tax relief for biofuels

Biofuels have been exempt from carbon dioxide tax and energy tax in Sweden since 2004. The tax exemption applies up to and including 2008. The oil companies started large-scale admixture of ethanol in petrol in 2003, which has rapidly led to the situation that almost all petrol sold in Sweden now contains 5% ethanol. The use of biofuels has consequently increased from 0.7% of total petrol and diesel use in 2002 to 2% in 2004, in terms of energy content, and the increase has continued in 2005. The increase largely consists in increased use of imported ethanol for admixture in petrol.

EC-Directive limit the possible admixture level to no more than 5% in petrol but only a national statutory amendment is required to make it possible to mix 5% RME (Rapeseed Methyl Ester) from rapeseed oil into diesel. The Swedish government has given notice[35] of its intention to implement such an amendment in 2006. If the conditions to be met for low admixture are not amended, it is assumed that total use of biofuels will only increase marginally by 2010 in comparison with present-day levels.

Instruments affecting the introduction of green cars in Sweden

The total number of 'green cars'[36] has also increased sharply in recent years. New additions of green cars in 2004 amounted to just under 7000 vehicles[37] i.e. around 2.5% of new-car sales. This is a level which is slightly higher than the rate of introduction adopted in the forecast, see Chapter 5. Fuel-flexible ethanol vehicles are showing the greatest increase. Sales of ethanol for vehicles, known as E85, also increased sharply in 2004, but the statistics show that fuel-flexible ethanol vehicles use petrol as their fuel in around half of cases.

[34] Government Bill 2004/05:150.
[35] Government Bill 2004/05:150.
[36] Green cars are classified in tax legislation as cars to be run on ethanol, natural gas/biogas, electricity and hybrid cars.
[37] www.miljofordon.se. In addition to vehicles adapted to alternative fuels, the statistics include hybrid cars running on petrol and diesel. Both gas and ethanol vehicles can also use petrol.

The increase in green cars is largely explained by changes in instruments which have taken place and been announced.

- biofuels are exempt from tax
- green cars have lower benefit values when they are taxed as fringe benefits. The benefit value and therefore the tax for green cars was lowered in 2002. Sales of green cars to companies have increased from 3500 vehicles in 2002 to 6000 in 2003. Most of these cars are sold as company cars.
- grants from municipalities and national government (for example in the form of LIP grants) for the purchase of green cars
- local incentives for green cars, such as free parking and, in Stockholm, the prospect of avoiding planned congestion charges
- new procurement rules from 2005 for government agencies. The intention behind the rules is that at least 25% of cars purchased or leased by the Swedish State during a year shall be green cars.
- the government has additionally presented a legislative proposal obliging filling stations to supply renewable fuels. The proposal is to be considered by the parliament, and it is intended that it will come into force on 1 January 2006.

Several car manufacturers have launched models adapted for E85 in 2005. There are a number of reasons for assuming that the proportion of green cars among new-car sales will rise very sharply over the next few years.

It is estimated[38] that the total decrease in emissions in Sweden as a result of the instruments introduced to date under the biofuels strategy will amount to around 0.6 million tonnes of carbon dioxide equivalent a year in 2010. It is estimated that around 80% of this decrease is due to low admixture of ethanol to petrol and the remaining 20% to increased use of biofuel-powered green cars and heavy vehicles.

4.2.6 Waste

Emissions of methane from landfills are estimated to have decreased by 32% between 1990 and 2003. Emissions have successively fallen since the early 1990s, firstly as a result of the collection and disposal of methane gas from landfills having been expanded since the 1980s and secondly due to the quantity of organic material sent to landfill having decreased. The collection of methane gas for energy recovery was started partly with the support of investment grants and because this type of measure had proved cost-effective in many cases.

The landfilling of organic waste started to decrease during the second half of the 1990s. The instruments which were of significance during this period included the introduction of producer responsibility for a number of different groups of articles, such as packaging, waste paper, office paper and tyres. The requirement for municipal waste planning, which was introduced in 1991, is an instrument which is judged to have contributed both to the collection of methane gas having expanded and to the quantity of degradable waste sent to landfill having decreased. These plans have to contain the measures the municipality intends to take to deal with the waste in an environmentally correct and resource-efficient way.

A tax on waste sent to landfill was introduced in 2000, and a ban on the landfilling of sorted combustible and organic material has subsequently been introduced. These prohibitions came into effect in 2002 and 2005 respectively but are being implemented successively as derogations are granted for areas where there has not been sufficient time for alternative treatment capacity for recovery of materials and waste incineration to be expanded to an adequate extent.

The prohibitions have started to prove effective. Landfilling of household waste decreased sharply in 2003 and 2004 (by 30 and 34% respectively in comparison with the previous year). The landfilling of household waste has decreased by just over 70% since 1993. Landfilling is expected to continue to decrease over the next few years. Some of the waste is covered by producer responsibility or is recycled in some other way, but large proportions (around 80% in 2003) go to incineration with energy recovery, the extent of which has increased sharply in recent years. The extent to which biological treatment methods such as digestion and composting are applied has also increased. Many digestion and composting facilities have been subsidised by government investment programmes (LIP and Klimp). Both incineration with energy recovery and material recovery including biological treatment are regarded as acceptable methods from the environmental point of view in Sweden provided a high level of protection is maintained with regard to the quality of the waste and the cleaning technology used.

Combined effect of instruments in the area of waste

Sweden's Third National Communication (2001) presented the result of an analysis of the combined effect of instruments which affect discharges of methane from landfills. The assessment included instruments introduced during the 1990s and instruments which, at that time, were planned to be introduced during the early 2000s. The analysis was also used

[38] Swedish Environmental Protection Agency Report 5433 Skattebefrielse av biodrivmedel leder den rätt? (Tax exemption for biofuels – is it leading in the right direction?) Swedish EPA 2005.

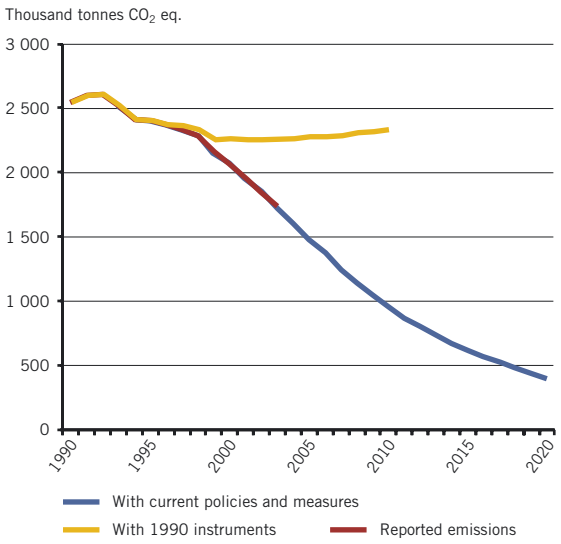

Figure 4-10 **Emissions from landfills with current policies and measures and with 1990 policy instruments.**

as a forecast of development in the sector. The base year for the forecast was 1999. The effect of present-day instruments was compared with a scenario with the instruments that existed in 1990. Figure 4-10 presents the analysis from 2001 together with the emission figures for the period 2000-2003. As can be seen, there is very good agreement between the forecast and development over recent years.

The analysis also shows that for 2010, emissions in the scenario with instruments decided upon at present end up 1.4 million tonnes of carbon dioxide equivalent lower than emissions in the scenario with 1990 instruments. The difference is estimated to amount to 1.9 million tonnes of carbon dioxide equivalent in 2020.

At the same time, waste incineration in the district-heating sector is expected to increase by around 10 TWh by 2010 in comparison with 1990 levels. Waste incineration means that at the same time as methane emissions from landfills decrease, emissions from heat production are avoided if the waste fuel displaces fossil fuel. If waste incineration is assumed instead to replace increased use of biofuels, the expansion signifies slightly higher emissions in the district-heating sector.

4.2.7 Agriculture

Emissions of methane and nitrous oxide from the agricultural sector account for around 12% of total greenhouse gas emissions in Sweden. Emissions decreased by around 9% between 1990 and 2003 and are expected to continue to decrease by 2010 to a level around 15% below 1990 emissions. The reduced emissions of methane are chiefly due to decreased livestock farming, while the reduction in nitrous oxide emissions is principally related to lower use of commercial fertiliser and farmyard manure.

At present there are no instruments in this sector that are *directly* aimed at reducing emissions of methane and nitrous oxide. For those instruments which indirectly affect greenhouse gas emissions in the sector there is at present only a basis for qualitative assessments of the effects.

The EU Common Agricultural Policy

The EU Common Agricultural Policy (CAP) has a significant bearing on the extent, orientation and profitability of agriculture. Implementation of the policy affects greenhouse emissions from agriculture. Agreement was reached by EU ministers of agriculture in June 2003 to reform the CAP. The reform in principle means that subsidies are decoupled from production. Subsidies are thus not governed by the size of production. The agreement also meant that some direct subsidies are transferred to rural development (modulation) and that intervention prices for milk and butter are lowered. In Sweden, the reform is being implemented from 2005.

According to a study from the Swedish Board of Agriculture[39] the reform means that around 20-50% of present-day farms in Sweden may become unprofitable, depending on orientation of production and geographical location. However, production is not expected to decrease to the same extent.

The Swedish environment and rural development programme

There are a number of targeted environmental payments in the *Swedish environment and rural development programme 2000-2006 (LBU)*, partially financed by the EU as part of the CAP. The environmental payments have been designed to attain environmental objectives such as preserving an open cultivated landscape, preserving biological diversity and reducing leaching of crop nutrients. There are no special payments for measures which limit greenhouse gas emissions in the programme, but support for measures which reduce nitrogen leaching may contribute to lower emissions. A recent evaluation of the environmental payment for reduced nitrogen leaching shows good results[40]. However, the combined effect of LBU for greenhouse gas emissions from agriculture seems to point in the opposite direction. The reason for this is that subsidies for the growing of forage crops and for pastureland, for example, have a positive impact on livestock farming, which counteracts the decrease in livestock numbers which otherwise would have positive effects on national greenhouse gas emissions.

[39] Swedish Board of Agriculture, Report 2004:16.
[40] Swedish Board of Agriculture, Report 2004:5.

Swedish Board of Agriculture action programme for reduced losses of crop nutrients

The Swedish Board of Agriculture's action programme to reduce losses of crop nutrients from agriculture to air and water is implemented with the aid of legislation, development activity, economic instruments (payments and environmental charges) and advice. The programme has existed since the late 1980s.

Among the measures which come about under the programme, mention can be made of the following:

- *Covering of slurry tanks*. This measure is designed to reduce emissions of ammonia but may also affect emissions of methane and nitrous oxide. What the effect is depends on how the measure is designed, but there is insufficient knowledge in this area.
- *Measures to reduce the supply of nitrogen to agricultural soil*. This measure also reduces releases of nitrous oxide.
- *Establishment of wetlands*. This measure may possibly increase releases of methane and nitrous oxide, but knowledge on this is incomplete.
- *Increased grazing on nitrogen-poor soils*. This measure tends to reduce emissions of nitrous oxide from manure.

4.2.8 Land use, land-use change and forestry

Uptake of carbon dioxide in forest biomass in 2003 was estimated to amount to 25.3 million tonnes in Sweden. Compared with the base year of 1990, this means slightly greater carbon dioxide sequestration, just over 1 million tonnes, in the forest. The removal of carbon dioxide is greater than emission when growth is greater than loss in the form of felling and natural loss. As the emission of carbon dioxide from agricultural land is estimated at around 3.8 million tonnes of carbon dioxide in 2003, the net sink from the "land use, land-use change and forestry" (LULUCF) sector is 21.5 million tonnes of carbon dioxide.

Measures in forestry which may contribute to reduced climate change are:

- Creating the necessary conditions for the use of forest fuels to replace fossil fuels and use of wood as a raw material instead of material whose manufacturing and degradation result in greenhouse gas emissions or high energy consumption.
- Avoiding the use of forestry methods that increase greenhouse gas emissions and otherwise adapting forestry so that greenhouse gas emissions decrease.
- Deliberately increasing forest biomass and using forestry methods that result in increased carbon content in forest soil.

It is measures of the latter two types that affect carbon sequestration in forest and soil.

Legislation and certification systems

Two overarching objectives have been formulated for forest policy in Sweden, a production objective and an environmental objective. These are equated. The environmental objective for forest policy emphasises the protection of biological diversity and genetic variation in particular.

The methods employed in forestry are chiefly governed in Swedish law by provisions in the Forestry Act and the Environmental Code. There are no special rules at present geared towards promoting increased sequestration of carbon in Sweden. On the other hand, application of relevant provisions directly affects the development of carbon sequestration in various ways. These include in particular:

- *Provisions on forest stewardship etc. in the Forestry Act*. Forest stewardship with measures where soil scarification, regeneration, clearing and thinning have been properly adapted to the requirements of the growing site for a good environment creates the necessary conditions for robust and vital forests with a high rate of growth, which is favourable for carbon storage.
- *Provisions on drainage in the Environmental Code*. Drainage affects greenhouse gas emissions. A low water table after drainage increases carbon dioxide emissions while discharge of methane and nitrous oxide may decrease. Applications for permits and exemptions for drainage are mandatory and are considered by the county administrative board.
- *Provisions on nature reserves and habitat protection in the Environmental Code and nature conservation agreements*. These create long-term formal protection not just for biological diversity but also for the carbon stock calculated as forest biomass. Swedish forest, which in relation to the boreal natural forests has a low average age, additionally has high carbon storage capacity, even a certain time after set-aside through reserves, habitat protection and nature conservation agreements has taken place. The target in Sweden is for another 400 000 hectares of forest to be protected by 2010 in comparison with the 1998 level of approximately 850 000 hectares of productive forest land.
- Alongside the legislation, the *target for voluntary set-aside* (an increase by 2010 of 500 000 hectares compared with 1998) is favourable for carbon storage. Voluntary set-aside forms an important part of the voluntary *forest certification schemes* (FSC and PEFC) which have been introduced with the aim of creating sustainable forestry.

4.2.9 International transport

Emissions from use of bunker fuels in Sweden for international shipping and aviation amounted to around 7.2 million tonnes of carbon dioxide equivalent in 2003. Emissions from bunker fuels were twice as high as in 1990. Emissions from international shipping account for the greatest share in the Swedish statistics, around 80% in 2003, and this type of bunkering is also showing the greatest increase. Emissions from fuel use for international transport are not included in the Swedish national commitment under the Kyoto Protocol as this form of transport is not covered by the protocol. According to the provisions of the Kyoto Protocol, on the other hand, each party has to present an account of work undertaken within the International Civil Aviation Organisation (ICAO) and the International Maritime Organisation (IMO) to contribute to and/or implement decisions in these organisations that limit greenhouse gas emissions.

Sweden is pressing in ICAO and IMO for aviation and shipping to be included in a global climate regime after 2012. However, the different conditions in the two branches of transport need to be taken into account in these activities.

Sweden is taking part within IMO in efforts to develop baselines for fuel consumption data and consequently for greenhouse gas emissions for different types of ships and sizes. The baselines can provide the foundation for an index system with certification which can be applied together with economic instruments.

Sweden is a member of the ICAO Committee on Aviation Environmental Protection (CAEP) and is actively involved in the committee and its subgroups in devising measures to limit the climate impact of aviation. This work is guided by *Decision A35-5 Consolidated statement of continuing ICAO policies and practices related to environmental protection*, which was adopted by the ICAO General Assembly in the autumn of 2004. The climate impact of aviation is principally dealt with in *Appendix H Environmental impact of civil aviation on the atmosphere* and in *Appendix I Market-based measures regarding aircraft engine emissions*. Sweden is involved in two working groups under CAEP, one for improved technology for reduced emissions in cooperation with aircraft and engine manufacturers, and another which analyses the environmental and cost effectiveness of the various proposed measures.

Sweden has also supported ICAO efforts to draw up a manual entitled "Operational Opportunities to Minimize Fuel Use and Reduce Emissions" (Circ 303, 2004) and has promoted the holding of regional seminars. Through these seminars, ICAO informs the industry in various parts of the world about technology and processes for more fuel-efficient procedures for air-traffic control and for carrying out flights.

During the ICAO General Assembly in 2004 Sweden, together with other European states, successfully pressed for all types of market-based instruments to limit greenhouse gas emissions to be kept on the agenda for the organisation's continued work. Sweden has also urged deeper cooperation between ICAO and the secretariat of the Convention on Climate Change with regard to methodological issues and the reporting of emissions. During the period up to the next General Assembly in 2007, Sweden is heading a working group, the Emissions Trading Task Force, one of the tasks of which is to draw up guidance for states wishing to incorporate aviation into their emissions trading schemes in accordance with the processes under the Convention on Climate Change.

Within the EU (Expert Group on International Aviation and Maritime Transport), Sweden is taking part in the preparations for a common position on how fuels for international air traffic and shipping can be covered by international commitments under the Convention on Climate Change. Sweden is also taking an active part in European cooperation with regard to limiting emissions within bodies such as ECAC and Eurocontrol.

4.3 The project-based flexible mechanisms of the Kyoto Protocol

Under the 1997 energy-policy decision, SEK 350 million was earmarked for international climate-policy efforts for the period 1997-2004. Some of these funds related to multilateral cooperation and work involving the flexible mechanisms of the Kyoto Protocol, primarily the clean development mechanism (CDM) and joint implementation (JI). During the period 1997-1999 some of these funds were used for the pilot phase of activities implemented jointly (AIJ). Sweden is also to introduce the 'Linking Directive'. This directive is an addition to the directive on emissions trading, and links together the European trading scheme and the flexible mechanisms of the Kyoto Protocol. It means that companies can make use of certified emission reductions from CDM projects together with European emission allowances when reporting that their actual emissions are covered.

The Swedish State takes part in two multilateral funds, the Prototype Carbon Fund (PCF) and Test-

ing Ground Facility (TGF). The PCF is the World Bank's early multilateral investment fund for greenhouse gas-reducing projects which invest in JI and CDM projects. TGF is aimed at implementing JI projects in the Baltic states, Poland and Russia under the Baltic Sea Region Economic Cooperation Council (BASREC) and transferring emissions reduction units to the investor countries, which are the Nordic countries and Germany. In addition, Sweden is committed to a government-financed CDM and JI programme – SICLIP (Swedish International Climate Investment Programme) – which is administered by the Swedish Energy Agency. The total sums invested in the funds and in SICLIP are expected to lead to the acquisition of emission reduction units over the period 2008-2012 amounting to around 5 million tonnes of carbon dioxide equivalent, i.e. around 1 million tonnes of carbon dioxide equivalent a year.

Sweden has committed itself in work related to the flexible mechanisms of the Kyoto Protocol to bring about cost-effective emission reductions, gain early experience and contribute towards the mechanisms being developed into credible climate policy instruments. Through international cooperation under CDM, Sweden is also pressing for climate measures to contribute to sustainable development in developing countries. The experience is used in the international work on the development of mechanisms and to improve the prospects for Swedish companies of being able to utilise the opportunities presented by the linking directive in the EU trading scheme.

Table 4-5 **Sums invested for acquisition of emission reduction units**

Fund/Programme	Sums invested	Comments
Testing Ground Facility	EUR 4 million	JI cooperation under the Baltic Sea Cooperation
Prototype Carbon Fund	USD 10 million	The World Bank's fund for acquisition of emission reduction units from CDM and JI projects
SICLIP	SEK 160 million	Sweden's national programme for acquisition of emission reduction units from CDM and JI projects

4.4 Cost-effectiveness of policies and measures in Swedish climate strategy

4.4.1 How is the cost-effectiveness of a policy instrument judged?

The term cost-effectiveness relates to a situation where a given goal is attained at the lowest possible cost. To be able to judge the cost-effectiveness of different instruments, there is therefore a need for (a) a specified goal and (b) an idea of which consequences of the instruments are to be regarded as costs. In the case of a national objective with regard to greenhouse gas emissions, it is the macro-economic costs that are relevant, i.e. the change in the scope for consumption (in a broad sense) of households to which the instrument gives rise. Effects on future generations should also be considered in the analysis so that a comprehensive assessment is obtained.

The costs of an instrument contain several different parts:

- The costs of the measures implemented as an effect of the instrument
- Transaction costs, for instance to gather information and decide on possible measures
- The administrative costs of the instrument both among authorities and among companies and households.
- The effect on the total economy to which an instrument may lead.

The instrument in question may have to attain several goals, and it may therefore be difficult to allocate the costs of the instrument concerned in a fair manner. The instrument may, for example, as commonly happens in Swedish climate strategy, be intended to have an impact on several environmental objectives at the same time but also to contribute to the fulfilment of broader energy, waste and labour-market policy objectives.

It can generally be noted that instruments with a general action such as taxes and emissions trading which impose the same marginal costs for emissions on companies and households have the same prospects of attaining cost-effectiveness because they can lead in a flexible way to measures of different kinds and at low costs being adopted. The information which private actors have on their own specific opportunities to reduce emissions is utilised in an effective way. The emissions trading scheme also has the advantage of covering several countries and that reductions in emissions can consequently be achieved at lower aggregate cost than would have been the case if the same reduction in emissions had been achieved through national measures alone.

More targeted instruments such as energy standards, investment grants and examination of terms often do not have the same flexibility with regard to choice of measure and individual commitment and may also be more demanding on resources.

Cost-effectiveness consequently is often lower than for the general and therefore more flexible instruments. In practice there is, however, a risk of the general systems not being possible to be constructed in a theoretically desirable way owing to conflicting aims. Targeted instruments can also contribute to increasing knowledge of the opportunities that exist for measures. This means that in practice it may be cost-effective in many cases to combine general and targeted instruments. To drive technological development forward, there is also, for the most part, a need for general economic instruments to be combined with other instruments. Both grants for research and development and grants for the establishment of initial markets are concerned.

Swedish climate strategy includes both emissions trading and energy taxes, but they do not cover all sectors of society, nor are they identically formulated. With regard to the energy tax system, different rates of tax have been applied to different sectors because some industries face international competition. There is a risk of such differentiation impairing the cost-effectiveness of the system as different actors incur different costs for their emissions. In a world in which not all countries face restrictions on emissions, differentiation of tax levels may nevertheless be judged to be cost-effective when the effects on the total economy are taken into consideration[41].

4.4.2 Cost-effectiveness of instruments in relation to global emissions targets and national commitments

To succeed in limiting levels of greenhouse gases in the atmosphere cost-effectively, international cooperation is required in both the short term and the long term. Measures to reduce emissions and disseminate technology can then be implemented as far as possible where the cost is lowest. Examples of such international cooperation are the flexible mechanisms of the Kyoto Protocol and the EU's emissions trading scheme. The fact that measures vary between countries is due to the varying starting situations. One factor is that countries have worked in widely differing ways on measures to improve the efficiency of energy use or reduce emissions. In countries with high energy intensity and a larger proportion of fossil fuels, emissions-reducing measures can generally be implemented at lower cost than in countries that have lower energy intensity and a limited use of fossil energy.

To ensure that long-term climate targets can be attained, pressure for change which leads to structural changes and the development of new technology needs to be created at the same time. Such development is necessary to create long-term sustainable growth.

Sweden has chosen a balance between these two objectives by conducting a national policy on climate change which contains firstly instruments that entail emissions-reducing measures being implemented domestically and secondly cooperation under the flexible mechanisms of the Kyoto Protocol and the EU trading scheme.

4.4.3 Estimated costs of measures implemented as a consequence of Swedish climate-policy instruments

It is difficult to calculate cost-effectiveness for the large quantity of measures which, taken together, are implemented as a consequence of the instruments included in Swedish climate strategy. A step in the assessment of the cost-effectiveness of an instrument is, however, as indicated above, the estimation of how high the costs of the measures taken as a consequence of the instrument are, and some examples of the costs of implementing commonly occurring measures can be presented.[42]

A crucial question for an assessment of the costs of a measure in relation to the effect it achieves is whether the measure is evaluated from an overall perspective, where global emissions have to be reduced at the lowest cost possible, or whether it is evaluated in relation to national emissions commitments. For measures taken in Sweden only the emissions reductions that take place within the Swedish borders can be credited to the country in relation to the country's national commitments. Note, however, that the costs reported here are calculated on the basis of the combined impact of the measures on emissions regardless of where this takes place. This is of particular significance for Sweden when discussing measures that reduce electricity use or entail adding new electricity-generating capacity. Measures of this kind lead to reductions in emissions in the integrated Nordic electricity system.

The measures which are and have been taken as a result of increased *energy and carbon dioxide taxation* in many cases point to relatively low costs in terms of reduced emissions. The clearest effect of energy and carbon dioxide taxation, increased use of biomass fuels instead of fossil fuels in district-heating production, can be judged to have costs as low as around SEK 0.1/kg CO_2.[43] The cost of re-

[41] Söderholm, Hammar. 2005, Kostnadseffektiva styrmedel i den svenska klimat- och energipolitiken (Cost-effective instruments in Swedish climate and energy policy)

[42] The principle applied is that the costs of replacing one energy technology with another with equivalent performance, but with lower emissions, have been estimated on the basis of differences in investment costs and operating costs between the alternatives. Many measures which follow from the instruments also affect the perceived benefit the actors encounter. There may, for example, be changes in heating comfort, transport activity or safety. To determine the cost of measures of this type, the analysis would need to be supplemented by an estimate of the value of benefits affected, for example by measuring the willingness to pay that exists for the benefits.

[43] Ekström et al. 2002. The comparison includes capital costs, variable operating costs and fuel costs, excluding taxes. If there is no need to replace existing heating production installations, the cost of replacement is slightly higher although the proportion of capital costs in the case of oil-based heating production is relatively small. The cost estimates also depend on the assumptions made on fuel costs. A change in the price of oil of 1 öre/kWh is equivalent to a change in cost of carbon dioxide reduction of around 3.5 öre/kg CO_2.

placing fossil fuels with wood pellets in apartment buildings, commercial premises and detached and semi-detached houses is around SEK 0.35/kg CO_2 for replacement in apartment buildings and commercial premises and SEK 0.5/kg CO_2 in detached houses.[44,45] The cost for these cases is thus deemed to be lower than the present-day carbon dioxide tax.

The *electricity certificate* system is intended to increase the production of electricity from renewable energy sources. If this production leads to replacement of fossil fuel-based electricity production (in Sweden or abroad) by new biomass combined heat and power plants or wind turbines being put into operation, the costs of measures can be estimated at between SEK 0.2 and 0.5 per kg CO_2 depending on what renewable technology is assumed and what fossil fuel-based electricity production is assumed to be replaced.[46] It is considered that the increase in renewable electricity production during the first few years of the system could have taken place at still lower costs as it has principally involved utilising opportunities for fuel conversions and increased use of existing electricity production capacity in biomass combined heat and power plants. It is felt that a large proportion of the potential for these measures at very low costs has already been utilised. It is considered that there is further potential for measures that can be implemented at low cost in retrofits of existing biomass combined heat and power plants. When these opportunities have been fully exploited, the next great potential will remain in expanding renewable electricity production capacity.

Emissions are increasing continuously in the transport sector despite a significant rise in carbon dioxide cost. This is an indication that the costs faced by transport consumers to reduce emissions in the sector are high. However, this is not due to vehicles with low fuel consumption being more expensive than fuels with high fuel consumption. It is rather the opposite that is the case. On the other hand, the willingness of consumers to pay for improved performance and road safety as well as for increased transport is high, which is the principal reason why high carbon dioxide costs are required to reduce emissions in this sector.

The increasing *use of ethanol* in Sweden in recent years is not one of the cheapest ways of reducing carbon dioxide emissions. However, the costs of low admixture of ethanol in petrol are small in comparison with running vehicles solely on ethanol. However, the cost of low admixture varies depending on what raw material is used. The cost of reducing emissions by replacing petrol with cereals-based ethanol produced in Sweden has been estimated at SEK 2.3 per kg carbon dioxide. The equivalent cost for ethanol produced from the European wine surplus is SEK 0.8 per kg carbon dioxide. The lowest cost is estimated for imported tropical ethanol. The cost in this case is estimated at SEK 0.4 per kg carbon dioxide today, falling to SEK 0.2 per kg carbon dioxide in 2010. The calculation includes costs for fuel transportation and additional costs of admixture in fuel.[47]

Costs and other consequences of measures implemented in the area of waste have been the object of a large number of system analyses. The analyses[48] show that the ranking with respect to costs varies depending on the waste fractions concerned. With regard to the organic fraction in the waste, i.e. the fraction which is principally covered by the prohibitions on landfilling, the costs of sending the waste to landfill or incinerating it, excluding taxes, are relatively close. Instruments in the area of waste have thus principally led to measures that entail reductions in emissions at relatively low cost. In some cases the measures may contribute revenue for society. In addition, the measures are primarily implemented to fulfil environmental-policy objectives other than the climate objective.

To summarise, the examples show that among the measures implemented in Sweden at present as a consequence of Swedish climate strategy, there are some which can be implemented at low cost but also others which are relatively costly.

4.5 Instruments no longer in use

In comparison with the account given in the third national communication, some instruments, chiefly in the energy sector, have now been taken out of use and replaced principally by other instruments. Several of the instruments concerned are nevertheless included in this national communication as they came to an end after 2001. The instruments are summarised in Table 4-6:

[44] Ekström et al. 2002. Conditional on replacement of heating system taking place when the system would normally have been replaced.

[45] Swedpower, 2005. Påverkan av olika styrmedel på investeringsbeslut inom fjärrvärme- och bostadssektorn (Impact of different policy instruments on investment decisions in the district-heating and residential sector).

[46] Swedish Environmental Protection Agency, Report 5286.

[47] Swedish Environmental Protection Agency, Report 5433.

[48] Syntes av studier på ekonomiska för- och nackdelar av olika avfallshanteringsstrategier ("Synthesis of studies of economic advantages and drawbacks of different waste management strategies") Marcus Carlsson Reich Fms report 186 December 2003

Table 4-6 **Instruments no longer in use**

Instrument	Primarily replaced by
Pilot project exemptions for biofuels	General tax exemption for biofuels
Investment subsidies for biomass fuel-based CHP	Electricity certificates
Investment subsidies for wind power and small-scale hydropower	Electricity certificates
Grants for conversion from electric heating to district heating	Continued tax shift, Klimp
Grants towards measures to develop electricity and heating supply in southern Sweden	Electricity certificates etc.
Commitment to pilot programme for joint implementation (AIJ)	Commitment to work on CDM and JI

4.6 Summary table of policy instruments

Table 4-7 **Summary table of policy instruments in Swedish climate strategy**

Name of measure/instrument	Primary purpose	Greenhouse gas primarily concerned	Type of instrument	Status of instrument	Administering government agency 2005	Estimated reduction in million tonnes CO_2e per year			
						2005	2010	2015	2020
Cross-sectoral policy instruments									
Local investment programme (LIP)	Change-over to ecological sustainability at local level	All	Economic	Finished (03.98)	Swedish EPA	Up to 1.5	Up to 1.5	Up to 1.5	Up to 1.5
Climate investment programme (KLIMP)	Subsidies for projects that reduce climate impact	All	Economic	In progress (2003-	Swedish EPA	Up to 0.5	Up to 0.5	Up to 0.5	Up to 0.5
The Environmental Code	Ecologically sustainable development	All	Legislation	In progress (1999-	Swedish EPA	N.E.	N.E.	N.E.	N.E.
Climate information campaign	Increased knowledge of problem of climate change	All	Education, training and public awareness	Finished (2002-2003)	Swedish EPA	N.E.	N.E.	N.E.	N.E.
Energy sector excluding transport									
Energy tax	Fiscal	Carbon dioxide	Fiscal	In progress (57-	National Tax Board	7	10	19	38
Carbon dioxide tax	Reduce use of fossil fuels	Carbon dioxide	Fiscal	In progress (91-	National Tax Board				
Programme for increased supply of electricity from renewables, 1998-2002	Increase supply of electricity from renewables	Carbon dioxide	Economic	Finished (98-02)	Swedish Energy Agency				
Electricity certificate system	Increase supply of electricity from renewables	Carbon dioxide	Economic	In progress (2003-	Swedish Energy Agency and Svenska Kraftnät				
EU Emissions Trading Scheme	Reduce use of fossil fuels in the trading sector	Carbon dioxide	Economic	In progress (2005-	Swedish EPA and Swedish Energy Agency				
Programme for reduced electricity use 1998-2002*	Reduce electricity use	Carbon dioxide	Economic	Finished (98-02)	Swedish Energy Agency	0	0	Up to 0.8	Up to 0.8
Subsidies for technology procurement	More efficient energy use and increased use of renewables	Carbon dioxide	Economic	In progress	Swedish Energy Agency	N.E.	N.E.	N.E.	N.E.
Energy labelling	More efficient energy use	Carbon dioxide	Education, training and public awareness	In progress	Swedish Consumer Agency	N.E.	N.E.	N.E.	N.E.
Subsidies for energy advisory services	More efficient energy use and increased use of renewables	Carbon dioxide	Education, training and public awareness	In progress	Swedish Energy Agency	N.E.	N.E.	N.E.	N.E.
Building regulations standards for energy efficiency	More efficient energy use	Carbon dioxide	Legislation	In progress	National Board of Housing, Building and Planning	N.E.	N.E.	N.E.	N.E.
Implementation of the Energy Performance of Buildings Directive	More efficient energy use	Carbon dioxide	Information on legislation	Planned		N.E.	N.E.	N.E.	N.E.
Programme for energy efficiency improvement	Reduce electricity use	Carbon dioxide	Voluntary/negotiated agreement	In progress (2005-	Swedish Energy Agency	N.E.	N.E.	N.E.	N.E.

* In the judgement of the Swedish Energy Agency reduced electricity use up to 2012 is expected to lead to reduced electricity production from coal-condensing power stations within the Nordic electricity system, but outside Sweden. However, after 2012 it is judged that electricity use within the Nordic electricity system will reach production volume and the new investments then made are expected to be in natural gas-fired combined-cycle power stations in or outside Sweden.

Name of measure/instrument	Primary purpose	Greenhouse gas primarily concerned	Type of instrument	Status of instrument	Administering government agency 2005	Estimated reduction in million tonnes CO_2e per year			
						2005	2010	2015	2020
Industrial processes including emissions of fluorinated greenhouse gases									
Application of the Environmental Code	Ecologically sustainable development	PFCs	Legislation	In progress (1999)	Swedish EPA	0	0.2	0.2	0.2
F gas regulation including mobile air conditioners directive		HFCs	Legislation	In planning		0	0.15	0.25	0.4
Transport									
Motor-fuel taxes	Internalise the external effects of road transport including greenhouse gas emissions	Carbon dioxide	Fiscal	In progress	National Tax Board	1.5-3.2	1.6-3.4	1.7-3.5	1.8-3.8
Implementation of the automotive industry's commitment on lower carbon dioxide emissions from new cars	Reduce carbon dioxide emissions	Carbon dioxide	Voluntary/negotiated agreement	In progress (1998-)	National Road Administration	N.E.	N.E.	N.E.	N.E.
Taxation of cars received as benefit (1997 amendment)	Fiscal	Carbon dioxide	Fiscal	In progress	National Tax Board	0.2	0.2	0.2	0.2
Tax relief on biomass fuels	Reduced greenhouse gas emissions	Carbon dioxide	Fiscal	In progress	National Tax Board	0.3	0.4	0.4	0.4
Instruments for increased introduction of green cars	Reduced greenhouse gas emissions	Carbon dioxide	Legislation, fiscal instruments, economic instruments	In progress	National Road Administration, National Tax Board	0.1	0.2	0.2	0.2
Waste									
Rules on municipal waste planning, rules on producer responsibility for certain goods, tax on landfilling of waste (2000), prohibition of landfilling of unsorted combustible waste (2002) and prohibition of landfilling organic waste (2005)	Increase recycling of waste and reduce total waste quantities	Methane gas	Legislation and fiscal instruments	In progress	Swedish EPA	0.8	1.4	1.7	1.9
Agriculture									
Targeted environmental payments in the environment and rural development programme	A varied agricultural landscape and reduced eutrophication	Nitrous oxide and methane	Economic	In progress	Swedish Board of Agriculture	N.E.	N.E.	N.E.	N.E.
Programme of measures to reduce losses of crop nutrients (subsidies, grants, environmental charges, information)	Reduced eutrophication	Nitrous oxide and methane	Economic and education, training and public awareness	In progress	Swedish Board of Agriculture	N.E.	N.E.	N.E.	N.E.
Land use, land-use change and forestry (LULUCF)									
Provisions on forest stewardship etc. in the Forestry Act.	Attaining environmental objectives and production targets for forests	Carbon dioxide	Legislation	In progress	National Board of Forestry	N.E.	N.E.	N.E.	N.E.
Provisions on drainage in the Environmental Code.	Biological diversity	Carbon dioxide and methane	Legislation	In progress	County administrative boards	N.E.	N.E.	N.E.	N.E.
Provisions on nature reserves and habitat protection in the Environmental Code and nature conservation agreements	Biological diversity	Carbon dioxide	Legislation	In progress	Swedish EPA and county administrative boards	N.E.	N.E.	N.E.	N.E.
Voluntary set-asides, partly through voluntary forest certification systems (FSC and PEFC)	Environmentally sound forestry	Carbon dioxide	Voluntary/negotiated agreement	In progress		N.E.	N.E.	N.E.	N.E.

N.E. means Non-Estimated effect

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5 Projections and the total effect of policies and measures

5.1 Aggregate projections

Projections[1] of greenhouse gas emissions focusing on 2010 and 2020 have been produced[2]. The projections are based on the policies and measures adopted by the Swedish parliament, that is to say they are projections "with measures". No projections "with additional measures" have been made as no further climate policies and measures are judged to be needed to meet Sweden's commitment under the Kyoto Protocol. In addition to the projections, another four projection calculations have been performed as a sensitivity analysis. The four sensitivity alternatives are faster and slower phase-out of nuclear power, a scenario with higher economic growth than in the projections and a scenario with higher oil and natural gas prices.

The projections indicate that emission levels as a mean value for the period 2008-2012 will not exceed 104% of 1990 emissions. If Sweden only reports emissions from land use, land-use change and forestry, according to the mandatory Article 3.3 of the Kyoto Protocol, an addition of emissions is obtained and net emissions according to the projections end up in line with the country's commitment. If Sweden chooses additionally to report emissions and removals from forestry in accordance with Article 3.4 of the Kyoto Protocol, net emissions are estimated instead to end up substantially below the country's commitment.

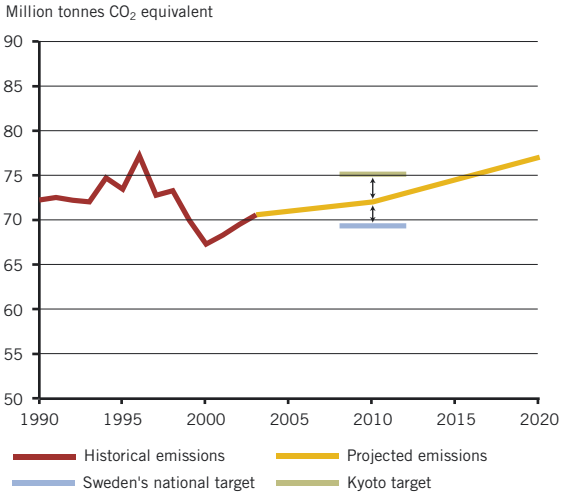

Figure 5-1 **Historical and projected emissions (excluding LULUCF), the Kyoto target and the Swedish national target for the limitation of greenhouse gas emissions.**

Total emissions in 2010 are estimated to be 99% of the 1990 level. Sweden has also established a national target according to which greenhouse gas emissions over the period 2008-2012 on average are to be 4% lower than the 1990 level excluding LULUCF. According to the projections, this target will not be met unless further measures are taken.

The projections point towards total greenhouse gas emissions excluding emissions and removals from the land use, land-use change and forestry

Table 5-1 **Historical and projected emissions of greenhouse gases per sector (millions of tonnes of CO_2 equivalent)**

	1990	2003	2005	2010	2015	2020	1990-2010	1990-2020
Energy* excl. transport	34.8	32.7	32.9	33.2	33.7	36.2	-5%	4%
Industrial processes**	5.7	5.9	6.0	6.1	6.2	6.4	8%	12%
Transport	18.9	20.9	21.4	22.6	23.8	25.0	19%	32%
Waste	2.8	2.0	1.8	1.2	0.9	0.7	-56%	-76%
Agriculture	9.6	8.7	8.5	8.1	8.1	8.1	-16%	-16%
Solvents	0.4	0.3	0.3	0.2	0.2	0.2	-41%	-41%
Total emissions (excl. LULUCF)	**72.2**	**70.6**	**70.8**	**71.5**	**73.1**	**76.6**	**-1%**	**6%**

* Energy includes electricity and district-heating production, industrial combustion, residential and service, refineries, fugitive emissions and other
** Industrial processes consist of raw material related emissions and fluorinated greenhouse gases.

[1] The projections were produced in 2004. The projections have been updated in 2005 so that they agree with the historical emissions reported in the annual emissions inventory for 2005 (Sweden's National Inventory Report 2005)
[2] Swedish Energy Agency ER 20:2004, Swedish Environmental Protection Agency 5393

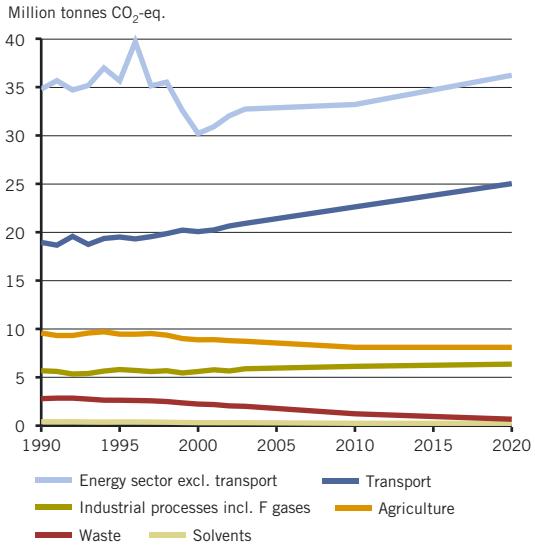

Figure 5-2 **Greenhouse gas emissions per sector (excluding LULUCF) over the period 1990 – 2020.**

sector (LULUCF) increasing up to 2010 in comparison with levels in recent years but they will nevertheless be slightly below the 1990 level. Emissions are expected to increase at a faster rate after 2010. This increase after 2010 is principally due to the assumption that Swedish nuclear power plants are decommissioned after an operational life of 40 years and are principally replaced by natural gas based power plants. Increased road transport by heavy goods vehicles also contributes to increased emissions during the period up to 2020.

The expected trend in emissions differs between different sectors of society. The energy sector excluding transport is expected to reduce its greenhouse gas emissions between 1990 and 2010 by 5% while the transport sector is expected to increase its emissions by around 20%. Emissions from the agriculture sector have decreased to date and are expected to continue to decrease to be just under 16% below the 1990 level in 2010. Emissions from the waste sector are expected to be halved in comparison with the 1990 level. On the other hand, emissions from industrial processes including fluorinated greenhouse gases are estimated to increase and are expected to be 8% higher in 2010 than the 1990 level.

Figure 5-2 shows historical emissions up to 2003 and the projections for greenhouse gas emissions from different sectors, millions of tonnes of CO_2 equivalent.

Carbon dioxide accounted for around 80% of total greenhouse gas emissions in Sweden in 2003 and is the greenhouse gas which is estimated to increase most, in absolute terms, according to the projections. At the same time emissions of methane, but also of nitrous oxide, are expected to decrease, which is expected to appreciably reduce the aggregate increase in emissions. Emissions of fluorinated greenhouse gases are estimated to increase over the period of the projections but to continue to account for a small proportion of total greenhouse gases.

5.2 Projections per sector

Projected results for emissions and removals from each sector and the assumptions on which the calculations are based are presented in this section. Emissions from each sector are also broken down by greenhouse gas and are presented in the following sections.

5.2.1 Energy excluding transport

The energy sector includes production of electricity and district heating, industrial combustion, combustion in the residential and service sector, fugitive emissions (e.g. flaring) and other (principally military transport). Total emissions of greenhouse gases from the energy sector are estimated to decrease up

Table 5-2 **Historical and projected greenhouse gas emissions per gas (million tonnes CO_2 equivalent)**

Greenhouse gas/year	1990	2003	2005	2010	2015	2020	1990-2010	1990-2020
Carbon dioxide	56.3	56.0	56.6	58.3	60.0	63.7	4%	13%
Methane	6.5	5.5	5.2	4.5	4.1	3.8	-32%	-42%
Nitrous oxide	8.9	8.2	8.2	8.0	8.2	8.3	-9%	-7%
Fluorinated greenhouse gases	0.55	0.84	0.82	0.79	0.82	0.85	43%	53%
Total emissions (excl. LULUCF)	**72.2**	**70.6**	**70.8**	**71.5**	**73.1**	**76.6**	**-1%**	**6%**

Table 5-3 **Historical and projected greenhouse gas emissions from the energy sector excluding transport (million tonnes CO_2 equivalent)**

	1990	2003	2005	2010	2015	2020	1990-2010	1990-2020
Carbon dioxide	33.3	31.1	31.2	31.5	32.0	34.6	-5%	4%
Methane	0.30	0.35	0.35	0.35	0.29	0.23	18%	-22%
Nitrous oxide	1.2	1.2	1.3	1.3	1.4	1.4	10%	18%
Total	**34.8**	**32.7**	**32.9**	**33.2**	**33.7**	**36.2**	**-5%**	**4%**

to 2010 but are expected to increase slightly up to 2020 in comparison with 1990. The principal reason for the decrease up to 2010 is an estimation of a continued decrease in emissions from the residential and service sector, while the increase up to 2020 is due to natural gas being expected to replace nuclear power.

The general assumptions on which the projections for the energy sector are based are summarised in Facts 5.1. In addition to these, a number of specific assumptions are made for the particular sub-sector concerned.

Projections of greenhouse gas emissions from the energy sector excluding transport are based on projections of the development of fuel use in the sector.

Facts 5.1 **General assumptions on which estimates for the energy sector are based:**

- The nuclear power stations are shut down after 40 years of operation and have availability of 80%.
- Barsebäck 1 and 2 have been decommissioned.
- In the EU trading scheme a price of emission allowances of 10 euros per tonne CO_2 has been assumed throughout the period up to 2020.
- It has been assumed on the basis of current decisions on the electricity certificate system that the system will lead to 10 TWh of new electricity production based on renewables being added in 2010. On the other hand, it is assumed that the electricity certificate system will not lead to any further new electricity production based on renewables between 2010 and 2020 as a consequence of current decisions on the electricity certificate system.
- Carbon dioxide tax remains to apply to those sectors covered by the EU emission trading scheme.
- It is otherwise assumed that current taxes and other policy instruments (2004) will remain up to 2020 (for a description of current instruments, see Chapter 4 "Policies and measures")
- Swedish Energy Agency estimate of the trend in prices for biomass fuels and waste:

Prices in SEK/MWh	2000	2010	2020
Liquors, pine tree oil, small-scale timber	15	15	15
Forest fuel for industry	60	70	80
Forest fuel other, mean	112	140	155
Energy forest, energy crops	130	140	150
Peat	110	120	130
Waste	15	15	15

- National Institute of Economic Research estimates of economic development:

	1990-2000	2000-2010	2010-2020
GDP	1.9%/year	1.7%/year	1.8%/year
Private consumption	1.5%/year	2.6%/year	2.6%/year
Industry production value	4.4%/year	2.6%/year	3.3%/year

- IEA* estimates for trend in fossil fuel prices.

	2000	2010	2020
Crude oil, USD/barrel	28	21	25
Coal, USD/tonnes in port	35	39	41
Natural gas, USD/Mbtu	3.0	2.8	3.3

* World Energy Outlook 2002, International Energy Agency

Use of fuels (excluding nuclear fuel) for the energy sector excluding transport increases in the projections, partly due to increased fuel-based electricity production and increased fuel use in the industrial sector. There is expected to be a very sharp increase in the use of natural gas up to 2020. Use of natural gas in the projections amounts to 50 TWh in 2020. This means that expansion of the infrastructure for gas has been assumed to occur as the existing pipeline system can be used for a maximum of 30 TWh of natural gas. The supply of oil is estimated to decrease up to both 2010 and 2020, principally due to reduced oil use for heating in the residential sector. Use of biomass fuels[3] is expected to increase sharply during the scenario period, mostly for production of electricity and district heating but also for use in the industrial sector. The use of waste for the production of electricity and district heating is also esimated to increase, while peat combustion for the production of electricity and heating is estimated to decrease up to 2020.

Production of electricity and district heating

Greenhouse gas emissions from the production of electricity and district heating including refineries account for three-quarters of energy sector emissions and are expected to increase by just under 40% by 2010 and by just over 70% by 2020 in comparison with the 1990 level of emissions.

Emissions from electricity production are expected to more than double by 2010, principally as an effect of an assumed expansion of combined heat and power plants based on natural gas. Emissions from district-heating production are also expected to increase slightly to return to the 1990 level in 2010 mainly due to the expected increased use of waste for district-heating production. Emissions from refineries are additionally estimated to increase substantially up to 2010 due to increased production and stricter product requirements.

After 2010, slightly increasing emissions from district heating production and an even greater increase from the production of electricity are expected. The projections show three times higher emissions from electricity production in 2020 than in 1990. The increase comes from electricity production in both combined heat and power plants and condensing power plants based on natural gas. For the period 2010-2020 the electricity production of nuclear power plants is expected to decrease by approximately 20 TWh (with the assumption of an operational life of 40 years) in comparison with 2010. It is assumed that Swedish exports of electricity will decrease from around 3 TWh of electricity

[3] The item of biomass fuel includes in this context peat, solid waste and waste liquors.

Table 5-4 **Fuel supply to the energy sector excluding transport in 1990-2020, TWh and percentage change**

	1990	2003	2010	2020	1990-2010	1990-2020
Coal, coke and blast-furnace gas	31	30	30	30	-3%	-3%
Biomass fuel, of which:	67	106	124	135	85%	101%
Peat	3	4	5	2	67%	-33%
Waste	4	7	12	18	200%	350%
Oils	79	75	62	50	-22%	-37%
Natural gas	7	9	15	50	114%	614%
Total fuel supply excluding nuclear fuel	**153**	**190**	**201**	**235**	**31%**	**54%**

Source:1990-2003 Swedish Energy Agency processing of Statistics Sweden's energy statistics, 2010-2020: Swedish Energy Agency report ER 20:2004.

Table 5-5 **Historical and projected greenhouse gas emissions from production of electricity and district heating and refineries (million tonnes CO_2 equivalent)**

	1990	2003	2005	2010	2015	2020	1990-2010	1990-2020
CO_2 from electricity and district heating production	8.0	10.1	10.1	10.2	11.1	14.1	27%	75%
CH_4 from electricity and district heating production	0.02	0.06	0.07	0.07	0.06	0.04	252%	71%
N_2O from electricity and district heating production	0.3	0.4	0.4	0.5	0.5	0.5	48%	66%
CO_2 refineries	2.2	2.7	2.9	3.5	3.5	3.6	63%	66%
CH_4 refineries	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0%	0%
N_2O refineries	0.03	0.04	0.04	0.05	0.05	0.05	48%	61%
Total	**10.5**	**13.3**	**13.5**	**14.3**	**15.2**	**18.2**	**36%**	**73%**

in 2010 to imports of just over 2 TWh in 2020[4]. It is estimated at the same time that demand for electricity will increase, which will lead to a need for additional production capacity. In addition to natural gas condensing and combined heat and power, electricity production from wind power is also expected to increase during the period.

Facts 5.2 **Assumptions on which estimates for electricity and district-heating production are based:**

- Electricity production from hydropower and nuclear power has been assumed to be:

	2010	2020
Hydropower (TWh)	69.0	69.5
Nuclear power production (TWh)	63.6	42.5

- The lowering of carbon dioxide tax on fuels used for heat production in combined heat and power plants with effect from 2004 has been included in the calculation.
- For the refineries sector, an increase in production based on investment plans has been assumed for 2010 which is above the economic trend for the petrochemical industry based on investment plans. The National Institute of Economic Research estimate of 3% growth per year in the petrochemical industry has been used for the period 2010-2020.

Residential and service sector

Greenhouse gas emissions from the residential and service sector are expected to continue to decrease sharply until 2010. The expected decrease is principally due to the use of oil for heating is expected to be replaced by electricity and district heating. In addition, it is estimated that total energy use will decrease in the sector.

The rate of decrease tails off slightly between 2010 and 2020. This is due to most of the oil which then remains in the sector being used in industries which have a lower rate of carbon dioxide tax (mainly agriculture and forestry). The estimated decrease in use of energy in comparison with 1990 is due to reduced conversion losses in the sector, 2010 and 2020 being assumed to be warmer than 1990[5] and the use of energy for heating and hot water being expected to become more efficient.

Carbon dioxide emissions account for just over 90% of total greenhouse gas emissions from the residential and service sector. Combustion in homes and the service sector is the largest source of methane emissions in the energy sector. According to the projections, methane emissions decrease by 30% between 1990 and 2020. Nitrous oxide emissions are expected to decrease by 28% up to 2010 and then be at a relatively constant level.

Use of electricity for household purposes is estimated to increase continuously up to 2020. The principal reason is increased private consumption. The principal reason why the increase is slightly greater in 2010-2020 is increased construction and slightly higher population growth. The use of electricity for common purposes in buildings is also estimated to increase, principally due to economic development with increased use of electricity despite more energy-efficient appliances. The somewhat more rapid increase between 2010 and 2020 is principally due to floor areas of premises being assumed to increase more during the latter part of the period of projections. Total energy use in agri-

[4] Average exports between 1990 and 2003 were 0.5 TWh. There are wide variations between years depending principally on availability of hydropower production: 2003 was a dry year and imports amounted to around 13 TWh, while 1998 was a wet year when approximately 11 TWh was exported. Exports in 1990 amounted to 1.8 TWh.

[5] The reference period for normal-year correction has been changed with effect from 2003 to a reference period with a higher temperature. A normal year with the new reference period 1970-2000 is calculated using the Swedish Energy Agency's normal-year correction method, is calculated as being around three per cent warmer than previously.

Table 5-6 **Historical and projected greenhouse gas emissions from residential and service sector (million tonnes CO_2 equivalent)**

	1990	2003	2005	2010	2015	2020	1990-2010	1990-2020
Carbon dioxide	10.5	6.2	5.7	4.4	3.7	3.1	-58%	-71%
Methane	0.23	0.24	0.24	0.23	0.19	0.16	0.9%	-30%
Nitrous oxide	0.32	0.28	0.27	0.23	0.23	0.22	-28%	-30%
Total emissions	**11.1**	**6.7**	**6.2**	**4.9**	**4.2**	**3.4**	**-56%**	**-69%**

Table 5-7 **Historical and projected greenhouse gas emissions from industrial combustion (million tonnes CO_2 equivalent)**

	1990	2003	2005	2010	2015	2020	1990-2010	1990-2020
Carbon dioxide	10.7	11.1	11.2	11.5	11.6	11.7	7.4%	9%
Methane	0.05	0.04	0.04	0.05	0.04	0.04	0%	-24%
Nitrous oxide	0.51	0.50	0.52	0.57	0.59	0.61	13%	20%
Total emissions	**11.3**	**11.7**	**11.8**	**12.1**	**12.2**	**12.3**	**8%**	**9%**

culture, forestry and fisheries is expected to increase slightly. Electricity use in other service is expected to increase somewhat throughout the period of projections.

Facts 5.3 **Assumptions on which the estimates for the residential and service sector are based:**

- Assumptions on number of homes, commercial premises and population trend

	2000	2010	2020	2000-2010	2000-2020
Det./semi-det. houses (number in thousands)	1 781	1 863	2 004	5%	13%
Apartment buildings (number in thousands)	2 194	2 332	2 543	6%	16%
Commercial premises (million m^2)	158	162	170	3%	8%
Population (millions)	8.88	9.27	9.72	4%	9%

Source: Statistics Sweden, National Board of Housing, Building and Planning and Swedish Energy Agency calculations.

- The rate of efficiency improvement for energy use for heating and hot water is assumed to 0.6% a year for detached and semi-detached houses and 0.4% for apartment buildings and commercial premises.
- It is assumed that 45% of heating systems will be replaced by 2010, except for direct-acting heating, where it is assumed that 20% will be replaced (note that the replacement may be made to the same heating systems as are already in use). It is assumed that 100% of heating systemswill be replaced by 2020, except for direct-acting electric heating, where it is assumed that 50% will be replaced.

Industrial combustion

Emissions from industrial combustion are estimated to increase somewhat up to 2010 and stabilise over the period 2010-2020. The expected increase during the first part of the period is caused by increased use of coal, coke and oil. It is principally emissions from the iron and steel industry that are expected to increase up to 2010. Emissions from the pulp and paper industry also increase in the projections. The stabilisation of emissions after 2010 is explained by use of natural gas being estimated to increase at the expense of oil use.

Total energy use in industry is expected to increase up to 2010, but energy intensity measured as energy used per production value is estimated to decrease. After 2010, energy use is expected to increase at a lower rate as the rate of growth in energy-intensive industry is expected to decline. Electricity use is estimated to follow the same trend as total energy use.

Use of coal and coke is estimated to increase due to increased use in the iron and steel and mining industries. Use of biomass fuels is expected to increase particularly in pulp and paper production. Use of natural gas is expected to increase by 2010, and an even sharper increase is expected by 2020. Use of oil up to 2010 is estimated to increase as the assumed trend in relative prices between oil and electricity favours increased oil use. Oil use is assumed to increase over the period from 2010 to 2020. Use of district heating is estimated to increase and the engineering industry accounts for the largest single increase in use of district heating. Use of electricity in the industrial sector is expected to develop at a slightly slower place than the historical trend. This follows from the growth assumptions made and the trend in relative prices of electricity and oil, which is expected to be to the benefit of oil. The pulp and paper industry is the sector expected to account for the greatest increase in electricity use.

5.2.2 Industrial processes

Total emissions from industrial processes are estimated to increase by 8% up to 2010 and 12% up to 2020 in comparison with the 1990 level according to the projections. It is principally carbon dioxide emissions that are estimated to increase, while emis-

Facts 5.4 **Assumptions on which estimates for industrial combustion are based:**

- Energy intensity measured as kWh per SEK of production value is estimated to decrease by 1.5% annually between 2000 and 2010 and by 2.6% between 2010 and 2020.
- Annual percentage change in production value for the period 2000-2010 and the period 2010-2020:

Industry	Annual development 2000-2010	Annual development 2010-2020
Pulp and paper industry	1.6%	1.4%
Chemical industry	4.1%	4.2%
Iron and steel industry	1.2%	0.4%
Earth and stone industry	0.5%	0.2%
Metalworks	0.9%	0.1%
Engineering industry	3.3%	4.5%
Total industry	2.6%	3.3%

Source: Statistics Sweden annual accounts, National Institute of Economic Research and Swedish Energy Agency processing.

sions of other greenhouse gases account for a small proportion of the expected increase. Emissions of nitrous oxide are expected even to decrease.

Emissions of carbon dioxide are estimated to increase, from all industries, by around 13% by 2010 and by around 17% by 2020 above the 1990 level. The principal reason for this is an assumed high rate of growth in the iron and steel industry, despite the trend noted to date, towards decreasing intensity of emissions, being assumed to continue. Emissions from the cement industry are also expected to increase, principally due to the trend towards increased intensity of emissions (tonnes of carbon dioxide per production value) in the cement industry being expected to continue.

Emissions of methane from industrial processes are very small but are expected to increase slightly over the period. Emissions of nitrous oxide from industrial processes are relatively small and are expected to decrease by just under 40% from the 1990 level up to 2010 and then to be constant until 2020.

Facts 5.5 **Assumptions on which estimates for industrial processes are based:**

- Assumptions on future growth in production are the same as for industrial combustion in the previous section.
- A large proportion of the emissions from industrial processes will be included in the EU emissions trading scheme, but some smaller emission sources are outside the scheme.

Emissions of fluorinated greenhouse gases are estimated to increase by just over 40% from 1990 to 2010 and then to further increase somewhat up to 2020. An EC regulation governing emissions of fluorinated greenhouse gases from certain key areas of use is expected to be adopted shortly. If the regulation is principally formulated in accordance with the Commission's original draft, this is estimated to lead to emissions of F gases in 2010 only increasing by 15% in comparison with 1990 and to an expected decrease in emissions in 2020 of around 15% in comparison with 1990.

5.2.3 Domestic transport

Emissions from the domestic transport sector are expected according to the projections to increase at a higher rate than the historical trend. Aggregate emissions are estimated to increase by just over 19% over the period 1990-2010 and by 32% between 1990 and 2020. *Carbon dioxide* accounts for around 95% of emissions from domestic transport and is expected to increase by 18% between 1990 and 2010 and 30% between 1990 and 2020. The changes in methane and nitrous oxide emissions follow from an increased number of cars fitted with catalytic converters but account for a very small proportion of the total emissions from this sector.

The total increase in emissions is principally due to the rate of growth in the transport-intensive in-

Table 5-8 **Historical and projected greenhouse gas emissions from industrial processes (million tonnes CO_2 equivalent)**

	1990	2003	2005	2010	2015	2020	1990-2010	1990-2020
Carbon dioxide	4.3	4.5	4.6	4.8	4.9	5.0	13%	17%
Methane	0.005	0.007	0.007	0.008	0.009	0.009	60%	80%
Nitrous oxide	0.87	0.53	0.54	0.54	0.54	0.54	-38%	-38%
Fluorinated gases	0.55	0.84	0.82	0.79*	0.82	0.85*	43%	53%
Total	**5.7**	**5.9**	**6.0**	**6.1**	**6.2**	**6.4**	**8%**	**12%**

* If the proposed European Commission regulation to control emissions of fluorinated greenhouse gases comes into force, emissions are expected to be 0.63 million tonnes CO_2 eq. in 2010 and 0.47 million tonnes CO_2 eq. in 2020.

Table 5-9 **Historical and projected greenhouse gas emissions from domestic transport (million tonnes CO_2 equivalent)**

	1990	2003	2005	2010	2015	2020	1990-2010	1990-2020
Carbon dioxide	18.4	20.1	20.5	21.7	22.8	24.0	18%	31%
Methane	0.27	0.14	0.12	0.08	0.07	0.07	-70%	-75%
Nitrous oxide	0.32	0.72	0.75	0.82	0.90	0.98	153%	202%
Total emissions	**18.9**	**20.9**	**21.4**	**22.6**	**23.8**	**25.0**	**19%**	**32%**

dustries with increasing heavy goods transport and a consequent increase in the use of diesel. Petrol use is estimated to increase slightly in comparison with current levels but is expected in 2010 still to be at a lower level than in 1990. It has been assumed that there is increased introduction of more fuel-efficient vehicles, increased use of biofuels, principally ethanol as a 5% admixture in petrol, and a changeover from petrol to diesel for light commercial vehicles. The IEA projection[6] that oil prices will only increase slightly by 2020 also has an impact on the result.

Facts 5.6 **Assumptions on which estimates on transport are based:**

- A technical rate of development (new vehicle types and more energy-efficient conventional technology) has been assumed during the period of projections. The number of fuel-flexible vehicles (FFV) is expected to increase by around 5 000 over the period 2004-2020. These vehicles at present on average run on 55% ethanol (E85) and 45% petrol, which has been assumed to apply throughout the period of the projections.
- The tax relief introduced in 2004 biofuels is assumed to apply throughout the period up to 2020.
- Average fuel use for new vehicles is assumed to decrease at a faster rate than the historical trend, by around 19% between 1990 and 2010 and around 26% between 1990 and 2020.
- The total number of passenger cars is estimated to increase by 14.2% between 2000 and 2010 and 15.9% between 2010 and 2020. On the other hand, it has been assumed that the proportion of passenger cars running on diesel will continue to be at the same level as in 2000 over the period of the projections.
- Assumed fuel prices in öre/l, including energy and environmental taxes (including VAT[7]):

Fuel/Year	2000	2010	2020	2000-2010 %	2010-2020 %
Petrol, lead-free, MK 1	993	951	1020	-4.2	7.2
Diesel, MK 1	818	749	791	-8.4	5.7

Box 5.7 **Assumptions on which estimates for the waste sector are based:**

- The projections are based on the existing policies and measures for reduced landfilling of organic waste, such as the prohibition of landfilling and landfill tax, and has then been calculated partly on the basis of estimates of future quantities of landfilled waste, the emergence of alternative treatment capacity and future efficiency in gas recovery at landfills[8].
- The estimates of future quantities of organic waste sent to landfill are based on capacity studies. It has been assumed in these investigations that the present-day expansion plans up to 2007-2008 will be followed by further plans for alternative treatment capacity. This means that the landfilling of organic waste will not be allowed to increase after this period. However, waste incineration has been assumed to be a maximum of 12 TWh in 2010 and 18 TWh in 2020 in the projections on the development of electricity and district-heating production.
- After 2008 it is assumed that methane gas recovery has been extended to all landfills, which means a collection rate of 60% methane. After 2010, it is assumed that collection efficiency decreases as the organic element in the waste becomes smaller.

5.2.4 Waste

Total greenhouse gas emissions from the waste sector are expected to more than halve between 1990 and 2010. The decrease is expected to continue until 2020, when emissions from the sector are expected to be 76% lower than 1990 emissions.

The quantities of organic waste sent to landfill are expected to decrease sharply up to 2007 and then stabilise. Release of methane from landfills is estimated to continue to decrease by 62 up to 2010 and by 84% up to 2020 in comparison with the 1990 level as a result of the prohibitions on the landfilling of combustible and organic waste. This trend is dependent on landfilling being replaced by other treatment capacity in the form of waste incineration and material recovery.

Emissions of carbon dioxide from the burning of hazardous waste and emissions of nitrous oxide from wastewater treatment are assumed to remain at the same level up to 2010 and 2020.

5.2.5 Agriculture

Emissions from the agriculture sector are greatly influenced by the formulation of EU Common Agricultural Policy. Principally because of the uncertain-

Table 5-10 **Historical and projected greenhouse gas emissions from the waste sector (million tonnes CO_2 equivalent)**

Emissions sector	1990	2003	2005	2010	2015	2020	1990-2010	1990-2020
Carbon dioxide	0.04	0.12	0.12	0.12	0.12	0.12	175%	175%
Methane	2.6	1.7	1.5	1.0	0.7	0.4	-62%	-84%
Nitrous oxide	0.20	0.14	0.14	0.14	0.14	0.14	-28%	-28%
Total	**2.8**	**2.0**	**1.8**	**1.2**	**0.9**	**0.7**	**-56%**	**-76%**

Table 5-11 **Historical and projected emissions of methane and nitrous oxide from the agricultural sector (million tonnes CO_2 equivalent)**

Emissions sector	1990	2003	2005	2010	2015	2020	1990-2010	1990-2020
Methane	3.4	3.3	3.2	3.0	3.0	3.0	-10%	-10%
Nitrous oxide	6.2	5.4	5.3	5.1	5.1	5.1	-18%	-18%
Total	**9.6**	**8.7**	**8.5**	**8.1**	**8.1**	**8.1**	**-16%**	**-16%**

[6] World Energy Outlook 2002, IEA.

[7] Value-added tax (VAT) on biofuels in Sweden has been charged at 25% since 1992. This has been assumed to apply during the period of projections.

[8] Swedish Environmental Protection Agency, report 5169.

ty over policy after 2010, no projections have been made for emissions during the period up to 2020. It has instead been assumed that emissions remain at the 2010 level. Emissions are estimated to continue to decrease up to 2010 and be 16% lower than 1990 emissions. The decrease is largely due to the expected decrease in livestock farming. A reduced number of cattle contributes to lower methane discharges from the animals' metabolism while losses from farmyard manure are estimated to increase as a result of increased use of slurry management. Discharges of nitrous oxide decrease principally as a result of reduced use of mineral fertiliser, smaller area of cultivated organogenic soils, and reduced nitrogen leaching. The change-over to slurry management contributes to reduced nitrous oxide emissions.

For the period 1990-2010, emissions are estimated to decrease by around 10% for methane and around 18% for nitrous oxide. Nitrous oxide accounts for a slightly larger percentage decrease than methane but also for a larger proportion of emissions.

A reform of the EU Common Agricultural Policy. known as the Mid-Term Review, is being carried out in 2005. The European Commission has carried out impact analyses which have been modified using national assessments, and these form the basis for the assumptions in the projections. An important source of data has been the Swedish Board of Agriculture's profitability calculations[9] for different forms of production in Swedish agriculture after the reform has been implemented. These show that between 20-50% of existing farms involved in milk or cereals production may become unprofitable in comparison with the present-day situation. Meat production is also expected to be adversely affected.

With the exception of a continued decrease in the number of dairy cows, livestock numbers in agriculture were at a relatively constant level over the period 2000 – 2003. It is assumed that livestock numbers will decrease up to 2010 due to the effects of the MTR reform.

Facts 5.8 **Assumptions on which estimates for the agriculture sector are based**

- The projections are based on economic impact analyses of national application of the Mid-Term Review (MTR), the reform of the EU Common Agricultural Policy, which is being introduced in Sweden in 2005.
- No direct measures against greenhouse gas emissions have been included, but indirect effects of reduced emissions of substances causing eutrophication and acidification have been included.
- For pigs and dairy cows, the trend of an increasing proportion of slurry management is assumed to continue, and a slightly prolonged period of grazing is assumed for cattle. For other types of livestock, it is assumed that both grazing period and manure management system will be unchanged in comparison with 2000.
- For the use of mineral fertilisers, the decreasing trend noted since the early 1990s is assumed to continue in a straight line. The area of minerogenic arable land is expected to decrease by 160 000 ha to 2.3 million ha in 2010, while organogenic soils are estimated to decrease by around 10% to 225 000 ha. An increase in cultivation of forage crops of just over 200 000 is assumed to occur, to a total of 1 million ha in 2010.

[9] Swedish Board of Agriculture report 2004:16

Table 5-12 **Number of livestock in Swedish agriculture in 1990, 2000, 2003 and projection for 2010 (thousands)**

	1990	2000	2003	2010
Dairy cows	576	428	403	360
Suckler cows	75	167	165	150
Other cattle	1 067	1 089	1039	950
Total cattle	1 718	1 684	1607	1460
Pigs	2 264	1 918	1 902	2 000
Poultry	15 200	16 900	16 402	17 000
Sheep	406	432	448	500
Goats	4	5	6	5
Horses	300	300	300	300
Reindeer	271	221	229	220

Source: Data for 1990 and 2003 come from the Statistics Sweden and the Swedish Board of Agriculture. Data for 2010 comes from the Swedish Environmental Protection Agency.

5.2.6 Land use, land-use change and forestry (LULUCF)

Net removals of carbon dioxide are reported in Table 5-13. They relate to previously reported values for 1990 and 2003 based on empirical data (NIR 2005).

The projected values in Table 5-14 for 2005, 2010, 2015 and 2020 are based on scenario results taken from the forest impact analyses SKA 03[10].

Table 5-13 **Reported emissions and removals of greenhouse gases in the LULUCF sector (millions of tonnes of carbon dioxide)**

	1990	2003
Removals in forest biomass*	24.1	25.3
Emissions from agricultural soil	3.8	3.8
Net removals	**20.3**	**21.5**

* Estimated emissions based on empirical inventory data. Removals in 1990 calculated according to change in stock. Removals in 2003 calculated according to difference between growth and release.

Table 5-14 **Projections on emissions and removals of greenhouse gases in the LULUCF sector (millions of tonnes carbon dioxide)***

	2005	2010	2015	2020
Removals in forest biomass	17.7	17.2	14.0	10.9
Emissions from agricultural soil	3.8	3.8	3.8	3.8
Net removals	**13.9**	**13.4****	**10.2**	**7.1**

* Projected removals calculated according to the methodology section in this chapter.
** The projected value for 2010 is comparable with previous information submitted to UNFCCC (CSD-Sweden, Aug. 2000; Doc. FCCC/SBSTA/2000/9/Add.1).

[10] Gustavsson & Hägg 2004, Skogliga konsekvensanalyser SKA 03 (Forest impact analyses SKA 03)

The scenario has been produced using the HUGIN model.

The difference between the reported value for 2003 and the projected value for 2005 may seem quite large. However, most of the difference can be explained by a 5 year mean value for felling (105 million tonnes carbon dioxide) having been used for the reported value for 2003 but not for the projected year 2005, where yearly felling has been used. The actual felling in 2003 was equivalent to 111 million tonnes of carbon dioxide, which would result in a net removal of 15 million tonnes of carbon dioxide.

Felling has increased sharply in recent years as a consequence of increasing demand for forestry industry products. Timber consumption by the Swedish forestry industry today is substantially higher than felling within the country, and imports at present account for 10 – 15 per cent of annual timber consumption. According to a preliminary calculation, felling in 2004 amounted to approx. 84 million cubic metres total trunk volume (approx. 113 million tonnes carbon dioxide). The model used for the projections up to 2020 estimates the felling for 2005, 2010, 2015 and 2020 to be 108, 113, 120 and 126 million tonnes of carbon dioxide.

No account has been taken in the projections for 2005 of the storm fellings which occurred on 8-9 January 2005 in southern Sweden. The volume of timber felled the in storm has been estimated by the National Board of Forestry at 75 million m^3 total trunk volume, that is to say nearly one year's felling throughout the country. The short and long-term impact of the storm on timber stocks, forest growth and losses (felling and natural loss) has not yet been analysed. It is difficult to gain an overview of the repercussions as the effects may have an impact on forestry for several years.

The projections show a downward trend in net removals. If the timber stock is studied over a longer period (a cycle), it is estimated that the net removal will continue in future to stabilise at a lower level than at present, provided the actual felling is at the highest level (100%) of what can be regarded as sustainable. This level of felling is consistent with annual felling for years 2002 to 2004.

The estimation of future felling assumes a continued great need for Swedish forest raw material. As even minor changes in demand for Swedish forestry industry products may have relatively great consequences for felling, a sensitivity alternative with a level of felling at 90% of the sustainable level has been drawn up (Table 5-15). This alternate scenario reflects felling during the 1990s.

Table 5-15 **Projections on greenhouse gas emissions and removals in the LULUCF sector (million tonnes of carbon dioxide) at a felling level of 90% of sustainable felling**

	2005	2010	2015	2020
Removals in forest biomass	23.0	27.6	25.2	22.7
Emissions from agricultural soil	3.8	3.8	3.8	3.8
Net removals	**19.2**	**23.8**	**21.4**	**18.9**

Facts 5.9 **Assumptions on which estimates for LULUCF are based**

- It is assumed in the projections that the environmental measures in forestry and environmental policy aimed at preserving biological diversity which have the greatest significance for the removal of carbon dioxide in the forests are implemented. These are set-asides for nature conservation (national parks, nature reserves, habitat protection, nature conservation agreements and voluntary set-aside) and leaving trees and stands of trees behind in regeneration felling.
- Annual felling, which is of great significance to removal of carbon dioxide, is assumed to be at the highest level of what is regarded as sustainable. This assumption is supported by projections made by UNECE/FAO (Sustainable felling here means the highest possible felling within the limits indicated by the environmental and production targets in forestry policy and by the national environmental quality objective of "Sustainable Forests").
- Forest stewardship is assumed to have the same orientation in the future as during the mid-1990s.
- No account is taken of future climate change in the calculations.

The calculations show that relatively small changes in level of felling have great consequences for net removal. Felling for 2005, 2010, 2015 and 2020 has been assumed to be 103, 102, 108 and 114 million tonnes of carbon dioxide.

Emissions of carbon dioxide from agricultural soil are also reported in the LULUCF sector. It is assumed that in the near future these emissions will be at approximately the same level as the most recently reported emissions.

5.2.7 Solvent and other product use

Solvent use leads to emissions of volatile organic compounds. The carbon in these emissions is assumed to be oxidised to carbon dioxide. Nitrous oxide is used for example in health care. Emissions of carbon dioxide from solvent use are estimated to decrease relatively sharply, while the use and emissions of nitrous oxide are expected to increase.

Facts 5.10 **Assumptions on which estimates of solvent and other product use are based:**

- A linear trend analysis has been made of emissions for the period 1990-2002 (for nitrous oxide 1992-2002) and is used as the basis for projection to 2010. Emissions in 2020 are assumed to remain at the same level as in 2010.

Table 5-16 **Historical and projected emissions from solvent and other product use (million tonnes CO_2 equivalent)**

Emissions sector	1990	2003	2005	2010	2015	2020	1990-2010	1990-2020
Carbon dioxide	0.32	0.17	0.14	0.08	0.08	0.08	-75%	-75%
Nitrous oxide	0.09	0.14	0.14	0.16	0.16	0.16	81%	81%
Total	**0.41**	**0.31**	**0.29**	**0.24**	**0.24**	**0.24**	**-41%**	**-41%**

5.2.8 International transport

Total emissions from international transport are estimated to double over the period 1990-2010 and are expected to be 143% higher in 2020 than in 1990. Carbon dioxide accounts for by far the largest share of total emissions.

The assumptions on increased number of landings abroad and increased private consumption lead to use of aviation fuels being expected to double over the period 1990-2010 and to increase by a further 20% over the period 2010-2020 for international aviation.

The use of fuel for international shipping depends firstly on changes in passenger traffic between Sweden and nearby countries and secondly on freight transport to and from various parts of the world.

The aggregate estimate is that bunkering of diesel and fuel oil 1 increases by just 20% over the period 1990-2010, while bunkering of fuel oil 2-5 increases by 165% over the corresponding period. It is expected that both diesel and the use of fuel oils will increase by around 20% over the period 2010-2020.

Total energy use for international transport is estimated to almost double between 1990 and 2010 and then to continue to increase by a further 20% over the period 2010-2020.

Facts 5.11 **Assumptions on which estimates of international transport are based**

- According to Swedish Civil Aviation Authority projections of the number of landings at state-owned airports, the number of international landings is estimated to increase by 13.8% over the period 2003-2010. Greater fuel efficiency has been assumed over the period 2010-2020 in comparison with 2000-2010.
- No major changes in passenger traffic between Sweden and nearby countries are expected to take place during the period of the projections. On the other hand, cargo transport is estimated to increase, in part due to expected increases in GDP and exports.

5.3 Sensitivity analysis

Four sensitivity alternatives have been drawn up to complement the projections, and the results presented in this section are based on the following alternative assumptions:

- NP32: the operational life of nuclear power plants is assumed to be 32 years, instead of 40 years which is assumed in the projections.
- NP60: the operational life of nuclear power plants is assumed to be 60 years
- Higher GDP: the assumed trend in GDP is shown in the table below

GDP growth per year %	2000-2010	2010-2020
Higher GDP	2.3	2.4
Projections	1.7	1.8

- Higher oil and natural gas price: the price of oil has been assumed to be 50 USD/barrel and the price of natural gas to be 6.4 USD/Mbtu, which can be compared with 21 USD/barrel and 2.8 USD/Mbtu in the projections.

The various assumptions in the sensitivity alternatives lead to different electricity prices, which in turn means that use of electricity in industry and the residential sector varies between the scenarios in favour of other energy carriers such as oil. The differences in electricity prices, on the other hand, do not affect the transport sector as electricity use represents a small proportion of total energy use in this sector. On the other hand, it is electricity production that contributes to the greatest differences in emissions between most of the alternatives. In the alternative with higher oil and natural gas prices, on the other hand, it is energy use in the transport sector that contributes to the greatest differences in comparison with the projections. No calculations have been made for the period after 2010 in the latter alternative. The high oil prices are expected to lead to high natural gas prices, which means that investments in the construction of the natural gas network will not be as cost-effective as in the pro-

Table 5-17 **Historical and projected greehouse gas emissions from international transport (million tonnes CO_2 equivalent)**

	1990	2003	2005	2010	2015	2020	1990-2010	1990-2020
International transport	3.6	7.2	7.2	7.3	8.0	8.8	101%	143%

Table 5-18 **Historical and projected emissions of greenhouse gases in the projections and in all the sensitivity alternatives (million tonnes CO_2 equivalent)**

	1990	2003	2005	2010	2015	2020	1990-2010	1990-2020
Projection	72.2	70.6	70.8	71.5	73.1	76.6	-1%	6%
Nuclear power 32 yrs	72.2	70.6	70.8	75.1	80.0	83.3	4%	15%
Nuclear power, 60 yrs	72.2	70.6	70.8	71.5	72.3	73.1	-1%	1%
Higher GDP	72.2	70.6	71.6	74.4	78.4	82.3	3%	14%
Higher oil and natural gas prices	72.2	70.6	69.9	69.2	-	-	-4%	-

jections. What would replace the natural gas in this case depends on what prices and instruments apply, but in the circumstances applicable at present an increase in the use of biomass fuels appears to be significant. It is important to point out that several of the parameters analysed in the various sensitivity alternative may have opposite effects. Higher economic growth combined with higher oil and natural gas prices mean, for example, counteracting effects which largely cancel each other out.

If the operational life of all remaining nuclear power stations is assumed to be 60 years, the increase in emissions between 1990 and 2020 is estimated to amount to just under 1%. In the NP32 alternative, a production shortfall from nuclear power in 2010 of 20 TWh is assumed, which leads to emissions being 1.5% higher than in the projections. In 2020 it is assumed in NP32 that all nuclear power stations are decommissioned and emissions are then 9% higher than in the projections. In the alternative with higher GDP, emissions increase sharply up to both 2010 and 2020 in comparison with the projections. It is carbon dioxide emissions that are most affected, while emissions of methane and nitrous oxide change very little. In the alternative with higher oil and natural gas prices, emissions decrease in comparison with the projections by just over 2 million tonnes, with approximately 1.4 million tonnes of the decrease occurring in the transport sector. The change in comparison with 1990 emissions is -4%.

The NP32 alternative gives the highest emissions in both 2010 and 2020. The shortfall in nuclear power production is expected to lead to just over 7 TWh of condensing production based on natural gas in 2010 and just over 23 TWh in 2020. This can be compared with the results for the alternative with higher GDP, which is the alternative that gives the second highest emissions. No condensing production based on natural gas is estimated to take place in 2010 in the alternative with higher GDP, and this production is estimated to amount to just over 7 TWh for 2020. Altogether, the faster phase-out of nuclear power in NP32 already leads to higher emissions in 2010.

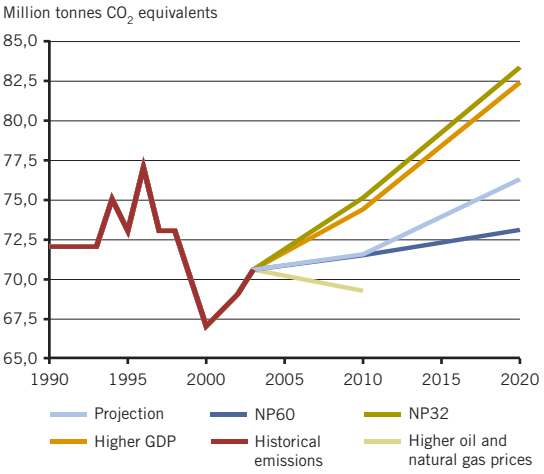

Figure 5-3 **Total greenhouse gas emissions in all the projected alternatives.**

The lowest emissions for both 2010 are in the alternative with higher oil and natural gas prices, principally due to lower use of oil products in the transport sector in comparison with the projections. In 2020 the lowest emissions are in the NP60 alternative, where nuclear power production is maintained throughout the period. Less fossil fuel-based electricity is needed and greenhouse gas emissions are lower. Sweden is a net importer of electricity in 2020 in all the alternatives except in the alternative with a 60 year operational life for nuclear power plants, where Sweden is expected to be a net exporter of electricity in 2020.

5.4 Methodology

Different projection methods are used for different sectors. The methods which have been used to draw up the projections in this report are described in this section.

Projections for carbon dioxide emissions from the **energy sector** are drawn up by multiplying the total consumption of each fuel by the corresponding emissions factors. The energy projections, together with expert assessments of future emission factors, have provided the basis for the projections of methane and nitrous oxide from incinerators.

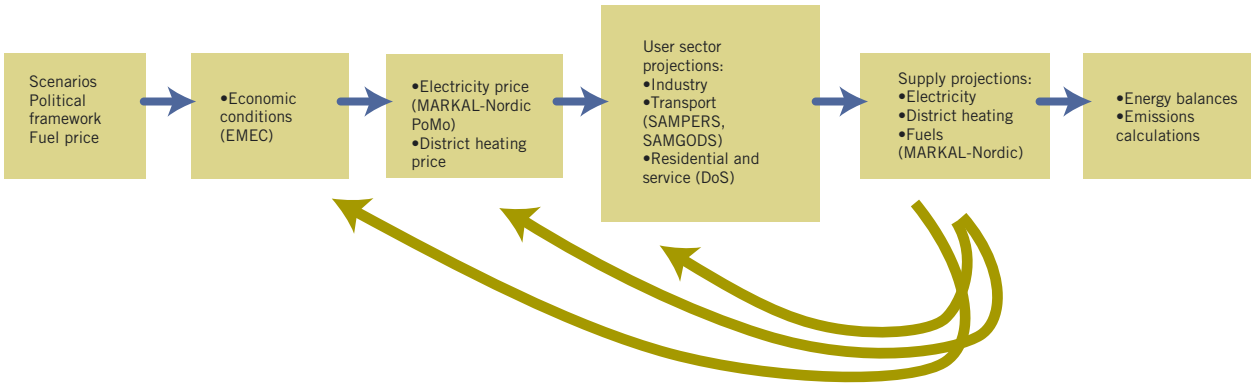

Figure 5-4 **Projection process for emissions from the energy sector. Models used in brackets.**

Different models are used for each sub-sector in drawing up projections of trends in the energy system[11] . The MARKAL-Nordic model is used to make projections for the whole energy system excluding transport. Demand in the sub-sectors, taxes and other policy instruments, fuel prices and economic and technical development are used as input data for MARKAL-Nordic. MARKAL is a dynamic optimisation model. Most of the methods and models used to project development in the energy system are based on a bottom-up perspective. The work takes place in an iterative process where model results for different sub-sectors are coordinated so that weighted projections for the whole energy system are finally obtained. The process is described in Figure 5-4. Expert assessments are an important element in all stages of the process.

An important starting point in the projection work on the development of the energy system in the short and long term is assumptions on economic trends, both in Sweden and internationally. The economic variables included in the work on energy projections mainly consist of estimates of the trend in gross domestic product, private and public consumption, disposable income and trends in industry and commerce. Estimates of economic development at the level of individual industries are included for industry.

The projections on economic development are drawn up using a general equilibrium model, EMEC, by the National Institute of Economic Research[12]. The projections on economic development and the projections on the development of the energy system are drawn up in an iterative process where input data and results are harmonised by the National Institute of Economic Research and the Swedish Energy Agency. The economic growth generated by the EMEC model is governed firstly by access to production factors such as labour and capital and secondly by technical development, which are given exogenically in the model. The advantage in using this type of model is that it encompasses the whole economy. The model is therefore able to capture repercussions between sectors, for example a change of tax or the introduction of emission caps. The total socio-economic impact is therefore captured in a more complete way than in partial models.

Another important basis for projections on trends in the energy system is fuel prices. A model is used to convert international fossil-fuel prices for crude oil and coal to domestic user prices paid by the final customer as crude oil has to be refined into finished motor fuels and fuels for heating before it can be used on the Swedish market. Biomass fuel prices are calculated on historical time series from 1995 to 2002, together with qualitative analyses on future biomass fuel use, partly based on assumptions on European directives for renewable energy, international trading in biomass fuels and Swedish energy and environmental policy.

The projections on using fuel use for **electricity and district-heating production** are based on the MARKAL-Nordic model. The demand for electricity and district heating is exogenic data for the model which, through its optimisation algorithm, works out the most cost-effective fuel mix for the whole energy system, i.e. including energy use in the user sectors. MARKAL-Nordic represents all Nordic countries (excluding Iceland) and permits electricity trade between neighbouring countries. Not just the Swedish energy system but the Nordic energy system is therefore optimised. PoMo (Power Model), which is a bottom-up model, has additionally been used to compare the electricity price with that projected by MARKAL-Nordic and thus to assure the quality of the result.

The projections of energy use in the **residential and service** sector are drawn up by combining the model results from the DoS model (Demand and

[11] Swedish Energy Agency report ER2005:37
[12] National Institute of Economic Research, Working Paper No. 69

Supply model), MARKAL-Nordic and assessments by industry experts. The DoS model is a bottom-up model which produces projections based on assumptions on different variables such as electricity and fuel prices, economic development, population development, potential for different heating systems, investment costs of heating systems, levels of efficiency and energy efficiency improvement.

The projections on energy use in the **industry sector** come from an Excel-based bottom-up model, economic circumstances and assumed energy prices. This result is harmonised through contacts with energy-intensive companies and industry organisations. Use is also made of the DoS model, which models demand for electricity for industry with special emphasis on electricity-intensive industry. Account is also taken of the results of the MARKAL-Nordic energy system model.

The projections on carbon dioxide emissions from the **transport sector** are calculated on the basis of projections on energy use in the transport sector. The calculation of emissions of other greenhouse gases is based on the change in transport activity, number of vehicles in different vehicle types (e.g. fitted with catalytic converter) and emissions factors. The transport sector has been divided into four sub-sectors: road traffic, air traffic, rail traffic and shipping. The projections on the energy use of road traffic have been calculated with the support of two parallel methods, one based on present-day traffic activity[13] and the other based on present-day energy use. Projections for air traffic, rail traffic and shipping have been calculated on the basis of present-day energy use.

Projections of passenger transport activity and freight transport activity are based on the SAMPERS and SAMGODS models respectively[14] which have been developed jointly by the Swedish Institute for Transport and Communications Analysis (SIKA), the transport agencies and VINNOVA. The projections on petrol use have been calculated using a top-down demand model. Demand is expected to be influenced principally by the price of petrol, household incomes and technical development. Technical development in particular provides estimates of future fuel consumption. These estimates are made by the National Road Administration using the EMV model[15]. The projections on diesel use have been calculated using a top-down demand model. The model includes assumptions on the price of petrol, trends in various industries and technical development. A weakness of the model is that it does not take account of structural changes relating to the vehicle population.

The carbon dioxide emissions of **industrial processes** have been calculated using an Excel-based trend analysis of historical emissions. In addition to official statistics, data and other information from industry organisations and companies have been used to obtain better detailed knowledge on the industries and emissions concerned.

Emissions from landfills in the **waste sector** are calculated using a model developed by the IPCC which has been partially modified so that it fits Swedish circumstances better. The results of the model calculations are also compared with results of field measurements. The method is based on figures on quantities of landfilled waste from 1952, the organic content of the waste, the gas potentials of different types of waste and emissions factors.

The same method of calculation has been used in the projection calculations for the **agricultural sector** as is used when the historical emissions are reported. The emissions are calculated using specific emission factors and activity data in the form of figures relating to numbers of livestock, manure production, housing period, method of mature management and annual balances of nitrogen flows to and from agricultural land. The projections are based on expert assessments. The assessments are based on actual development up to 2003 and impact analyses of agricultural policy.

The projections for net removals in the **Land Use, Land-Use Change and Forestry** sector are analysed using the Hugin calculation system[16], which simulates the future development of the forests on the basis of assumptions on how they are managed and exploited over a hundred-year period. In Hugin, sustainable felling is estimated as mean values per year for ten-year periods (2005-2014, 2015-2025, etc.). The total carbon stock is calculated for the first year in each such period. Net removal is calculated in the projections as the difference between the stocks at different times. Linear interpolation is applied to produce estimates of both net removal and felling for 2005, 2010, 2015 and 2020.

The calculations encompass biomass in living trees on forest soil. Tree biomass includes the following fractions: stemwood and bark, branches, needles and stumps including incl. thicker roots.[17]

The values reported to date (1990-2003) are based on empirical data for all land apart from mountains, the built environment and protected areas (military restricted areas and land within national parks, nature reserves and habitat protection areas) [18]. Productive land in national parks, nature reserves and habitat protection areas is included in the scenario results. Dead trees are included in reported felling

[13] Traffic activity measures the movement of vehicles, i.e. the number of kilometres per vehicle.
[14] SIKA, SAMPLAN Report 2004:1
[15] EMV-modellen (The EMV model), Swedish National Road Administration.
[16] Lundström A. & Söderberg U. 1996.
[17] Marklund, L-G. 1988.
[18] Anon. 2004. Skogsdata 2004 –.

but not in the scenario results. The reported net removal for 2003 is calculated as the difference between growth and loss (felling and natural loss) while it is calculated in the scenario results as the difference in stocks at different times. With effect from 2006 reporting (NIR), the annual net removal will be calculated as the difference in stock, and the whole time series from 1990 onwards will also be recalculated.

5.5 Comparison with the third national communication

5.5.1 Comparison between projected results in NC3 and NC4

The projections in this report show a decrease in emissions between 1990 and 2010, while the projections in NC3 showed a slight increase. For 2020, both sets of projections show an increase compared with 1990, but this increase according to the new projections is half as great as the increase shown in NC3.

Figure 5-5 shows how the trend in emissions between 1990 and 2010 and between 1990 and 2020 differs between the projections made in the third national communication and these projections.

The present projections show approximately the same trend between 1990 and 2010 for the **energy sector excluding transport.** The differences between the projections recur in the trend up to 2020, when the new projections show an increase of 4%, which is one-third the increase shown in NC3. These projections show smaller emissions from the residential and service sector but higher emissions from electricity production. Total use of natural gas in 2020 is twice as high as in NC3. A large-scale expansion of the natural-gas infrastructure is therefore assumed according to the new projections, in contrast to the projections in NC3.

The projections for **domestic transport** produce a slightly higher increase in emissions between 1990 and 2010 compared with NC3. The difference between NC4 and NC3 is far greater for 2020, and the new projections produce a far greater increase in emissions from 1990. This is principally due to increased use of diesel in comparison with NC3.

The projections for emissions from **industrial processes** shows a smaller increase than was stated in the third national communication. The differences are partly due to the whole time series for emissions from industrial processes from 1990 to 2003 having been revised as part of the improvement in the quality of data. The revision has led to the trend showing less of an increase with the revised data used in NC4 compared with previous data used in NC3. The historical trend provides important underlying data for the projections and the projections consequently show a smaller increase in emissions. In absolute terms, these projections shows somewhat lower emissions for both 2010 and 2020.

The projections for **agricultural** emissions show a greater reduction in emissions between 1990 and 2010 than previously: 16%, compared with 8% in NC3. The difference is due firstly to an extensive revision having been made of the calculation methodology between these occasions and secondly to account having been taken of changes in livestock husbandry as well as use of commercial fertilisers, use of farmyard manure, nitrogen efficiency in milk production, nitrogen fixing, nutrient leaching and losses of ammonia. In addition, the effects of the MTR (Mid-Term Review) reform have been considered.

The projections for the **waste sector** show a smaller decrease in emissions than was stated in the third national communication. This is due to fur-

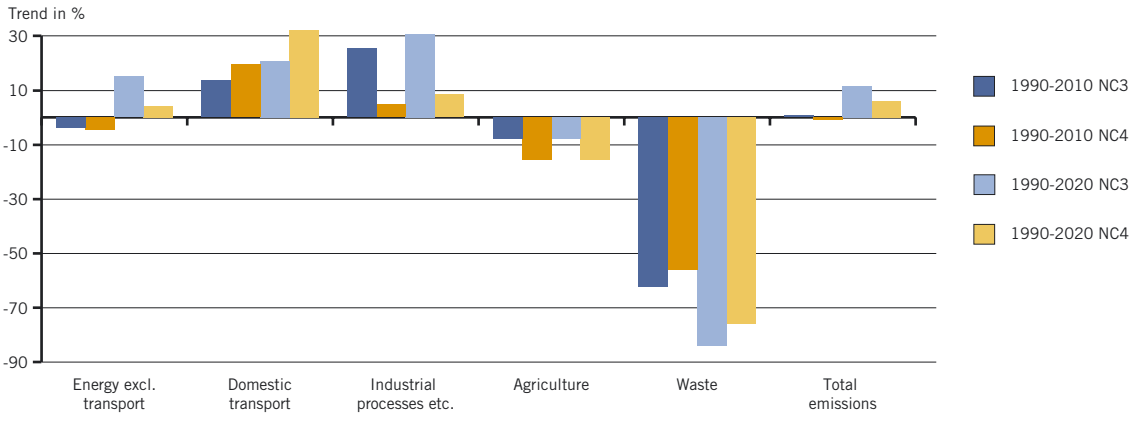

Figure 5-5 **Percentage development between 1990 and 2010 and between 1990 and 2020 according to the projections in NC3 and NC4 per sector.**

ther emissions from burning of hazardous waste and emissions of nitrous oxide from wastewater treatment now being reported in the sector. On the other hand, projections for methane emissions from landfills are the same as in the third national communication.

The projections for the **land use, land-use change and forestry** sector point to lower removal of carbon dioxide in forest biomass than the projections made at the time of the third national communication. The reason for this is that felling in recent years has been at a higher level (on a par with the maximum that can be felled) than previously estimated, and that it is estimated in this communication that it will continue to be so over the next fifteen years.

It was assumed in the third national communication that emissions from **use of solvent and other product use** would be constant over time. The projections now presented show that emissions will decrease.

5.5.2 Comparison between assumptions underlying projections in NC3 and NC4

An important difference in the assumptions underlying the projections is that slower economic growth was assumed in NC3, 1.1% per year over the whole period 1997-2020 compared with the assumption of 1.76% per year in 2000-2010 and 1.82% per year between 2010 and 2020 in these projections.

The projections are based on policies and measures decided on at the time when the projections were made. A number of policies and measures have been changed since NC3. For example, carbon dioxide tax has been increased, the electricity certificate system was introduced in 2003, emissions trading started in the EU in 2005 and a climate investment programme has been introduced.

5.6 The total effect of policies and measures

Figure 5-6 shows the aggregate estimated effects of climate-policy instruments in Sweden as the difference between the two curves represented. The curve with lower emission values shows historical emissions of greenhouse gases in Sweden up to 2003 and projected emissions up to 2020. The actual trend in and projected level of emissions has been adjusted with respect to the effect of cross-sectoral policy instruments and policy instruments in the sector concerned according to the estimates reported in Chapter 4. There may be some overlap between the effects of sector-specific and cross-sectoral policies and measures (LIP and Klimp), but it has not been possible to quantify this. The curve with lower emission values shows the estimated level of emissions if 1990 policy instruments had been retained. For further information on how the individual evaluations have been made, see Chapter 4.

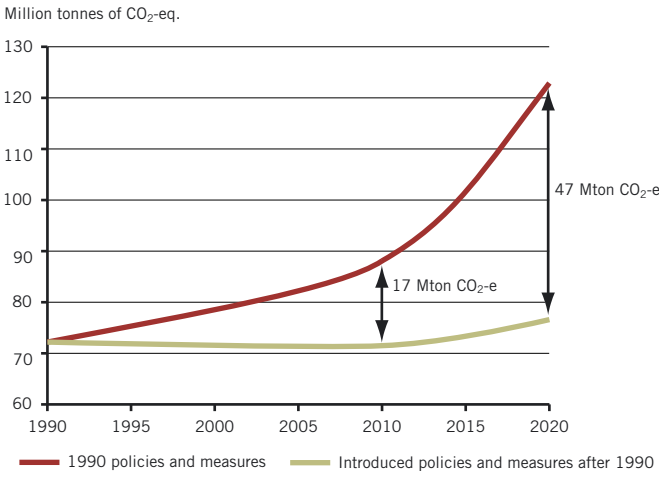

Figure 5-6 **Total effect of Swedish policies and measures in the area of climate change.**

Table 5-19 **Example on assumptions for the projections in NC3 and NC4**

	NC3		NC4	
	1997-2010	2010-2020	2000-2010	2010-2020
GDP (annual % change)	1.1	1.1	1.76	1.82
Industrial production (annual % change)	2.3	2.1	2.6	3.3
Private consumption (annual % change)	2.4	1.9	2.6	2.5
Public consumption (annual % change)	1.2	0.8	0.7	0.5
	2010	2020	2010	2020
Crude oil (USD/barrel)	17	22.5	21	25
Coal price (USD/tonne in port)	42	42	39	41
Natural gas price (USD/Mbtu)	2.6	3.5	2.8	3.3
Electricity certificate system	0.15 SEK/kWh		10 TWh new electricity from renewables in 2010	
EU's emissions trading scheme	Did not exist		10 EUR/tonne CO_2	

The effects of the instruments presented as the quantity of reduced greenhouse gas emissions in million tonnes of carbon dioxide emissions per sector are shown in Table 5-20.

Figure 5-7 shows how the aggregate contributions of the instruments to reduced emissions are broken down between different sectors and the cross-sectoral instruments LIP and Klimp. As mentioned, there may be some overlap between the effects of cross-sectoral instruments, and the effect of LIP and Klimp is consequently stated as being up to 2 million tonnes of carbon dioxide emissions. The total effect of evaluated policy instruments introduced after 1990 is estimated to amount to up to 17 million tonnes in 2010 and up to 47 million tonnes in 2020.

Table 5-20 **The total effect of Swedish climate-change policies and measures broken down by sector (million tonnes CO_2 equivalent)**

Sector /Year	2010	2020
Cross-sectoral: LIP and Klimp	Up to 2	Up to 2
Energy excl. transport without limitation in model of new investment in coal-based electricity and heat production	10	39*
Industry	0.4	0.6
Transport	3.3	3.6
Waste	1.4	1.9
Total	**17**	**47**

*The total decrease in emissions in the energy sector excluding transport of 39 million tonnes in 2020 includes 0.8 million tonnes from reduced energy use (see Table 4.3 in chapter 4). This reduction in emissions of 0.8 million tonnes is expected to take place in the Nordic electricity system, and the figure of 0.8 must therefore be regarded as a maximum value for emissions reduction in Sweden.

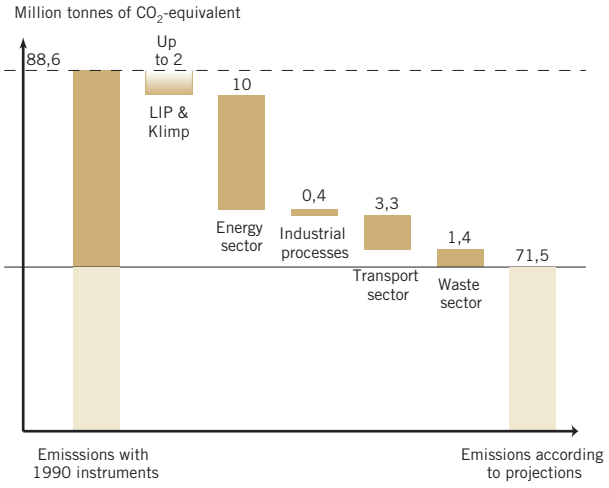

Figure 5-7 **Contributions by the sectors and the cross-sectoral instruments LIP and Klimp in 2010 to the aggregate effects of introduced instruments in comparison with 1990 instruments.**

5.7 Target fulfilment in relation to Sweden's commitment under the Kyoto Protocol

According to the previous description in this chapter, the projections that have been made indicate that emissions are below Sweden's commitment under the Kyoto Protocol and EU burden sharing agreement solely with policies and measures already introduced. If Sweden only reports emissions from land use, land-use change and forestry, according to the mandatory Article 3.3 of the Kyoto Protocol, an addition of emissions is obtained and net emissions according to the projections and specific calculations for the LULUCF sector end up in line with the country's commitment. If Sweden chooses additionally to report emissions and removals from forestry in accordance with Article 3.4 of the Kyoto Protocol, net emissions are estimated instead to end up substantially below the country's commitment.

According to the EU's internal burden sharing agreement, Sweden is to have emission levels of less than 104% of the level of emissions in 1990 as a mean value for the period 2008-2012, as an aggregate for the six greenhouse gases covered by the Kyoto Protocol and calculated in carbon dioxide equivalent. The projections made indicate emissions levels excluding the land use, land-use change and forestry sector of 99% of 1990 carbon dioxide equivalent for 2010.

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6 Vulnerability assessment, climate-change impacts and adaptations

6.1 The Swedish climate in a state of change

To conduct vulnerability analyses for a climate in a state of change, it is essential to have detailed information on regional variations in the change, where account is taken of global uncertainties in future emissions and the sensitivity of the climate system.

At the Rossby Centre of SMHI[1] , regional climate scenarios are calculated with high resolution in both time and space for Europe and the Baltic Sea[2] in order to provide a basis for studies of climate effects and vulnerability analyses. Four scenarios which describe conceivable climate changes from the period 1961-1990 to the period 2071-2100 have been drawn up since the latest national report (2002)[3]. To supplement these, two scenarios have also been calculated for the whole period 1961-2100, which thus also makes it possible to study the development of the climate over the next few decades. The development of the climate over the course of time throughout the 21st century is additionally important for assessments of effects on the ongoing development of both society and the natural ecosystem.

Data from two different global climate models have been used in the regional climate scenarios, one from the Hadley Centre at the Meteorological Office in the United Kingdom and the other from the Max-Planck-Institut für Meteorologie in Hamburg, Germany. Global modelling based on what are known as the A2 and B2 scenarios have been used, where the A2 scenario describes a relatively sharp increase in the concentration of greenhouse gases in the atmosphere and the B2 scenario a more modest increase[4]. Results from the German global model based on the A2 and B2 emissions scenarios have been used for the long simulations over the whole period 1961-2100.

6.1.1 Future climate change

Temperature and seasons

In these scenarios, Sweden's annual mean temperature increases by between 2.5 and 4.5°C over the whole period (2071-2100 compared with 1961-1990). Despite the wide variability from year to year, the trend is clear (Figure 6-1). The estimated change in annual mean temperature is already statistically significant[5] if the period 1981-2010 is compared with the reference period 1961-1990. It is also found that the rise in temperature is greatest during the winter, between 2.8 and 5.5°C at the end of the century. Warming results in the temperature zones moving northwards.

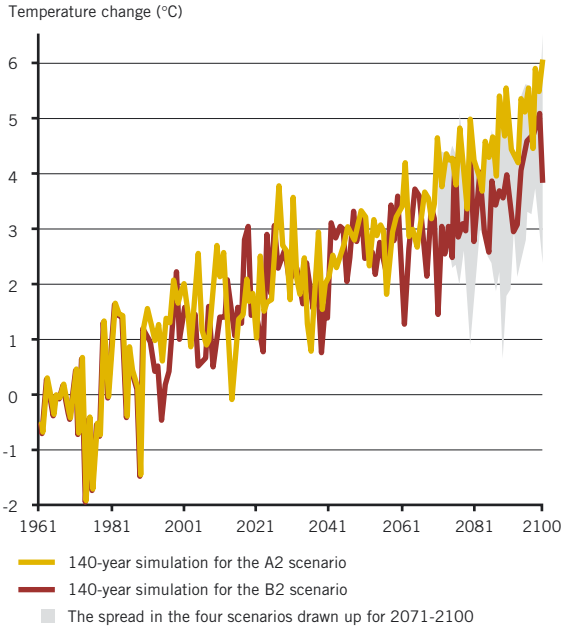

Figure 6-1 **Change in annual mean temperature from the 1961-1990 mean value for Sweden.**

[1] Swedish Meteorological and Hydrological Institute
[2] See Ambio 33(4-5), 2004
[3] Räisänen J. et al, 2003.
[4] Nakićenović N. et al., 2000.
[5] Statistically significant here means that given the simulated inter-year variability over the control period, there is a maximum 5% chance that the climate-change signal is random.

The mean temperature but also the frequency of the number of days with temperatures in certain ranges are of great significance both for society and for the ability of plants to cope in different regions. The length of the vegetation period is estimated to increase by between one and two months throughout the country except in the far south, where the estimated increase is up to three months.

Precipitation

The precipitation that falls over Sweden is expected to increase over the next century by between 5 and 25% (Figure 6-2). To an even greater extent than for temperature, there are great variations between years and decades. The trend is nevertheless clear, and the difference in annual precipitation in comparison with 1961-1990 is already statistically significant in a comparison with calculated values for the period 1981-2010. The increase in precipitation is greatest during the winter. During the summer, southern Sweden is expected to have reduced rainfall, while precipitation is expected to increase slightly in the far north.

Measured changes in temperature and precipitation

Changes observed in temperature and precipitation/run-off over the last 15 years are in good agreement with the simultaneous global warming and are in line with estimated changes due to human impact on climate[6] (Figure 6-3). The change in precipitation over the period 1991-2004 appears to be slightly greater than the trends estimated for 2071-2100 would lead to, which may mean either that calculated climate scenarios underestimate the regional climate change that follows the global warming or that part of the regional change at a later time is due to chance variations.

Wind

Wind conditions change only marginally during the summer in the various scenarios. During the rest of the year and principally during the winter, the change varies depending on the global climate model on which the regionalisation is based. In the calculations based on the German model, the winds increase during the winter months by 7 to 13% in the calculations for 2071-2100. This is linked to changes in large-scale circulation. Slightly greater changes occur over the Baltic Sea in the winter, particularly over the Bay of Bothnia and the Bothnian Sea. This is due to the sea ice largely disappearing in the scenarios. Reduced stability of the atmosphere results in higher wind speeds. Maximum wind speed changes to approximately the same extent as average wind speed. In the calculations based on the British model, wind changes are generally small in the region.

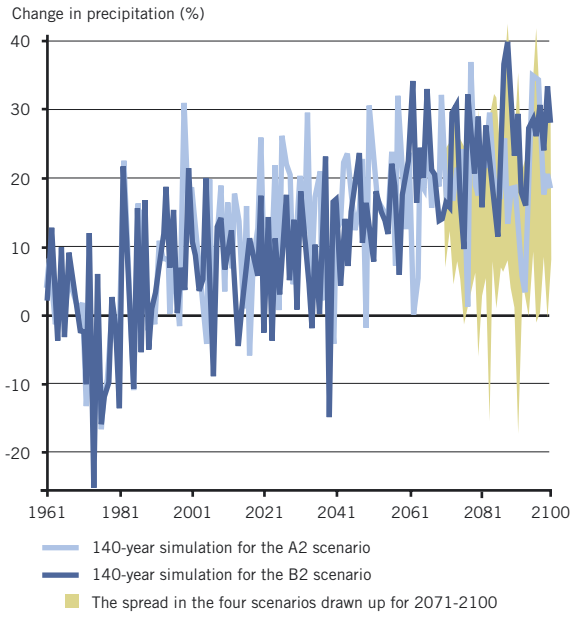

Figure 6-2 **Change in annual precipitation in comparison with the mean value for 1961-1990.**

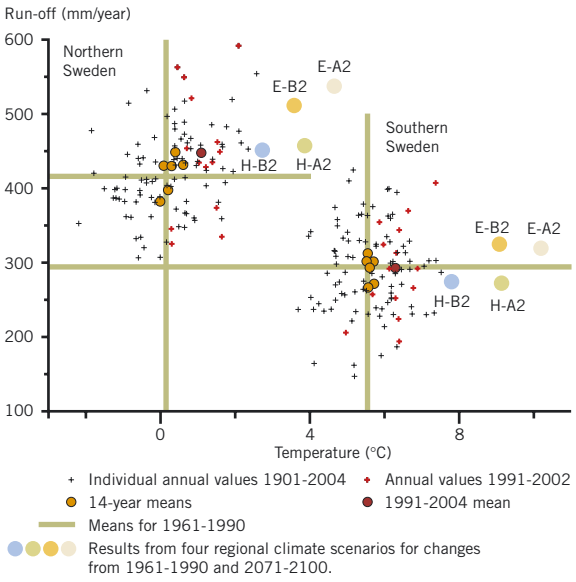

Figure 6-3 **Temperature and run-off in northern and southern Sweden 1901-2004 based on measured data.**

[6] Lindström G. and Alexandersson H., 2004.

Variability and extremes

Changes in variations in the weather (variability) and in extreme weather events (extremes) may either follow the mean condition or change disproportionately in some way. The 24-hour variability of temperature is expected to decrease during the winter, which means that the difference between mild and cold winter days will diminish. This is principally due to a sharp reduction in cold extremes. The converse applies in the summer, in that 24-hour variability may increase somewhat, due to a certain disproportionate increase in warm extremes. The really large increase in warm extremes is, however, expected to occur further south in Europe.

The trend in precipitation appears to be not just towards more but also towards more intensive precipitation throughout the country. This applies in all parts of the country, and for those seasons where total precipitation increases, but more intensive precipitation is also expected in southern Sweden, where total precipitation decreases during the summer. This means that at the same time as dry periods become more common, the intensity of rainstorms increases.

6.2 Climate impacts and vulnerability assessment

The following section describes the impacts of expected climate change and vulnerability for those areas where studies have been made, based on the climate scenarios presented in Chapter 6.1. Vulnerability is principally dependent on the extent of climate change and how quickly it happens but also on how well prepared society is to face up to it and how adaptable natural ecosystems are.

6.2.1 Water resources

Under the prevailing climate, Sweden generally speaking has good water resources, in terms of both quality and availability for the production of drinking water and for hydropower. However, in some regions of southern and principally south-eastern Sweden, including the islands of Öland and Gotland in the Baltic Sea, there has been insufficient availability of water during the summer months in dry years. Dry years are also noticeable for the production of hydropower.

Run-off

The future climate according to the Rossby Centre scenarios will be both warmer and wetter, which means that run-off increases in Sweden as a whole, by between 5 and 24% towards the end of the 21st century depending on the scenario chosen. However, there are great regional differences. The greatest increases will occur in the mountainous regions of north-western Sweden, while south-eastern Sweden can anticipate substantially reduced availability of water.

The seasonal distribution of run-off is also affected and it is generally the case that run-off during the autumn and winter increases. In northern Sweden the spring flow will occur 2-4 weeks earlier than today and at the same time decrease, except in the far north, where it will be approximately the same. In southern Sweden the spring flow will almost completely disappear and run-off during the summer months will decrease substantially.

Higher average run-off during the autumn and winter suggests that run-off during this period may become more extreme, with an increased risk of flooding. However, no comprehensive survey of how future climate change may affect extreme water flows has yet been compiled.

Baltic Sea

The level of the Baltic Sea is obviously affected by the global sea level. In addition, there are effects caused by wind changes. As far as Sweden is concerned, it is also necessary to consider land uplifting and land subsidence which is in progress. Taking these factors into account, two alternative scenarios are shown in Figure 6-4 for changes in mean water level (extreme water levels change slightly more in some cases) where land uplift and land subsidence have been added to a global raising of the water level of 9 and 88 cm respectively and effects of wind changes according to the regional scenario which produces the smallest and largest rises respectively in the Baltic Sea. As regional rises in sea-water level vary differently than the global rise, these results for the Baltic Sea should not, however, be regarded as best or worst cases.[7] Regional warming also entails a sharp reduction in the period of time during the year when the Baltic Sea is covered with ice (Figure 6-5).

The increasing inflow brings in more freshwater, which may cause a dilution effect in the salt content of the Baltic Sea. Increased inflow from more or less polluted watercourses may also have consequences for water quality.

Water supply and water quality

The expected decrease in summer inflow in southern and south-eastern Sweden combined with in-

[7] IPCC (2001) concluded that the global increase in seal level may average 9-88 cm from 1990 to 2100. Regional changes, e.g. for the North Sea region, varied more in and between different calculations.

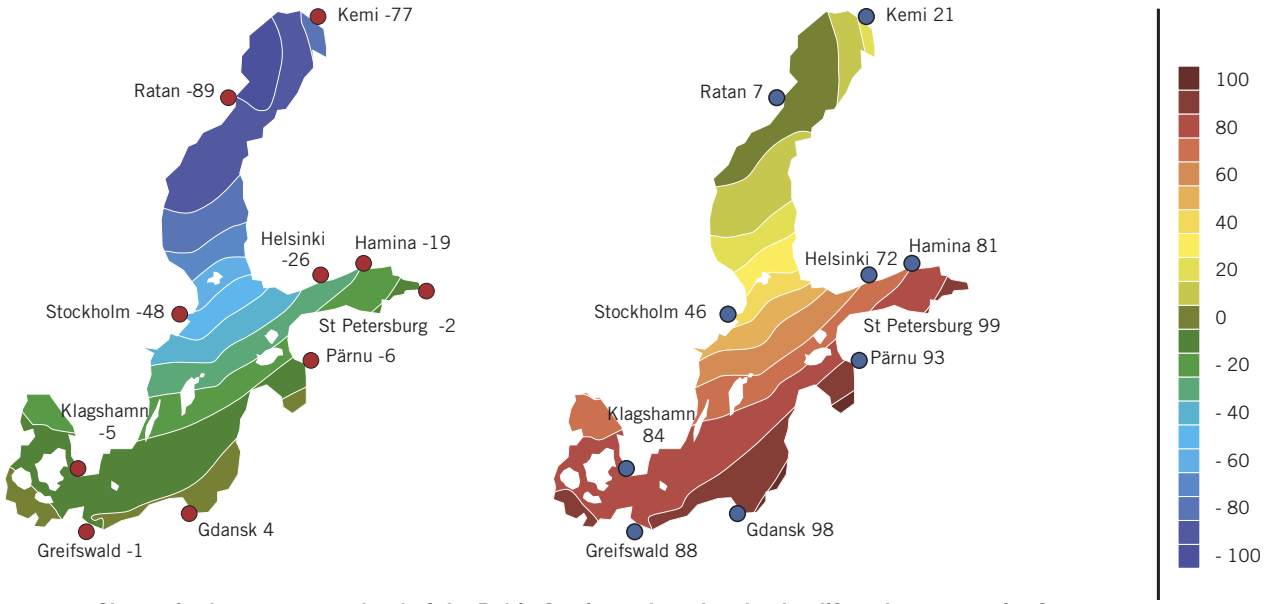

Figure 6-4 **Change in the mean water level of the Baltic Sea in cm based on land uplift and two scenarios for global water level and wind-driven effects (see text).**

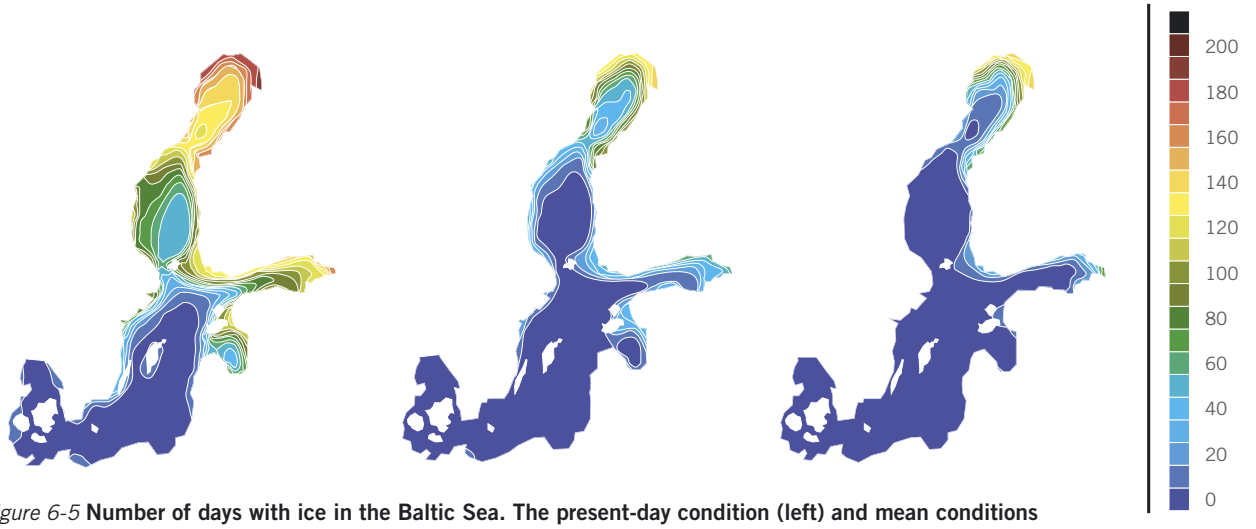

Figure 6-5 **Number of days with ice in the Baltic Sea. The present-day condition (left) and mean conditions in two regional scenarios for 2071-2100 which follow B2 (middle) and A2 (right).**

creased temperature in Swedish lakes may have negative consequences for both the supply and quality of drinking water. In those parts of the country where flow is expected to increase, there is an increased risk of contaminants and toxins being dispersed as floods upstream of aquifers carry pollutants into lakes and watercourses.

If the frequency of extreme precipitation increases in a future climate, it will have direct repercussions for surface water systems. Under-dimensioning of these systems is already leading to great damage and high costs for insurance companies and individuals today. An increased frequency of floods increases the risk of wastewater treatment plants being overwhelmed and of surface water polluting aquifers, with direct consequences for water supply. In conjunction with floods, environmentally hazardous substances may also come into circulation when industrial sites and landfills are affected. The fact that summers in southern Sweden are expected to become drier, combined with a change in sea surface level, increases the risk of intrusion of saltwater into aquifers and sewer networks. Vulnerability can be reduced through a long-term strategy to safeguard alternative aquifers.

Model studies show that the problems of eutrophication can increase with higher concentrations of nitrogen in watercourses (>10%) and higher levels in the sea (>20%). This is principally due to increased leaching from agricultural land because

of increased mineralisation during the winter and increased water discharge. Sharp changes in water quality have also been modelled for the biogeochemistry of lakes, with increased total algal production and increased concentrations of phosphorus and nitrogen. These model calculations are supported by a number of observed changes in water quality which it has already been possible to link to temperature rises and sometimes also to unusually high water flow rates. As a consequence of high flow rates in the autumn of 2000, some lakes became very brown due to the flushing of humus substances, which caused great problems for water treatment plants in the Stockholm area[8,9].

The observed increase in water temperature has led to cyanobacteria starting to grow earlier in recent years, with the result that the risk of the occurrence of toxic species has increased and will continue to increase in a future warmer climate[10].

The greatest threat to water quality is altered odour and taste problems, the presence of toxic algae and increased dispersal of harmful substances in flooded watercourses.

6.2.2 Infrastructure and physical planning

Technical infrastructure

Roads, railways, water supply, wastewater treatment, shipping and aviation are key areas in technical infrastructure. When constructing structures and installations which are to stay in service over a long period, it must be borne in mind that the climate may change during the lifetime of the installation. Systems to eliminate, monitor and warn and to take measures when crises and accidents occur need to be developed.

Expected future warming and expected changes in patterns of precipitation alter groundwater levels and pore-pressure conditions, which in turn has an impact on the risk of landslides and mudslides[11]. Stability is expected to deteriorate, particularly in sloping clay terrain and along steep sandy river banks, and in some cases the deterioration will be substantial. Areas which today are regarded as stable will need to be the subject of stability improvement measures.

The increased risk of landslides and mudslides increases the risk of damage to roads and railways. Some extreme weather events are expected to become more severe, which increases vulnerability. Higher maximum temperatures increase the risk of damage to roads and rails. Higher extreme flow rates in turn increase the risk of damage to culverts and bridges. The vulnerability of these systems can be reduced by taking account of climate change in sizing, particularly with regard to extreme precipitation and extreme water flow rates.

The expected warming also brings some positive effects with it in that the distribution between rain and snow will change during the cold months of the year. This reduces the need for snow clearing, gritting and salting of road surfaces, which in turn signifies better environment and air quality. Milder winters also mean less damage due to freezing and fewer accidents caused by falling on slippery surfaces.

High water tables and a possible rise in sea level increase the vulnerability of airports and sea ports. These are often located in areas that are particularly at risk, and there are examples of airports and sea ports which are already in the risk zone. Ice conditions around Swedish coasts are expected to become milder, which will be of significance to shipping. The need for icebreaker capacity will diminish in the future. Changes in the wave climate, particularly an increase in extreme waves, increase the vulnerability of structures along the coast.

Built environment

The built-up area is affected by climate change in that the circumstances that applied when the buildings were erected are changed. Historically, the built environment has been sited in good climatic locations, but less account has been taken of such consideration in recent decades. Buildings have been located in areas at risk of being exposed to flooding, landslides and mudslides. This applies in particular to areas alongside lakes and watercourses, but also coastal areas. More built-up areas will end up in the risk zone. Increased water flow rates means that capacity of dam installations and lake regulation at times becomes too small, resulting in flooding. This applies for example to regulation of Sweden's largest lake, Vänern. An example of this occurred during the autumn and winter of 2000/2001. It became necessary to weigh the risks of mudslides in the Götaälv river valley against the consequences of high levels around the shores of Lake Vänern.

An increase in extreme precipitation means that both drainage and guttering may be insufficiently dimensioned. The strength of wooden beams, for example, may be affected by increased moisture, as well as the presence of damp and mould damage.

Production and consumption of energy

The expected rise in temperature means that the need for energy for heating will decrease but this is counteracted to some extent by increased wind strengths. As minimum temperatures for the year and 24-hour period are expected to rise, the need

[8] Wallin M. and Weyhenmeyer G., 2002.
[9] Weyhenmeyer G. A., Willén E. and Sonesten L., 2004.
[10] Weyhenmeyer G. A., 2001.
[11] Swedish Geotechnical Institute, 2005.

for peak capacity, i.e. power reserves which must be held in readiness for the most severe cold periods, decreases. Swedish maximum consumption of electricity may be reduced by around 1500 Megawatts (equivalent to two small nuclear reactors) if the harshest winter cold is mitigated by 4°C.

The possibility of producing energy also changes. The greatest increases in water discharge are expected to occur in the mountainous regions of north-western Sweden, where the greatest quantity of water for power generation is obtained. Changed water discharge in regulated watercourses is also of great significance to the production of hydropower in the country as a whole, with increased and more even production.

The expected changes in the pattern of run-off in conjunction with possible changes in extreme weather increases vulnerability for power-station dams and other dams. It is chiefly dam accidents that can jeopardise parts of the electric power supply. Severe storms, like those in December 1999 and January 2005, even cause severe damage to the distribution of electricity. Increased incidence of extreme weather also increases the risk of ice storms, sleet and coatings of salt which can also cause severe disruption to the distribution of electricity. In addition, raised sea levels in storms may result in production shutdowns in nuclear power stations. The consequences for electricity distribution can be reduced with sturdier power lines and by burying cables.

Climatic conditions outside the borders of Sweden will also affect the country's energy production in the future as it is anticipated that the deregulation and internationalisation of the electricity market will continue. An example is the problems with the cooling of nuclear reactors on the European continent which may arise. The way in which such cooling problems can develop was revealed during the extreme summer of 2003, at the same time as the need for air conditioning increased demand for electric power.

Telecommunications

Line-based communication systems are expected to be affected by climate change in a similar way to the electricity network. When communications are knocked out, fault-tracing and repair work on the electricity network become more difficult, while power cuts do not just cause disruption between different parts of the fixed telephone network but also knock out base stations in the mobile phone network. Floods cause erosion in road banks, with buried lines, but water and moisture also knock out electronic equipment in the various parts of networks.

The Internet is not as susceptible to disruption as other systems, owing to its fine-mesh construction. However, in the event of an extreme weather situation the Net may become so overloaded that it becomes unusable. This means that radio and television have to play an important role as information providers. However, essential parts of the distribution networks for radio and television have an open and relatively unprotected location, which also makes these systems vulnerable.[12]

6.2.3 Finance and insurance

As climate change entails radical changes in circumstances for a number of functions in society, the finance and insurance sectors are also affected. Insurance premiums or excesses payable by the insured may be raised. In some cases it may become impossible to insure property against flooding. In the longer term, circumstances will probably change for other types of insurance (e.g. forest, sickness and animal).

Availability to hydropower creates sharp fluctuations in the price of electricity, as has been apparent in recent years. With a future integrated electricity market for a large part of Europe, the effects of hydrologically extreme years on the finance sector increase as hydropower can be used to offset variations in wind energy and/or to level out variations in the use of energy over the 24-hour period in large parts of Europe.

6.2.4 Agriculture, forestry and fisheries

Forestry

It is judged that a future milder climate will have several positive effects for forestry. The lengthening of the growing season alone could increase production by around 10-15% during this century. As an increased level of carbon dioxide makes increased photosynthesis possible, an increased level of carbon dioxide may also favour production while water economy is improved. Expected higher temperatures affect the breakdown of dead organic matter, which increases the release of nutrients, which may be of great significance for growth as the growth of Swedish forests at present is largely limited by shortage of nutrients. However, faster growth may mean a deterioration in the quality of the wood raw material, and the milder winters may cause disruption to the processes of regeneration. As growth is expected to get under way earlier in the spring, the risk of frost damage also increases. In southern Sweden, growth may be inhibited by shortage of water

[12] Marklund A., Barck-Holst S., and Fischer G., 2004.

and in the northern part of the country (Norrland) by increasing bogginess. Shortage of water may lead to a relatively drought-resistant types of tree such as pine and oak becoming more competitive and being chosen instead of spruce or beech when new forests are planted in the region.

The picture of damage in forests will also change. Windfalls may become more extensive due to a change in wind conditions and/or the ground thawing more often. However, it is uncertain whether severe storms, similar to those which occurred in December 1999 and January 2005, are chance events or will become more common.

The risk of insect and fungal attack increases in a warmer and wetter climate. Where summers become warmer and drier, there is also a risk of forest fires. Milder winters also alter the prospects for forestry as accessibility is made more difficult on forest roads and greater damage is likely to be caused to the ground by felling.

The positive effects might outweigh the negative ones, but as it is difficult to judge the scope of the total picture of damage with present-day knowledge, vulnerability cannot be quantified.

Agriculture

Agriculture in Sweden is highly sensitive to climate,[13] and harvests vary from year to year depending on the weather. Swedish agriculture is expected to benefit more than the agriculture of most other countries from the expected climate change. Yields are better in a warmer climate with a higher carbon dioxide level in the atmosphere and with longer growing periods which may lead to more harvests during a growing period. In the climate that may prevail in a hundred years, harvests may increase by an average of 20 per cent. There may also be an increase in the number of crops that can be grown in Sweden. Cultivation of sunflowers has already begun in southern Sweden, for example, and vine cultivation might also become possible in the future.

However, it is feared that access to water will increasingly become a limiting factor for agriculture in the south-eastern part of Götaland, the southern region of the country. As available climate scenarios show that extreme rains may become more common despite reduced average precipitation in south-eastern Sweden, harvest damage may worsen.

A warmer and damper climate favours pests such as fungal diseases, viral diseases, bacteria, nematodes and insects. The expected increase in pressure from various pests may increase the need for pesticides.

Taken together, the above factors mean that the quality and quantity of harvests may vary more than in the present-day climate. However, the effect of climate change depends on choice of crops, cultivation methods and soil changes, which means that the vulnerability of Swedish agriculture can largely be prevented and positive consequences can be utilised.

Fisheries

Water temperature is a key factor for fisheries. Both cold-water and warm-water species occur in Sweden. Optimums between these differ by 5-10 degrees Celsius. Geographical zoning therefore occurs in the Baltic Sea, but there are also seasonally dependent shifts in species composition. Some scope for natural adaptation appears possible in consideration of expected higher water temperatures. The same does not apply to cold-water species in shallow lakes. If great changes occur in flows of freshwater into the Baltic Sea, the marine species will also be affected. In conjunction with the expected warming, a reduced salt concentration would cause cod and other saltwater species to be displaced.

Warming and changes in water flow rates may displace fish species which are in demand from lakes and rivers, such as lake fish dependent on cold water, like char and vendace. High temperature and low water discharge in southern Swedish rivers mean that salmon and trout reproduce less well. High temperature favours the growth of warm-water species such as pike, perch and carp. Particularly on the west coast, the species composition may be affected by immigration of southern species. This is evident from the experience of changed fish fauna in areas affected by coolant discharges.

The vulnerability of fisheries is clearest in the Baltic Sea as species which are important to the fishing industry such as Baltic herring, cod and salmon are at a disadvantage. The expected effects for fisheries on the west coast are not so clear.

Reindeer herding

From the point of view of reindeer herding, the biological effects of climate change are probably both positive and negative. They can be managed to some extent due to the fact that humans control the use of land by reindeer.

Wetter and warmer winters result in more frozen snow crust and ice being formed, leading to more difficult grazing conditions on snow-covered ground. A shorter period of snow and a thinner and less complete snow cover will probably reduce the total dependence of reindeer on lichen grazing. The risk of more severe grazing of some lichen grounds increases at the same time as the protection of the snow decreases.

[13] Sigvald R., Lindblad M., Eckersten H., 2001.

An expected longer period with no snow on the ground may have positive effects on the availability of green pasture but result in worse average pasture quality with higher summer temperatures. Warmer summers also mean more insect disturbance, resulting in limited grazing time, and the animals will probably also be subject to higher rates of disease and parasite infestation.

A warmer climate may also mean that interest in other use of land increases, for example more intensive forestry and increased infrastructure and development of the built environment. Together with changes in natural conditions, a substantial change in land use will be forced on reindeer husbandry.

6.2.5 Natural environment and biodiversity

Ecosystems and natural environment

Climate change, particularly temperature and a rise in carbon dioxide concentration, affects a number of different plant-physiology processes, which in turn govern the structure and function of entire ecosystems. Effects that are expected and have already been observed are earlier sprouting and bud flushing, later leaf fall, increased growth, denser vegetation and changes in competitiveness. Increased susceptibility to fungal diseases and insect attack can also be expected.

The temperature increases projected for the end of the 21st century correspond to a shift in the northern boundary of the transition zone between boreal (coniferous) and nemoral (deciduous) forest of between 100 and 500 km. A shift in entire vegetation zones is limited by the relatively long life-cycle of trees, the limited ability to spread of types of tree that do not utilise wind or water to disperse seeds and competition from species populations already established. Human impact through silviculture, agriculture, control of wildlife populations and the built environment is probably most significant as both a limiting and accelerating factor in the movement of species. One way in which ecosystems and biological diversity can be at least temporarily preserved is to create migration corridors in the now fragmented landscape, to make it easier for species to move northwards.

It is anticipated that an expected increase in alternating periods of thawing and frost will pose the most serious threat to fauna. When periods of thawing occur during the winter, the formation of ice close to the ground increases and makes access to food more difficult, which has effects on species throughout the food chain, particularly in the mountains.[14]

Mountains

It is anticipated that virtually the whole country apart from the very highest mountain massifs will be below the potential tree line, and the total area of bare mountain is expected to become smaller than at any time since the last ice age. Newly established forests of both coniferous and deciduous tree species have already been recorded above previous tree lines in the Swedish mountains.

The balance between the most important tree species in the mountains, downy birch, spruce and pine, is expected to change radically in a warmer climate. A thinner and less permanent blanket of snow leads to general desiccation of mountain soil, despite increased precipitation. Downy birch forest cannot cope with general desiccation of the soil and is expected to lose its dominant position at the transition between forest and bare mountain. Pine and spruce are expected to gradually replace the receding downy birch forest.

In the slightly longer term the highest coniferous forests, just below the downy birch forest, may be affected by drought stress, which impairs vitality and opens the way for severe disruption in the form of fire, insect attack and windfall. The first indications of this are that older trees in particular have lost their ability to utilise the increased warmth for growth in recent decades.

Forecasts on the development of vegetation in montane regions in the future are complicated by a possible trend with increased atmospheric nitrogen deposition. Other types of impact that are difficult to assess are the future development of reindeer herding and mountain tourism.

With regard to fauna, less food will be available for example for lemmings. A further reduction in the supply of lemmings will have a severe impact on the Arctic fox, which is already an endangered species in Sweden.

Soil characteristics

A key question with regard to soil characteristics is whether climate change leads to reduced carbon storage in soil and consequently to an increase in the quantity of carbon dioxide in the atmosphere and exacerbation of climate change. Studies of quantities of carbon along climate gradients[15] have, however, generally pointed to a positive correlation with temperature and precipitation for northern latitudes, i.e. climate change in Sweden should lead to more sequestration of carbon dioxide as carbon compounds in soil. Annual addition of litter is expected to increase in large parts of the country as forest production is likely to increase[16]. Increased

[14] ACIA, 2004.

[15] Callesen I. et al., 2003.

[16] Bergh J. et al., 2003.

production of litter in conjunction with increased run-off will, however, result in increased leaching of dissolved organic matter to watercourses[17].

Climate change can generally be expected to increase the turnover of organic matter, which signifies increased mineralisation of substances linked to organic matter, such as nitrogen, phosphorus, calcium and potassium. This increases the formation of nitrates, which exacerbates the risk of nitrate leaching. This risk is strengthened by the fact that the soil, at least in southern Sweden, is expected to thaw to a greater extent than at present and that the level of precipitation is increasing during the winter.

Lakes

Physical, chemical and biological long-term data from national and regional environmental monitoring show that certain changes that can be linked to climate change have already occurred. Earlier ice break-up, for example, affects the growth of algae, and earlier spring algal bloom has also been observed[18]. Changes in species composition have been observed. An increase in *Aulacoseira*, for example, has great economic consequences as species in this genus have the ability to settle on fishing nets, boats and water pipes[19].

It is anticipated that temperature stratification will become more pronounced in the future as a consequence of warmer summer temperatures. This further reinforces the effects, with changes in species composition of fish, benthic flora, macrophytes, plankton etc. Expected warmer temperatures mean that cyanobacteria will have a larger biomass and that the risk of the presence of toxic algae increases. The vulnerability of lake ecosystems depends on how great changes in temperature become in the future. Vulnerability is also determined by how great the change in species composition can become before a threshold value is reached where an ecosystem can completely change character.

6.2.6 Health

An expected effect of the expected warming on health is a continued spread of tick-borne diseases (borrelia, TBE). Other disease vectors and exotic diseases which have arisen in Sweden or have been brought in by travellers are favoured by warming. Cold-related medical conditions will become less common while heat-related conditions will become more prevalent. In episodes of prolonged extreme heat, it must be possible for cooling requirements to be met, particularly for the elderly. The occurrence of pollen and related allergy symptoms will increase as a result of an extended growing season, change in vegetation and higher carbon dioxide concentration in the atmosphere. It is anticipated, however, that vulnerability to adverse effects on health can be prevented in most cases by advice, building planning and education.

6.2.7 Tourism

Tourism and climate are inextricably linked. An evident effect of warming in Europe is changes in snow conditions, and the fact that ski resorts will suffer from a lack of snow. Glaciers will shrink or disappear completely. In Sweden, the southern parts of the mountains will be affected first, with availability of snow and the length of the period of snow cover decreasing markedly within the next 30 years. The tree line is expected to move, so that popular hiking trails will pass through deciduous forest instead of going over bare mountain. It is anticipated that vulnerability to the economic consequences of reduced availability of snow may be partly counteracted by long-term planning of activities such as different utilisation of existing tourist areas.

Summer tourism will also be affected by a changed climate. If summers become hotter in the Mediterranean region, as the climate scenarios indicate, the Baltic Sea area and western Sweden may become more significant as tourist destinations, but on condition that problems associated with eutrophication and algal bloom can be tackled.

6.3 Adaptation measures

The question of adaptation to climate change is a crucial one because it is already too late to completely avoid climate change. It is also crucial in view of the sensitivity of society under prevailing climate conditions. This sensitivity has in some cases increased with the development of society. Vulnerability can be reduced through the strategic build-up of secure systems. Under the law on protection against accidents the local authorities have to compile action programmes for preventive measures and rescue efforts.

There is no national strategy yet in Sweden for adaptation to climate change, but a government inquiry was appointed in the summer of 2005, one of the tasks of which is to present proposals for how society can become more robust so that it can face up to future climate change.

As there is no national strategy as yet, there are wide differences in the way in which the issue of adaptation has been dealt with by those affected in society. Some have not yet paid any attention

[17] Michalzik B. et al., 2001.
[18] Weyhenmeyer G. A., 2001.
[19] Willén E., 2001.

to the issue, while others have made relatively great progress. There are a few examples of specific measures that are either planned or have already been implemented[20]. For example, a start has been made in some cases at local level on amending regulations for physical planning. In other cases only necessary adaptation to existing climate variability has been dealt with through measures that have been taken.

6.3.1 Planned and current adaptation measures

Examples of specific measures that relate to adaptation to climate change and on which a start has been made are given below. No measures have yet been taken in other sectors, although some vulnerability to climate change has been identified in several cases.

Forestry

Skogforsk[21] devised a new strategy for the breeding of pine, spruce, birch and contorta pine in the early 1990s. In this strategy, which is still applied, account was taken of expected climate change in order to ensure long-term dynamic preservation of genes, to create a state of readiness for future climate change and to improve the general characteristics of the trees in terms of vitality, growth and timber quality. In practice, this activity entails working on a number of breeding populations for different climatic conditions (temperature sum and light conditions). These cover existing climate zones in present-day Sweden and in a changed climate. This has created a readiness for measures in planting new forest stands when this is judged relevant.

Physical planning and the built environment

A start has been made in some municipalities on taking measures at the local level in physical planning and the built environment. This principally involves re-assessing high flow rates or water levels, with direct reference to the issue of climate change. Limits have been set for the location of buildings, and heights have been established for minimum floor level and levels for the capacity of sewer systems. Some examples are given below.

In the municipality of Malmö the limit for building development has been raised in the comprehensive land-use plan to a minimum of 2.5 metres above sea level from the previous limit of 2.0 metres

In Halmstad the safety margins for high water levels along the Fylleån river have been raised in the planning of new areas. Minimum floor level values are stated in the municipality's public display documents from 2003. The values are based on estimated 100-year flow rates and extreme values for sea water level. A margin of 0.7 m has been set, and this is judged also to be reasonable if account is taken of future climate change.

The issue of climate has been considered in the work of the municipality of Gothenburg since 2002. The municipal council has decided that the limit for building development is to be raised by 0.5 metres. The capacity of sewer systems is also being reviewed so that it will be possible to cope with raised coastal water levels and increased flow rates in the Göta älv river.

Other measures being implemented are primarily motivated by threats from the prevailing climate. The county administrative boards in the Mälaren valley, for example, have collaborated on plans to expand provisions for discharge from Lake Mälaren to prevent flooding. The need for increased discharge is a consequence of present-day climate variations, but can be expected to increase with a changed climate. The lowest point in Sweden is at Kristianstad, -2.4 m below sea level. To eliminate the risk of the town being flooded, the local authority is working to analyse the threat posed and take measures, for example to expand enclosure within embankments and improve the existing embankments around low-lying areas. In several other counties and municipalities, efforts aimed at reducing the risk of flooding have also been initiated.

Energy production and energy consumption

Since new guidelines for design flows for dam installations were drawn up by the 'Flow Committee' in 1990, a nationwide analysis of the ability of the Swedish hydropower system to cope with high flows has been in progress. This analysis has led to reconstruction in several cases. Account is taken of new risks which climate change entails in this review activity in a number of cases. In practice, it means a further increase in safety margins in reconstruction work, where technically possible and economically feasible.

Tourism

The vulnerability of winter tourism to climate change has been identified in several quarters. At the same time, the effect is less severe in Sweden than in the rest of Europe, which may benefit Swedish ski resorts. As well as developing year-round tourism, adaptation measures are planned, for example in the form of snow manufacturing. No new pistes are now being built without snow manufacturing,

[20] Rummukainen M. et al., 2005.

[21] Skogforsk is the research institute of Swedish forestry

and in one case a strategy has been developed for geographical dispersal of facilities to reduce their exposure to fluctuating weather conditions.

6.4 International activity

Sweden is taking part in work under the Framework Convention on Climate Change with a five-year programme on adaptation issues and in a working group recently created within the second stage of the EU's European Climate Change Programme (ECCP). However, the Rossby Centre at the Swedish Meteorological and Hydrological Institute is continuing to take part in several international projects aimed in particular at developing a basis for vulnerability analyses that can serve as a basis for adaptation strategies:

- CLIME is an ongoing EU project whose principal aim is to develop methods and models to administer lakes and catchments in a future climate. The latest regional climate scenarios and models are used for this purpose.
- SEAREG, which was concluded in the spring of 2005, focused on socio-economic and environmental assessments of climate effects on the Baltic Sea region, particularly the rise in sea level and changed run-off pattern from watercourses.
- ESPONHazard, which was completed in the spring of 2005, classifies vulnerabilities and risks and draws up vulnerability profiles for different regions. The results are intended to provide a better understanding of the risks and make targeted measures possible by identifying comparable situations in Europe (EU27+2).
- PRUDENCE, which came to an end in 2004, was an EU project aimed at developing extensive regional climate scenarios for 2071-2100 for Europe. The scenarios were used, for instance, to study changes in the incidence and intensity of extreme weather events. Assessments of the effects on selected sectors were made.
- ENSEMBLES is a new large EU project aimed at drawing up global and regional climate scenarios with probability assessments. The scenarios will be used in compiling impact studies on agriculture, health, food safety, energy, water resources and risk management in the insurance sector and other weather-dependent sectors.
- CE is an ongoing Nordic project which combines and processes climate scenarios for decisions on administration and planning on renewable forms of energy and carries out impact studies on biomass fuels, hydropower, wind power and solar power.

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7 Financial resources and transfer of technology

7.1 Introduction

The overall objective of Swedish development assistance policy is poverty alleviation. Swedish development assistance in the area of climate change is intended to contribute to measures that prevent or minimise greenhouse gas emissions, reduce the vulnerability of poor countries and people to the effects of climate change and enhance their capacity to cope and adapt to a changed climate. Climate-related activities in Swedish development cooperation are governed by two principles: the precautionary principle, that prevention is better than cure, and the principle that the issue of climate change has to be integrated into development assistance activity.

Climate-related development assistance covers various areas. For example, development cooperation in the sectors of energy, transport and industry and commerce is principally geared towards investments in energy efficiency improvements and production with the benefit of reduced greenhouse gas emissions, while support to activities in the health sector or in relation to water resources contributes to counteracting any negative consequences of climate change and as such reduces the vulnerability of societies. The Swedish climate-related efforts targeted at non-Annex 1 countries are described below.

Besides the official development assistance, Sweden also allocates resources specifically to support the work under the Framework Convention on Climate Change and the Kyoto Protocol.

7.2 Resources and objectives

Sweden's total development assistance budget has increased substantially in recent years. A sum of SEK 16 480 million was earmarked for development cooperation in 2000 and SEK 19 388 million (0.79% of GNI) in 2003. The budget has since increased further, and the development assistance budget for 2006 amounts to SEK 28 090 million or 1% of the calculated GNI for 2006. Sweden's financial assistance to developing countries is high in comparison with other donor countries (DAC[1] countries), as Sweden is one of the few countries to meet the 0.7% target.

Swedish development cooperation is intended to contribute in its entirety to sustainable use of natural resources, and environmental concerns have to be integrated into all Swedish development assistance activity. As such, earmarking of resources for specific climate-related efforts therefore occurs to a very small extent. To estimate how much development assistance can be regarded as related to climate, an extensive survey was conducted.

Swedish policy for global development

Up until December 2003, Swedish development cooperation was geared towards six principal goals, which together aimed at meeting the overall objective of poverty alleviation. These goals were established by the Swedish parliament in 1996:

- growth of resources
- economic and social equality
- economic and political autonomy
- democratic social development
- concern for the environment
- equality between men and women

Further goals were defined for the cooperation with countries in Eastern and Central Europe:

- promote regional security
- enhance democracy
- support socially sustainable economic reform
- support environmentally sustainable development.

[1] DAC is the Development Assistance Committee of OECD (Organisation for Economic Cooperation and Development).

In December 2003, the Swedish parliament adopted a new policy for global development inspired in part by the UN's Millennium Declaration and by the environmental conferences in Stockholm, Rio de Janeiro and Johannesburg. The goal of the new policy is for Sweden to contribute to fair and sustainable global development. To attain this goal, all aspects of Swedish policy are to strive for the same objective. The different policy areas are, to the extent possible, to be coordinated to ensure complementarity. For example, Sweden's work to bring about open and fair trade rules and its efforts to contribute to the development of local industry and commerce in developing countries relate to trade, agriculture and the environment, and may also be of relevance to security.

Joint responsibility for global development is emphasised in global development policy, which calls for the involvement of the whole of Swedish society, and in particular, industry and commerce and civil society. While it is difficult to estimate exactly how much this policy will affect future Swedish climate-related assistance, it can be expected that several actors will probably be engaged in climate-related development cooperation.

International cooperation

Within the international context, Sweden aims to ensure that international cooperation on the issue of climate change is as ambitious as possible. Sweden is active primarily through the European Union (EU), which has been a leading player in the climate-change negotiations, not least during the Swedish presidency in 2001. In addition to the Convention on Climate Change, the Kyoto Protocol and bilateral development cooperation, Sweden also participates in other international cooperation of relevance to the issue of climate change, for example in the Arctic Council and in bilateral and regional development cooperation.

7.2.1 Actors

The principal actors in Swedish climate-related development cooperation are presented below:

Ministry for Foreign Affairs, Ministry of Sustainable Development and Ministry of Finance

Financial support to multilateral organisations is administered by the ministries for foreign affairs, finance and sustainable development. Most of the assistance is given in the form of voluntary and regular grants in accordance with the commitments under the Convention and the Kyoto Protocol.

Swedish International Development Cooperation Agency (Sida)

The greater part of Swedish support consists of financial assistance for developing countries and countries with transitional economics. This is administered by the Swedish International Development Cooperation Agency (Sida).

Individual organisations

A large number of nongovernmental organisations are active in development cooperation in Sweden. These have their own financial resources to some extent, but also receive grants for development cooperation from Sida. As awareness of the issue of climate change has increased, so too have the climate-related activities in these organisations.

Private sector

Technology transfer and capacity building in developing countries which is relevant from the point of view of climate also occurs on a purely commercial basis. Sweden has well-developed environmental legislation with strict requirements for both technical solutions and internal organisation, which in various ways is reflected in international business contacts.

Sweden's new policy on global development calls for strengthened collaboration between the various Swedish actors to ensure that development cooperation is not just improved but also efficient. To improve collaboration on climate-related development assistance work, several efforts have been made to raise awareness on the issue of climate change among those who work on development assistance issues in Sweden. This has resulted among other things in an increased focus on climate change in the strategies of Sida (the Swedish International Cooperation Development Agency) for development cooperation for individual countries and regions.

From Sida's position on climate change and development, 2003

Sida should actively promote long-term solutions to climate problems in the South and East and assist in international policy processes. The role of Sida is to *contribute to creating the necessary conditions* for reduced impact on climate and adaptation to climate variation and change. Sida regards climate concerns as an integral part of development cooperation rather than the object of specially targeted efforts. As such, addressing climate change should be done in conjunction with the

country strategy work. Sida's priorities will be based on conditions in those countries and regions with which Sida cooperates and on the basis of technical issues which Sida pursues. In certain countries, principally in the South, it will be most urgent to deal with the consequences of climate change while in other countries, primarily in the East, the focus will be on activities that would contribute to reducing greenhouse gas emissions. Several of Sida's goals are shaped by the work on climate change. As such, Sida's work on climate change should be pursued on the basis of a number of overarching principles, such as that prevention is better than cure, that a holistic and long-term approach must be adopted, that the perspective on fighting poverty must be upheld and that the precautionary principle must be applied.

7.3 Multilateral contribution

Approximately a third of Swedish development assistance is channelled through multilateral organisations. These grants are usually not tied to specific programmes or purposes, and are provided as core support to the recipient organisation.

A significant portion of the Swedish contribution to the Global Environment Facility (GEF) is used for climate purposes and is a significant element in GEF activity. Table 7-1 summarises Sweden's payments to the GEF over the period 2000-2003. By paying in accordance with the country's commitment to the GEF, Sweden contributes towards ensuring that the GEF can fulfil its role, not least as a financial mechanism under UNFCCC.

Table 7-1 **Payments per year to GEF, in 2000-2003 (SEK million)**

	2000	2001	2002	2003
GEF	13.4	39.1	52.3 *)	136.9

*) Incl. payment to LDC fund of SEK 3.0 million

Swedish payments to GEF are made according to an agreed scale which is negotiated during each replenishment. Table 7-2 provides details of what Sweden has undertaken to pay during the second (GEF-2) and third (GEF-3) replenishments. In addition to the agreed sum for GEF-3, Sweden is to contribute a further SEK 100 million. The money is paid out over a specified period, for example for GEF-3 up to 2012.

Table 7-2 – **Payments to GEF-2 and GEF-3**

Replenishment	Swedish disbursements according to an agreed scale	Payment period
GEF-2	SEK 448 million	Up to 2010
GEF-3	SEK 665 million (+ SEK 100 million extra grant)	Up to 2012

In 2002 Sweden also gave grants of SEK 3.0 million to the fund for least-developed countries (LDC fund). In December 2004, Sweden decided also to contribute SEK 10 million to the Special Climate Change Fund (SCCF) administered by the GEF. These funds are to be used for adaptation (SEK 7 million) and technology transfer (SEK 3 million).

Table 7-3 provides examples of multilateral organisations and research institutes to which Sweden contributed resources over the period 2000-2003. The table is not exhaustive and merely presents examples.

Sweden supports the participation of developing countries in the work of the Convention on Climate Change among other things by making extra contributions to the UNFCCC (Trust Fund for Participation and Supplementary Activities). The resources are to be used primarily to finance the participation of developing countries in the convention conferences of parties. In addition, Sweden contributes to the work under the Clean Development Mechanism (CDM) Executive, one of the institutions created within the framework of the Kyoto Protocol.

Sweden also provides support to the different UN organisations and their specialised agencies as well as to the World Bank's consultancy funds, which include some climate-related projects. For example, Sweden contributed to building a facility in Cuba where waste from the sugar industry is used to produce electricity and steam. The project was carried out by UNDP and contributed to reducing carbon dioxide emissions.

International research

Sweden provides financial support to several international research institutions in the agriculture and forestry sector, such as the Consultative Group for International Agricultural Research (CGIAR), International Council for Research in Agroforestry (ICRAF) and the Center for International Forestry Research (CIFOR). The climate-related research is in areas such as biodiversity, livestock production, soil conservation, forest ecosystems and food crops, all of which are issues concerned with adaptation to and reduced vulnerability to climate change.

Table 7-3 **Payments to multilateral organisations, 2000-2003 (SEK million)**

	2000	2001	2002	2003
Multilateral institutions (example)				
1. World Bank	1471	1138	846	1106
2. International Finance Corporation	45	61	30	25
3. African Development Bank	48	22	14	12
3b African Development Fund	271	270	351	241
4. Asian Development Bank	2	2	8	18
4b Asian Development Fund	136	119	128	114
5. European Development Bank *)	56	71	8	6
5b via European Union **)	1462	1855	1837	2079
6. Development cooperation in EU budget	757	732	757	798
6b European Development Fund	0 ***)	431	304	194
7. Inter-American Development Bank	33	57	27	36
8. United Nations Development Programme	702	284	180	534
- specific programmes		1	1	
9. United Nations Environment Programme	2	8	15	7
10. UNFCCC				
- Supplementary Fund	0	2	0	0
- Trust Fund	1	2	2	1
- Trust Fund for Participation	0	0	1	1
Multilateral programmes for development of research, science, technology or other training (examples):				
1. Consultative Group for International Agricultural Research (CGIAR)	90	93	65	68
2. International Union for the Conservation of Nature (IUCN)	49	37	36	36
3. International Science Programs	31	23	24	25
4. Asian Institute of Technology	23	32	30	18
5. World Maritime University	22	25	25	24
6. African Energy Policy Research	15	12	12	3
7. International Centre Research Agroforest	10	11	11	9
8. World Resources Institute (WRI)	5	3	3	2
9. Global International Water Assessment (GIWA)	3	3	3	0

*) Sweden's bilateral aid to EBRD
**) Sweden's share of EU aid to EBRD (2.7%)
***) Payment to EDF deferred to 2001.

In addition to Swedish development assistance, the country also allocates other resources to multilateral funds (e.g. the Prototype Carbon Fund (PCF) of the World Bank and Testing Ground Facility cooperation) for the development and application of project-based mechanisms and acquisition of emission reduction units. These efforts, as well as the resources allocated to the bilateral investment programme (Swedish International Climate Investment programme – SICLIP) are described in Chapter 4 (policies and measures). For example, the resources contribute to capacity building and to promoting technology transfer to the developing countries involved. The resources provided to the PCF have been paid in advance and the interest earned on the money, currently amounting to approximately 2 million SEK per year, is used among other things for capacity building via the PCF-plus programme.

7.4 Bilateral contribution

Sweden's bilateral development cooperation is developed in dialogue with the partner country, on the basis of the country's needs and priorities and of its Poverty Reduction Strategy. Priority areas for development cooperation with Sweden are described in country or region strategies. These have increasingly focused on climate-related issues in recent years. When Sweden decides on areas of activity in a partner country, the contribution of these efforts to sus-

tainable development must be taken into consideration. As such, climate-related programmes that meet the objectives of the Convention on Climate Change are also implemented.

The capacity for a country to effectively promote its own development is essential to combat poverty. Development cooperation that demands the active participation of the recipient country in the whole process, from idea to implementation and follow-up, requires that the donor supports governance in the partner country. This is one of the reasons why Swedish bilateral financial assistance and sector support is increasing, while the proportion of specific projects or programmes is on the decrease. This trend to some extent reduces the degree to which Sweden can assess how its development assistance is used in the partner country and as such the specific contribution to climate change activities.

Annex 3 shows bilateral and regional financial aid related to the climate change for the years 2000, 2001, 2002 and 2003. The tables show the total sums allocated to these initiatives and may therefore include activities which cannot be regarded as directly relating to the Convention on Climate Change including credits administered by Sida. The total sum originating from credits is shown separately in the table.

Mozambique, Tanzania, Vietnam and Nicaragua topped the list throughout the period. Their high ranking in the context of climate change is more a reflection of a large total budget for Swedish development cooperation with these countries. Sweden endeavours to share its climate-related development cooperation among several different countries.

Table 7-4 shows that the work on climate change is mainly concentrated on efforts to reduce emissions in the energy sector, as well as on capacity building initiatives that relate to adaptation. Capacity building and research are areas to which Sida generally accords very high priority. There are components of institutional development, training or other types of administrative support in all major programmes and projects, not just where capacity building has been stated as being a principal aim. Relatively large sums are reported under the category "Other", which includes activities such as support for the development of environmental laws and regulations relating to air quality issues.

7.4.1 Countries particularly vulnerable to climate change

Sweden's development cooperation principally takes place with partner countries with a low or very low GNI per capita. Approximately a third of bilateral contribution goes to least developed countries (LDCs).

In many of Sweden's partner countries, people are directly dependent on agriculture, fisheries or other use of nature to obtain their daily sustenance and an income. A changed climate may therefore lessen their chances of survival. Many of Sweden's major efforts are aimed at enhancing food security, for instance in southern Africa and India. Taking account of climate-related aspects, for example in the choice and development of crops and agricultural methods is of key significance in all these efforts.

Agriculture Support Programme (ASP) and Policy Support, Zambia

The 5-year programme, which started in 2003, has a budget of SEK 240 million. It aims at supporting agricultural production, land-use management and entrepreneurship. The aim is to reduce poverty, by increasing food security and by strengthening and diversifying household economies. The people in the area thus become les vulnerable to the impacts of climate change, such as prolonged droughts or torrential rains and floods. The programme currently involves around 20 000 families and will be expanded to cover a further 20 000 families.

Table 7-4 **Climate-related bilateral and regional development assistance per sector and per year, based on Annex 3 (SEK million)**

	Mitigation						Adaptation			Other	TOTAL
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity building/ research	Management of coastal areas	Other vulnerability reduction		
2000	312	36	51	134	64	32.50	318	130	23	384	1 484
- of which credits	41	-	-	-	-	-	-	-	-	20	61
2001	557	27	65	102	58	24.4	398	73	31	532	1 867
- of which credits	340	-	-	-	18	-	-	-	-	62	421
2002	350	47	100	120	80	19.7	512	47	46	435	1 757
- of which credits	60	-	5	-	11	-	45	-	-	18	139
2003	354	161.1	92	108	106	18.2	473	36	50	249	1 646
- of which credits	108	-	-	-	-	-	-	-	-	181	289

Amhara Rural Development Programme, Ethiopia
This programme, which started in 2002, has a budget of SEK 50 million and aims at improving living conditions and boosting food security in the region. It includes activities to improve agricultural methods and the introduction of new crops to prevent food shortages in the event of drought or heavy rains. Various efforts are also being made to help diversify household finance, to reduce dependence on income from agriculture and reduce the risk of increased poverty in the event of drought or crop failure, which ultimately reduces vulnerability to future climate change.

Future climate change may entail a redistribution of the Earth's water resources and, for instance, reduced access to clean drinking water. In areas where there is already a shortage of water, this poses a particularly great threat. Sweden is involved in a large number of initiatives in the management of water resources, in particular in central and southern Africa (Tanzania, Mozambique), as well as in Asia (Laos, Bangladesh and Vietnam). The projects are based on natural catchment areas and also aim to create and strengthen forums for communication across borders in various ways. They also aim at enhancing knowledge and systems to predict ways in which water resources may be affected by future climate change. These efforts contribute to social and land-use systems that are better adapted to climate change. The vulnerability of people who are dependent on the water resources may also decrease as a result.

Mekong River Commission (MRC)
Sweden supports the work of the Mekong River Commission, the member states of which are Cambodia, Laos, Thailand and Vietnam. Areas of cooperation include shipping, fisheries, flood management, hydropower generation and environmental protection. The cooperation is principally relevant from the point of view of climate in the areas of adaptation and vulnerability reduction.

Making climate change forecasts and planning adaptation activities call for long term efforts. Work of this type may be regarded as a luxury for a country with very small margins, and it is relatively easy to downgrade its priority in favour of more urgent measures. Sweden therefore provides financial aid in several different sectors in order to boost the planning and forecasting capacity, for example, to minimise or prevent damage in the event of natural disasters. The assistance is provided at various levels, to advanced climate-related research and further training, as well as to practical application and capacity building.

The road sector in Mozambique
Following the major flood disasters in 2000 and 2001, the issue of climate change has also received considerable attention in the road sector in Mozambique. Sweden contributes to several initiatives in Mozambique, some of which are targeted at the road authority in Mozambique. The activities include institutional support and capacity-building for administration and maintenance of the road network, as well as financial assistance for reconstruction and maintenance. Climate change aspects are taken into consideration in defining both technical solutions and the working methods, in order to minimise the risk of damage during heavy rains or floods.

To improve the prospects of recipient countries developing and using technology and infrastructure that lead to low greenhouse gas emissions, Sweden provides assistance in order to disseminate knowledge on sustainable technology and energy, and on how regulations can be used to promote more efficient energy use. Support is also provided for developing and improving the utilisation of renewable energy sources.

Electrification of rural areas in Sri Lanka
The electrification programme is expected to lead to a shift from using wood and paraffin as sources of energy to electricity produced from domestic hydropower, and thus to lead to reduced greenhouse gas emissions. The overall aim of the initiative is to reduce poverty. By ensuring access to electricity, the development opportunities for the local communities are increased, for instance through improved healthcare, education, maintenance and information. This initiative targets around 65 000 households and industrial enterprises in 600 villages that will be connected to the national power grid.

7.4.2 Capacity building

Sweden's aspiration is that development cooperation should contribute to capacity building in the recipient country. Contributing to the development of individuals, organisations and institutional frame-

works underlies all of Swedish development assistance. Capacity building is thus one of the most important forms of Sweden's climate-related development cooperation (see Table 7-4).

In some areas, such as environmental management and institutional development, as well as environmental education and training, capacity building represents the principal purpose of the initiatives. But there are also elements of capacity building in the majority of Sweden's development assistance efforts in other areas.

Swedish development assistance in the area of management is aimed at strengthening the national and local administration of partner countries. The prospects for national climate-related activities can thus be improved, for example by reducing greenhouse gas emissions, promoting investments in new technology or improving land-use planning. The cooperation initiatives are, for example, in the policy area, development of environmental action programmes, support in the implementation of new legislation, and systems for environmental inspection and statistics.

Pungue River, Zimbabwe-Mozambique
The floods of recent years, combined with periods of water scarcity, have signalled a need for improved management of the Pungue River catchment area. Sweden is supporting a multi-year programme aimed at improving adaptation to climate change and thus improving access to water. The programme focuses on land use and includes, for example, wetland management and infrastructure. It also covers the institutional framework for the transboundary management of the catchment area of the Pungue River, and aims, *inter alia*, to contribute towards improving cross-border communication, which is also essential from the point of view of preventing conflict.

Sweden's development assistance to national systems for education, further training and research is increasing. Sweden works in particular to strengthen climate-related research in developing countries. An inventory of existing international and Swedish scientific institutions and programmes was compiled in 2003 in order to define new avenues for and forms of support for research by developing countries in the area of climate change. A number of priorities have been identified as a result of the inventory. For instance, Sweden will provide aid for participation in postgraduate courses and for the integration of climate research into bilateral initiatives in research and research programmes. Swedish aid will also be used to enable research teams from developing countries to take part in international programmes, and to facilitate cooperation between researchers from developing countries and Sweden.

Asian Regional Research Programme in Energy, Environment and Climate (ARRPEEC)
Sweden provides financial support to ARRPEEC, a programme at the Asian Institute of Technology (AIT), which is aimed at supporting more research in the areas of energy, environment and climate at national research institutes in Asia. The research is policy-oriented and aims at making a contribution to supporting the national and regional decision-making and innovation processes that promote reduced greenhouse gas emissions. Four strategic areas have been selected for the research, namely biomass, the power sector, small and medium-sized industries and transport.

Sweden annually funds around 70 international training programmes for participants from developing countries and from Eastern Europe. Several of the programmes are directly relevant to the Convention on Climate Change, for example the ten or so programmes targeted at the energy and industrial sectors, as well as programmes in agriculture and forestry, risk management, environmental administration, planning and land use.

7.5 Technology transfer

Technology transfer is another key issue for compliance with the Convention on Climate Change. Technology transfer is particularly relevant in certain areas of activity, such as energy and industry. Several different initiatives have been undertaken in Sweden to disseminate new and improved technology more widely and to provide opportunities for different actors to exchange experience and knowledge on how technologies can be used in different contexts. A few of them are presented below.

Greenhouse gas Emission Reduction from Industry in Asia-Pacific (GERIAP)
In cooperation with UNEP, Sweden is funding an initiative to reduce greenhouse gas emissions from industry in China, India, Indonesia, Mon-

golia, the Philippines, Sri Lanka, Thailand and Vietnam. By strengthening capacity in both industry and government bodies, the project aims at improving the capacity for improved environmental inspection and administration. Thus, it is also possible to create the conditions necessary for greenhouse gas emission reductions from energy production and use in the region. The initiatives are primarily aimed at the iron and steel, cement and lime, paper and pulp, as well as the chemical industries. The activities involve the training of both operators and civil servants, the preparation of guidance, and testing, supervision and inspection guidelines.

Technology transfer covers a broad range of activities and a large number of actors. Swedish authorities and institutions have a long tradition of international exchange and cooperation. Many local authorities have been active in cooperating with counterparts in developing countries or in Eastern Europe, and this cooperation is often focused on environmental management. Common areas of cooperation are Agenda 21 programmes, environmental education in schools, processes for local participation and issues relating to waste, water and sanitation. The issue of climate change is an integral part of local environmental activity. These forms of international cooperation between such organisations entail an exchange of knowledge and experience.

Swedish environmental technology is renowned for being of a high international standard. Of relevance to climate change, for example, are solutions and experience in energy, incineration, solid waste, wastewater and transport. Turnover in exports of environmentally-sound technology has shown a positive trend in recent years (8.4% growth in 2002). Several industry organisations are working to boost exports of Swedish environmentally sound technology and expert knowledge still further. Technology transfer and knowledge building also occurs at Swedish establishments abroad. As a rule, the latest technology is generally used as a standard throughout a group of companies operating nationally and internationally, which is often higher than the national requirements where investments are made. It is also common to have specific environmental requirements for activities between companies in Sweden and subcontractors abroad, for example in the context of the quality certification of the Swedish company.

The Swedish Trade Council promotes exports of Swedish environmentally sound technology on behalf of the government and carries out a number of activities to spread Swedish technology, for instance in the areas of water, wastewater, solid waste and air treatment. The Swedish Trade Council also coordinates the Environmental Technology Group, a network of around 600 Swedish environmental technology companies, which are involved in various ways in increasing exports of Swedish environmental technology. These endeavours have, for example, led to a major commitment to the "Sustainable Cities" programme in China, which is a long-term effort for sustainable urban development.

The aim of the Swedish Export Credits Guarantee Board (EKN) is to contribute to sustainable development. As part of this work, EKN introduced an environmental classification system in 2002 and requires an environmental impact assessment for all export projects where there is a risk of an adverse environmental impact. Climate concerns are an important criterion in the evaluation. EKN's guarantees amount to approx. SEK 50-100 billion and new guarantees of SEK 20 billion were provided in 2004. A large proportion of the export deals to which the guarantees relate are considered to be directly or indirectly aimed at attaining the goals of the Framework Convention on Climate Change.

7.6 Other activities

As well as the bilateral and multilateral development cooperation, Sweden provides support through other public bodies and non-profit organisations. These efforts are often partly financed using government grants, but it is difficult to estimate the total extent. Examples of such actors are the Church of Sweden and the Swedish Society for Nature Conservation.

Church of Sweden

The Church of Sweden has relatively extensive development cooperation and administers around SEK 150 million a year, of which 35% consists of state aid. It is estimated that 5 million a year of this may be linked to efforts relevant to the Convention on Climate Change. These efforts are principally in the areas of sustainable agriculture, e.g. adaptation of crops and farming methods, and in reforestation.

Swedish Society for Nature Conservation

The Swedish Society for Nature Conservation has provided financial support to environmental organisations in other countries, for instance in Russia, to support work on the Kyoto Protocol. This cooperation has also covered the exchange of knowledge and experience.

8 Research and systematic observation

8.1 Policy and funding in research, development and systematic observation

8.1.1 Climate-related research

Swedish climate-related research encompasses the whole range demanded in reporting to the Framework Convention on Climate Change. Swedish policy is that inter-disciplinary approaches are important in climate-related research, which in addition to natural science and technology should also encompass social science and the humanities, particularly with regard, for example, to effective policy instruments and behavioural issues.[1]

The Swedish government has given notice[2] of an increase in research resources for the environment and sustainable development over the period 2005-2008. Climate-related research falls within this area, but it is not clear how large a part of the increase will go to research related to the problem of climate change.

In addition, the Swedish parliament, on the government's proposal in the budget bill for 2005[3], has decided on a new long-term energy programme for the period 2005-2011 geared towards research, development and demonstration for the development of technology and processes for the change-over to a sustainable energy system.

Funding

There are principally two government research councils, which are significant funding bodies of basic research on the climate system and the impacts of a changed climate. There are also several sector agencies and certain research foundations, which fund climate-related research and development, with particular emphasis on the implementation of climate policy. Joint planning takes place between some of these research funding organisations[4] so that future programme announcements complement one another as far as possible. Public funds for research related to climate change are shown in Table 8-1.

Sweden supports research in support of developing countries through the Swedish Agency for International Development Cooperation, Sida. The research is carried out at Swedish universities, and the research appropriation is open to Swedish researchers in all disciplines. These funds are not included in Table 8-1. Special attention has been paid to the problem of climate change in developing countries since 2004, and climate change has also been introduced as a separate invitation area for the research appropriation.

In 2004 a special research investment running over three years was announced, focusing principally on impacts of climate change on ecosystems and the infrastructure of society as well as the need for adaptation measures in agriculture, forestry and fisheries and community building.

Decisions were taken on two new climate-related research programmes in 2005. A new four-year research programme starting in 2006 has total funding of around SEK 20 million. The purpose of the programme is to learn more about the vulnerability of

Table 8-1 **Annual public funds for climate-related research for the period 2002 to 2005**

Research area	SEK million*
Climate processes and climate systems	40
Modelling and projections	15
Impacts of climate change	11
Socio-economic analyses	85
Measures and adaptation techniques	275[5]

*The table is based on government funds. The figures do not include funding of infrastructure such as faculty funds, supercomputers including storage costs, logistics at research stations and research platforms (e.g. ships), expensive measuring instruments etc. Research funds from certain research foundations are included.

[1] Government Bill 2004/05:80
[2] Government Bill 2004/05:80
[3] Government Bill 2004/05:1

[4] www.sweclipp.se
[5] In addition to support for research, the area was assigned around SEK 375 million a year for development and demonstration activity during the period.

various ecosystems and sectors of society to climate change, to compile better planning material and to devise tools so that cost-effective adaptation measures can be developed that take account of undesirable impacts in various sectors of society. Another new research programme[6] amounting to some SEK 27 million is to run over the period 2006-2008. The aim of the programme is to develop, disseminate, market and implement a set of tools and models that are to support decision-making towards sustainable mobility. The research programme focuses mainly on reducing carbon dioxide emissions.

Who carries out research?

The greater part (64%) of publicly financed climate-related research in Sweden is conducted at universities and university colleges. However, it is becoming increasingly common for separate programme centres to be formed at the universities to focus on a particular issue over a limited period. There are several such programmes focusing on sustainable development, where climate is an important topic. At several of these centres, such as the Stockholm Environment Institute (SEI), research is done in co-operation with developing countries. A centre for atmosphere-related research was formed in 2004.[7] During the period a climate-policy institute[8] has been started which focuses on the interaction between science and policy in the area of climate. The headquarters of Swedish climate modelling is at the Rossby Centre of the Swedish Meteorological and Hydrological Institute (SMHI). Some climate-related research also occurs at industry and sector research institutes. However, Sweden lacks an institute where both focused research and commissioned studies can be carried out. Institutes of this kind are common in other countries.

Climate-related research funded and carried out by industry and commerce.

The greatest proportion of aggregate research and development work is funded and carried out in the corporate sector. It is difficult, however, to quantify how large a share of company-funded research is climate-related.

8.1.2 Swedish systematic climate observation

Climate observations comprise the systematic collection of data on meteorology, hydrology and oceanography. In addition, monitoring of sources and sinks for greenhouse gases is included, as well as climate-related impacts on ecosystems, for example changes in vegetation and soil.

Responsible organisations

The **Swedish Meteorological and Hydrological Institute** (SMHI) is to provide society with meteorological, hydrological and oceanographic data and related services for Sweden and surrounding sea areas. This responsibility includes obtaining data for the general needs of society, for forecasting activity and climate mapping, for research and education, for national and international collaboration and for commercial refinement. SMHI is also responsible in the long term for the construction and operation of the national databases for meteorological, hydrological and oceanographic data, as well as being the expert body for society on issues relating to climate. Through SMHI, Sweden contributes to the establishment of monitoring systems in certain developing countries.

The **Swedish Environmental Protection Agency** (EPA) is responsible for coordinating all environmental monitoring in Sweden. The Swedish EPA undertakes governmental environmental monitoring, and contributes to regional monitoring programmes at the same time. Environmental monitoring is important to follow up climate effects and sources/sinks for greenhouse gases.

The **Swedish National Space Board** (SNSB) represents Sweden in the European Space Agency (ESA), where Sweden is a full member of the Group on Earth Observations (GEO). Accordingly, Sweden is part of ESA's engagement in the worldwide Global Environment Observation System of Systems (GEOSS), with earth observation data from various space-based sources. Sweden, via SNSB, also contributes to the EU-wide satellite monitoring programme EUMETSAT.

The **Swedish University of Agricultural Sciences** (SLU) mainly contributes in this context through joint funding with the Swedish EPA and by having principal responsibility for the National Forest Inventory (RIS), which is a nationwide inventory of forest and soil in Sweden. RIS covers everything from forest and land status to environmental monitoring of biological diversity and carbon storage in forest and soil.

The geographical survey organisation Lantmäteriet, the Swedish EPA, the Swedish National Space Board, the National Board of Forestry and SMHI are in the process of establishing cooperation to increase access to current and historical satellite data sets on Sweden. The archive is to be supplied annually with optical satellite data covering the whole of Sweden, with 10-30 metres resolution, which are collected during the vegetation period.

[6] Sustainable Mobility Initiative
[7] Göteborg Atmospheric Science Center, GAC. See http://www.gmv.chalmers.se/gac/
[8] The Swedish Institute for Climate Science and policy Research, CSPR. See http://www.cspr.se.

8.2 Climate-related research

8.2.1 Climate processes and climate systems, including palaeoclimatic studies

Sweden has a strong tradition in atmospheric research and research on exchange processes.

Sweden contributes to international research programmes (IGBP/WCRP, EU framework programmes, the programmes of the European Science Foundation etc.) through its involvement in research programmes concerned with climate variability[9] and palaeoclimatology, for instance with a reconstruction of the development of the climate in Scandinavia over the last 2000 years.[10]

Ongoing research in geosphere dynamics was strengthened regarding exchange processes between the Baltic Sea and the atmosphere and surrounding land areas. Within this initiative, Swedish researchers are taking part in several international programmes, for instance in the regional research programme on energy and water flow rates in and between the components of the climate system for the Baltic Sea, including its catchments areas[11]. The programme has been in progress since 1993, and during the current second phase (2003-2012) also encompasses climate variability and climate change, water resources (extreme events and long-term changes), the atmospheric and aquatic environment and extended contacts with clients. A new activity[12] in the programme is to compile information on climate trends and climate projections for the Baltic Sea region from around 1800 to 2100. The compilation covers changes in hydrology and ecosystems and in wave frequency. The format and procedures are intended to fit the Intergovernmental Panel on Climate Change (IPCC) process so that they can be used in the IPCC assessments.

Sweden is taking part in the Nordic initiative for strong research environments, Nordic Centers of Excellence Programme. Linked to Swedish expertise in the area of research on carbon flow measurements, one of these groups has been sited at a Swedish university for the period 2003-2007[13]. The centre is to contribute increased knowledge on variations in the biosphere and feedback from these to the climate system on the basis of the knowledge that every year large quantities of carbon dioxide are turned over through uptake by plants and through exchange between the sea and the atmosphere.

As well as these collective initiatives, research is in progress on processes and the climate system in individual projects and in major programmes with a different principal focus.

8.2.2 Modelling and projections including general circulation models

Since the third national report, the regional climate model[14] in Sweden has continued to develop towards more linked systems.

The Swedish modelling system for Europe has developed to a linked system that covers atmosphere, the Baltic Sea, sea ice, hydrology and lakes. Feedback between these is consequently described better. The results are used among other things impact studies on hydrology, studies of forest and forestry and in ecosystem studies. The modelling system is currently undergoing further development, for instance with interactive vegetation/ecosystems and more detailed process descriptions of cloud and radiation. The Arctic is also being included in the Swedish climate model. The research is partly underway in an EU project[15].

The Rossby Centre contributes research and empirical information to several international networks and projects on climate modelling. Results are communicated to the IPCC process. There is also cooperation in several EU projects[16,17,18]. There is additional cooperation relating to the Baltic Sea research[19] and the Arctic[20]. A pilot project involving global modelling has been started to produce regional climate strategies for a particular level of stabilisation relating to the concentration of greenhouse gases in the atmosphere. The first results are expected towards the end of 2005.

A new Internet-based map service intended for clients who need climate scenario maps and numerical data for further use in their own applications, such as information, impact studies and planning tools, is being created at the Rossby Centre. A number of common climate variables are first being made available on an annual and seasonal basis, for a number of periods between 1961 and 2100. The map service will be expanded and updated in due course. A first version of the map service has been set up during the autumn of 2005.

8.2.3 Research on impacts of climate change

Swedish impact research of climate change is focused on forests, mountains and the Baltic Sea, impacts on ecosystems and society.

Research in this area is undertaken in individual research projects, some independent and some as parts of larger programmes with a different focus. Among the individual national research projects there are projects geared towards impacts on the hydrological cycle (for example relating to water supply, flooding,

[9] European and North Atlantic daily to MULtidecadal climATE variability, EMULATE
[10] Multi-proxy Studies of Climate Anno Domini (MUSCAD)
[11] Baltic Sea Experiment, BALTEX, see http://w3.gkss,de/baltex/
[12] Baltic Assessment of Climate Change (BACC).
[13] Nordic Centre for Studies of Ecosystem Carbon Exchange and its interactions with the Climate system, NECC
[14] The Rossby Centre regional Atmosphere-Ocean model, RCAO
[15] Global implications of Arctic climate processes and feedbacks, GLIMPSE
[16] Prediction of Regional scenarios and Uncertainties for Defining EuropeaN Climate change risks and Effects (PRUDENCE)
[17] PRogramme for Integrated Earth System Modelling (PRISM)
[18] ENSEMBLE-based Predictions of Climate Changes and their Impacts
[19] Global Energy and Water Cycle Experiment, Continental-Scale Experiments, The Baltic Sea Experiment, WCRP/GEWEX CSE BALTEX
[20] Arctic Regional Climate Modelling Intercomparison Programme and Arctic Ocean Model Intercomparison Programme, WCRP.

dam safety, erosion, slope stability and dispersal of pollutants), impact on biological diversity, greenhouse gas balance in organogenic soils and melting permafrost.

Under the international programmes described in the sections on processes and modelling there are also sub-projects focusing on impacts. Other international programmes with Swedish part-funding have focused on physical infrastructure and the vulnerability of society in the Baltic Sea region [21,22].

At the Royal Swedish Academy of Agriculture and Forestry, the Climate and Forest Committee is working on the current state of knowledge on the possible impact of climate change on the forests and forestry in Sweden. It is intended to encourage interdisciplinary research which can increase knowledge of the biotic effects of climate change on the forest and discussion with the forestry industry of the need for a change in the orientation and planning of forestry on the basis of different risk scenarios. The Academy also takes part in the Nordic Council of Ministers' Climate and Energy project on climate impacts on renewable forms of energy.

Sweden has several platforms for climate-related research on impacts and processes in sub-Arctic areas. The Tarfala research station in the Swedish mountains has a long tradition of measuring and studying changes in the extent of glaciers and permafrost. At the Abisko scientific research station, ecological, geological, geomorphological and meteorological research is undertaken in the sub-Arctic area. Special focus is on the effects on the mountain ecosystem of increased temperature and increased carbon dioxide concentration in the atmosphere.

8.2.4 Socio-economic analyses, including analyses of both impacts of climate change and possible response

Climate-related socio-economic research in Sweden has been strengthened since 2001 through a new climate-policy research programme. Continued initiatives have been taken in programmes that focus on the prerequisites for building environmentally sustainable energy and transport systems.

A research programme[23] initiated in 2004 comprises two major research projects, which are aimed at providing support to decision-makers in international climate negotiations and developing emissions trading as a tool of climate policy. Another programme[24], focuses on market-based instruments, such as the flexible mechanisms of the Kyoto Protocol and the EU's emissions trading scheme as well as research on the development and design of future international climate agreements. The national climate policy implementation is the focus for a programme studying the role of the interaction between policy, legislation and economics[25]. Research teams well placed to conduct research in the area of climate policy in the long term have been established.

Two programmes with a partly common orientation[26,27] are intended to contribute broad knowledge on how the energy system functions and on the prospects of building environmentally sustainable energy systems. Under these programmes, energy systems are analysed not just on the basis of technical and economic factors but also with regard to institutional factors and the social function of energy systems. Examples of priority areas of research are mechanisms of change, instruments, developments of methodology for the preparation of forecasts and studies on the basic principles of energy policy. Several of the research projects in the programmes are directly linked to the issue of climate change.

Under a research programme focused on household use of electricity and human use of technology, the research is being undertaken by multi-disciplinary research teams in technology and behavioural science.

In the area of transport there are programme initiatives on public transport in sparsely populated areas as well as on the development towards increased quality and efficiency in the public transport system. In addition, a special research initiative related to energy use in the transport sector is being put into practice. Twenty-six projects were in progress in this area at the end of 2004. Since 2002 there has been a research school focusing on climate impact linked to transport.[28]

8.2.5 Research and development on measures to reduce greenhouse gas emissions and for adaptation to a changed climate

A major initiative on pilot plants for the production of climate-neutral biofuels has been launched since the third national communication. Substantial contributions have come from Swedish research in the area of solar cells and the production of hydrogen gas using artificial photosynthesis. A decision to build a pilot plant for carbon dioxide capture has been taken by the Swedish energy company Vattenfall AB.

A programme for the development of an energy system that is ecologically and economically sustainable in the long term represents, in terms of extent, the dominant element in Swedish climate-related research. The orientation of the programme is governed by two overarching aims: (i) to build up such scientific and technical knowledge and ex-

[21] Sea level change affecting the spatial development in the Baltic Sea region, SEAREG.
[22] The ESPON Hazards project European Spatial Planning Observation Network. Project 1.3.1
[23] Climate Policy Research Programme, CLIPORE
[24] The International climate policy programme
[25] Communication, Organisation, Policy instruments, Efficiency, COPE
[26] Allmänna energisystemstudier (general energy system studies – AES)
[27] Program Energisystem (Energy Systems Programme)
[28] Göteborg Centre for Environment and Sustainability (GMV).

pertise in the universities, university colleges, authorities, government agencies and in industry and commerce as is required to make a change-over to a long-term sustainable Swedish energy system possible through the application of new technology and new services, and (ii) to develop technology and services which can be commercialised by Swedish industry and commerce and thereby contribute to change-over and development of the energy system both in Sweden and on other markets. Five centres of expertise and around fifty research and development programmes in different scientific areas are funded under the programme. The programme, which is divided into thematic areas, involves a long-term commitment to research, development and the demonstration of new energy technology.

Issues relating to sustainable energy production, emphasising biomass fuels, are studied in the area of fuel-based energy systems. Issues relating to carbon sinks and forest carbon balances are studied, and this is expected to provide a basis for strategies to increase carbon dioxide uptake in sinks in the forest sector. Special attention is paid to measures which relate to the commitments in the Kyoto Protocol. In the area of heating and combined heat and power, knowledge is being developed to improve the efficiency of established technologies and to introduce new more environmentally friendly and more efficient technologies and systems, for example for production, storage, handling and use of hydrogen gas. Research and development of biofuels, combustion engines and electric drive systems is being undertaken in the field of transport.

In the area of electricity production and power transmission there is research on the renewable forms of energy wind power, solar power, tidal power and the development and modernisation of hydropower. One of the aims of wind-power research is to attain a cost-effective connection to the power grid without any loss of safety and electrical quality. Research on solar cells is focused on what are known as thin-film solar cells and nanostructured solar cells and on integration, installation and adaptation in buildings. Research in the area of power systems is focused on creating a reliable and efficient system adapted to the new techniques and methods of production which are being introduced to an ever greater extent. In the area of industry, priority is given to development towards more efficient utilisation of energy, particularly for energy-demanding process steps in the paper and pulp industry and in the steel industry. Initiatives in the area of the built environment are focused on a number of different areas such as improved efficiency in the use of energy, small-scale combustion of biomass, district heating and district cooling, heat pumps and solar heating. Three major investments in pilot plants for the production of biomass fuels and/or electricity based on forest raw material have been initiated. These investments, which cover the whole chain from research to demonstration, are based on a plant for ethanol production, a plant for black liquor gasification and further development of a plant for biomass gasification.

The Swedish State has signed a contract on vehicle research with the automotive industry.[29] Under a sub-programme aimed at bringing about more environmentally sound automotive technology through research and development, around 100 projects have been started for the programme period 2000-2005.

In 2001, the state-owned energy company Vattenfall AB started an R&D project on the capture and storage of carbon dioxide from coal-fired installations. Vattenfall has decided to build a pilot plant for carbon dioxide capture in connection to an existing coal-fired power station in Germany. The pilot plant is expected to be ready for operation in 2008, and the investment is estimated to amount to around SEK 370 million. Vattenfall is taking part in several EU projects on capture and geological storage of carbon dioxide from fossil fuel use. One of the projects[30] is being coordinated by Vattenfall.

An extensive synthesis project[31] has been carried out with the aim of creating an insight and visions on development in Sweden in the area of energy with a systems-based and international perspective. A large number of representatives of the spheres of research, industry and commerce and authorities were involved in this work. The project has been presented in a number of reports. The climate impact of the energy system has been an important parameter in the analyses performed within the project.

8.3 Systematic observation

A broad range of long-term observations is required to understand and follow current climate development. It is also essential to measure and track changes in ecosystems, soil, water and various functions in society so that the impacts of climate change can be analysed in relation to other changes.

There are a large number of national and international networks for monitoring for this purpose. Some are official, while others still exist as prototypes or are at the research stage. In Sweden there are monitoring systems that have great potential to contribute to more systematic and cohesive information on changes in land-based systems – an area

[29] Programrådet för FordonsForskning (Programme Council for Automotive Research – PFF)
[30] Enhanced Capture of CO_2, ENCAP
[31] Energiframsyn Sverige i Europa (Energy Foresight Sweden in Europe), IVA.

in which there are particularly great deficiencies at present, including in the Nordic region.

The Convention on Climate Change has encouraged improved support for the Global Climate Observing System (GCOS). A detailed account of Sweden's systematic climate observations is provided in a separate report.[32] A brief summary of new Swedish activities, which make a contribution to GCOS, is given below.

This national communication only reports on new activities launched since the previous national communication. For information on current, long-term observation, see Sweden's third national communication or the more detailed report to UNFCCC on the Swedish contribution to GCOS.

8.3.1 New Swedish activities which contribute to Global Climate Observing Systems

Sweden contributes to GCOS through SMHI and certain collaborating agencies[33] with long-term observations and measurements of temperature, precipitation, wave height, icing, variations in glaciers etc. Measurement from satellite-based systems is also required for observations with global, regional and national coverage. Sweden contributes to a number of international programmes in this area.

Atmospheric observation

SMHI reports atmospheric data to the WMO's, World Meteorological Organisation, World Weather Watch (WWW), which is then forwarded to GCOS. New data sources have gradually been developed, and one way in which Sweden contributes is through data on wind and temperature at various levels which civil aviation (SAS) gathers from national and international routes. In addition, weather radar contributes information on wind and precipitation. By using new technology it is possible to extract detailed information about moisture in the atmosphere from the satellites of the GPS system.

Ocean observation

Sweden plays an active part in the Global Operational Oceanographic System (GOOS)[34], which is part of GCOS. SMHI hosts the European EuroGOOS secretariat[35], and is taking part at the European scale to increase access to data and improve measurement activity, particularly in coastal zones. Similar activities are taking place in the Baltic Sea, where the Baltic Operational Oceanographic System (BOOS)[36] is responsible for coordination and where Sweden has provided new buoys. SMHI also cooperates in the European meteorological network, EUMETNET, for development and optimisation of modern integrated observation systems. This work also includes measurements above and from the surface of the North Atlantic. These are important contributions to GCOS and to ocean observation.

Terrestrial observation

During the period, SMHI expanded its reporting to the Global Terrestrial Observing System, GTOS/ Global Runoff Data Center (GRDC) of water discharge data from 25 stations to 38.

Swedish contribution to satellite data from climate monitoring

Satellite-based remote sensing has developed very rapidly over the past decade and today is just as important as ground-based climate monitoring. Sweden contributes through SMHI in the development of satellite products for climate monitoring on various scales and the work of calibrating a new geostationary satellite generation commissioned in 2004. In addition, the Swedish National Space Board contributes to the European satellite programme EUMETSAT, for instance through contribution to the Swedish satellite Odin, which has supplied data to atmospheric research.

ESA – GMES – GEOSS

Sweden takes part in the European Space Agency (ESA) through the Swedish National Space Board in the voluntary earth observation programme. The National Space Board assists in the development of new generations of meteorological satellites and other remote-sensing satellites for studies of the Earth and its climate system. Research satellites, including the environmental satellite ENVISAT, have contributed and will continue to contribute to our understanding of climate. ENVISAT today forms part of the WMO's WWW.

Sweden contributes to the development of services based on remote sensing in Global Monitoring for Environment and Security (GMES)[37], which is the EU's contribution to GEOSS. In this way Sweden also contributes to the international monitoring system which is demanded for work on climate change in the climate negotiations. Under a national remote-sensing programme, the Swedish National Space Board also funds research in remote sensing, for example in the area of climate. Nationally there are two institutes that undertake research and development in space technology[38].

[32] Report to the UNFCCC regarding Sweden's participation in Global Climate Observing System (GCOS) and on Systematic Observation in Sweden 2005.
[33] The Armed Forces, the National Road Administration, the Swedish Civil Aviation Authority and the National Board of Fisheries.
[34] http://ioc.unesco.org/goos/. Sweden participates in JCOMM, GLOSS, EuroGOOS, NOOS, BOOS.
[35] http://www.eurogoos.org/
[36] http://www.boos.org/
[37] www.gmes.info
[38] The Swedish Institute of Space Physics, Kiruna, and the Onsala Space Observatory, Gothenburg.

8.3.2 Swedish monitoring programmes and research networks not reported to GCOS/GTOS

Data and measurements in Swedish environmental monitoring can contribute to follow-up of climate impacts regionally, which represents an important step towards global understanding of the problem of climate change. The Swedish observation of terrestrial systems, which may be of particular interest regionally, comprises for example soil type, land use, vegetation type, biomass and groundwater.

Monitoring of biomass and land use from satellites

The National Inventory of Landscapes in Sweden (NILS) is a new programme (2003) in the national environmental monitoring work of the Swedish EPA. The primary aim is to monitor the necessary conditions for biological diversity in a landscape perspective. NILS includes monitoring of vegetation in a network of fixed trial areas over all ground types. A development project for satellite-based monitoring of changes in vegetation in wetlands was carried out in 2003-2004. It is anticipated that the project can lead to the start of operational satellite-based monitoring of wetlands in 2005.

The aim with respect to mountain areas is to track the development of climate change. The mountain birch forest and zones above are included, which means that the shift in the tree and forest line can be tracked.

Monitoring of change in carbon balance

Climate-related environmental monitoring is also undertaken through the National Forest Inventory (RIS), which encompasses the National Forest Survey (RIS-RT) and the Forest Soil Inventory (RIS-MI). These monitoring programmes are important to track changes in forest and soil, which may affect the quantity of carbon sequestrated in vegetation. The National Forest Survey forms part of the Official Statistics of Sweden and there are data from 1923. The Inventory comprises more than 10 000 sample plots visited each year and inventoried during the time of year when the ground is free of snow. Remote sensing in recent years has made a substantial contribution to the quality and fineness of scale of the National Forest Survey.

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9 Education, training and public awareness

9.1 Public awareness

The greenhouse effect is a familiar concept to the Swedish population, and familiarity with it has increased. Awareness levels among the public peaked between 2002 and 2003, when the Swedish Environmental Protection Agency, on behalf of the Swedish government[1] and as part of Sweden's climate strategy, implemented an information campaign on climate change[2]. More than nine out of ten people know that the burning of fossil fuels is a principal cause of the climate change. Fossil fuels are correctly identified as being the most important cause of the accelerating climate change.

More than one in two Swedes believe that Sweden is already being affected by an increasing greenhouse effect today, and a clear majority also consider it likely that floods and storms will become more common and that we will have a warmer climate in the future.

Attitudes towards taking personal action to slow down the climate change have become more positive. There is also a willingness to accept proposals to limit the climate change, both state control and voluntary commitments. However, it is most difficult for the public to accept higher motor fuel taxes and using their cars less.

9.2 Views of the mass media on the issue of climate change

Two media analyses[3,4] were conducted during the period from 2000 to 2003, which show that:

- The debate on the existence of climate change has subsided. The media picture has shifted from questioning to noting that climate change is in progress. The issue of climate change is known, well established and does not need to be defined according to the media.
- There has also been increased focus on what private individuals and households themselves can do to reduce the climate change. The media previously hardly touched on this topic.
- Regional and local climate measures with favourable results are reported. Both economic investments in new technology and local lectures on climate issues are generally reported together with facts about the climate change.

9.3 Policy toward education, training and public awareness

According to the decisions on climate policy up to 2002, an active climate policy is to be conducted which is integrated into the whole of society. An important measure in this context is the dissemination of information to create an understanding of the changes required in policy instruments in the short and medium term, and to increase awareness among the public and businesses about what can be done at the individual level. The climate strategy also emphasises the importance of utilising local commitment in the municipalities if the favourable trend which has occurred in the environmental area is to be continued. Activating and stimulating the environmental efforts of the municipalities is an important complement to national instruments. The government has therefore been supporting 'local investment programmes' for ecological sustainability since 1998, and local action programmes of measures which reduce greenhouse gas emissions in Sweden since 2002. Many measures under the local investment programmes contain public education and information efforts.

[1] Swedish Environmental Protection Agency Appropriation directions for the 2002 budget year
[2] Swedish Environmental Protection Agency, Report 5365.
[3] Swedish Environmental Protection Agency 2002, Media analysis
[4] Prime Public Relations

9.4 Education

Basic education

Work related to sustainable development in Swedish schools for basic education is steadily expanding. This work covers the whole environmental area and has the explicit aim of influencing everyone's understanding of the need for a good environment and how the actions of individuals can contribute to such a good environment. The issue of climate change is an element in this work[5].

The Swedish government established the Green School Award (Utmärkelsen Miljöskola) in 1999[6]. The Swedish National Agency for Education was given responsibility for the award. The aim is to encourage teaching on ecological sustainability in pre-school, primary and lower secondary school and adult education and for pupils to take part in the whole process. In 2003 the Swedish National Agency for School Improvement took over, and since February 2005 the Green School award has been replaced by the new award of "School for Sustainable Development"[7]. The focus here is on educational work relating to sustainable development, including the economic and social dimensions. The majority of upper secondary schools have in-depth teaching on the issue of climate change, while around half of lower secondary school classes deal with climate issues in a more general way.

Higher education

There are no requirements for general environmental knowledge for students at colleges of higher education and universities equivalent to those in the curricula of primary and lower secondary school. However, the majority of universities and colleges of higher education have brought environmental issues, including the issue of climate change, into their teaching.

The *Network of Swedish Ecodemics* is a nationwide Swedish student organisation founded in 1994. Today there are around forty member associations at Swedish universities and colleges of higher education and a national board.[8] Most of the work takes place in the association, with support from the board, which also undertakes its own projects and works at the national level on the core issue of integrating the perspective of sustainability into all higher education. In 2001 the network conducted a climate campaign, and in 2002 it produced study material on the issue of climate change together with other environmental organisations "The issue of climate change – behind all the fine words"[9]. The principal target group was universities and colleges of higher education. Today most universities and colleges have education programmes geared towards sustainable development.

Energy in the School is a two-year project begun in 2003 and aimed at pupils in school years 7-9. Various models for providing pupils with a knowledge of energy are being studied under this project. The project is being undertaken in cooperation with the Swedish District Heating Association, the Swedish Energy Agency, the Swedish Petroleum Institute, the Swedish Gas Association and the Swedish Bioenergy Association[10].

9.5 Public information campaigns

Information forms part of Swedish climate strategy, and several public information campaigns have been conducted in the last four years.

Climate campaign

As mentioned, the Sweden's Environmental Protection Agency conducted an information campaign in 2002/2003 to increase the level of awareness among the Swedish population on the cause and impact of the greenhouse effect, change attitudes to individual efforts and increase acceptance of the adjustments in society which become necessary for sustainable development. The campaign cost a total of SEK 60 million and was conducted in cooperation with the Swedish Consumer Agency, the National Road Administration, the Swedish Energy Agency and the Swedish Federation of Local Authorities. Altogether more than 100 actors in authorities, municipalities, voluntary organisations and industry and commerce took part in the campaign activities.

A mass communication campaign on the theme of "Something odd is happening to the weather" was held from December 2002 to April 2003 to draw the attention of the public to the topic of the greenhouse effect. The campaign comprised advertising on television, on billboards and in the daily press as well as PR activities. A special website was launched for information on the issue of climate change in depth. A brochure on the climate change was translated into English and the five major immigrant languages in Sweden. The brochure was posted on the special website and advertisements in all five languages were published in newspapers in the major city regions to guide readers to the website. The film "The world of corals", relating to how warming of the oceans is contributing to the death of corals, was shown in wide-screen format at the Swedish Museum of National History. Each show-

[5] SOU 2004:104
[6] SKOLFS 1998:25
[7] SKOLFS 2002:5
[8] www.svenskaekodemiker.se
[9] Svenska Ekodemiker, et al. 2002
[10] www.stem.se/energikunskap

ing of the film was introduced by a series of pictures on the greenhouse effect.

During the summer of 2003, the Swedish Environmental Protection Agency launched a campaign on eco-driving which involved many different parties. Motorists around Sweden were offered tyre-pressure measurement and were informed that correct tyre pressure reduces fuel consumption and therefore carbon dioxide emissions, as well as saving money. If tyre pressure is too low, fuel consumption may increase by 5%.[11] The campaign was repeated in 2004, when a major commitment was made to tailored factual material for the mass media and the population of municipalities relating to how much fuel can be saved by eco-driving and correct tyre pressure. The results showed that more than half of motorists in Sweden drive around with insufficiently high air pressure in their tyres, costing the country's motorists SEK 1.2 billion in unnecessary fuel consumption and 270 000 tonnes extra in carbon dioxide emissions. 90 per cent of those who had been aware of the campaign had understood the message. The fact that the message was positive and easy to understand, that the input for the individual is modest and there are economic and/or emotional advantages is an important success factor.

During World Environment Day on 5 June and in the campaign "In town without my car" on 22 September 2003, the Swedish EPA provided information on the greenhouse effect by rewarding climate-friendly behaviour. This activity resulted in 50 000 personal encounters in more than 50 locations.

Two of Sweden's best-known meteorologists were recruited to inform about the climate change and about the fact that something odd is happening to the weather. In around thirty places the public and journalists were invited. The aim was to make the climate change a topic of discussion in the local media.

Conclusions from the campaign

The success of the climate campaign is due to two important factors, broad collaboration and an integrated approach to communication on the basis of a national platform. The campaign was based on a mix of national and local activities, where the national initiative put the issue of climate change higher on the social agenda and the local initiatives brought the issue closer to home. The climate campaign has led to deeper and better cooperation on the issue of climate change. There are now very good prospects for new and strengthened cooperation, principally between central authorities but also between these, local authorities and other actors.

Increased knowledge among businesses and increased incentives for a commitment on the issue of climate change are important. If more businesses make a clear commitment and also communicate the issue of climate change, this will have an impact both on the public and on industry and commerce.

Annual assessments of how well information activities are working show that people today expect information and are used to searching for information, principally on the Internet. However, the best effect is achieved if the information on the Internet is combined with meeting people face-to-face, for example at conferences and seminars.

Additional information initiatives

Klimat.nu was a network of voluntary organisations, the Swedish Society for Nature Conservation, the Church of Sweden, the Swedish Red Cross, the United Nations Association of Sweden, the Workers' Educational Association (ABF), the Study Promotion Association, the Sensus study association and the Non-Formal Adult Education Association, which between 2001 and 2002 launched a major climate information initiative.

BLICC Sweden (Business Leaders Initiative on Climate Change)[12] forms part of the international climate network Respect BLICC, which started at the time of the EU summit in Gothenburg in 2001. BLICC Sweden contains large Swedish companies which are endeavouring to reduce greenhouse gas emissions. Its work is essentially based on calculating and reporting the carbon dioxide emissions of companies. A joint calculation tool, "Greenhouse Gas Protocol", ensures quality and transparency.

Local investment programmes

Sweden's municipalities received subsidies for local investment programmes for ecological sustainability from 1998 on, and since 2002 grants have been made to local climate investment programmes which reduce greenhouse gas emissions in Sweden. Government grants account for a minority share of the investment, while those who apply for grants provide the bulk of the investment. The programmes are drawn up in collaboration between industry and commerce, organisations and others involved in the municipalities. Climate investment programmes for which grants are sought are required to contain public education and information efforts relating to the greenhouse effect. The reason for this was that assistance by and commitment on the part of the public and users has been found to provide greater success and better environmental effects in projects, while knowledge and experience from programmes are disseminated.

[11] The campaign was conducted in cooperation with the Swedish Consumer Agency, the National Road Administration, the Non-Formal Adult Education Association, the Swedish Vehicle Inspection Company, the Tyre Industry Information Council, the Swedish Association of Driving Schools/Eco Driving International, the National Association of Petroleum Product Retailers, Statoil, OKQ8, Norsk Hydro, Preem, the cities of Stockholm, Gothenburg and Malmö and 20 other Swedish municipalities

[12] BLICC, www.respecteurope.com

"Heat in the Home" campaign

The autumn of 2002 saw the launch of the "Heat in the Home" ("Värme i Villan") campaign[13], which was undertaken in cooperation between the Swedish Energy Agency, the Association of Swedish Regional Energy Agencies, the municipal energy advisers, the Swedish Association of Plumbing, Heating, Insulating, Refrigerating and Ventilation Contractors and the Swedish National Association of Master Chimneysweeps. Owners of houses and smaller properties were informed about alternative heating systems to reduce their dependency on oil and electricity. Over a period of four months, the campaign called at around a hundred locations, where it attracted 30 000 visitors. A total of around 320 exhibitors took part. A questionnaire-based survey showed that most of the visitors were house owners who wanted to find more economically advantageous heating alternatives.

Sustainable Municipality

Sustainable Municipality is a five-year programme launched by the Swedish Energy Agency in 2003. Its purpose is to support local energy measures that contribute to sustainable local growth, in consideration of ecological, economic and social aspects. Five municipalities which differ greatly with regard to geographical location, land area, population and structure of industry and commerce are taking part. The role of the Swedish Energy Agency is to develop and disseminate knowledge, for instance on municipal collaboration processes. The programme is being continuously followed and assessed by three different research teams from universities and university colleges.

9.6 Information centres

Swedish Environmental Protection Agency

The Swedish Environmental Protection Agency (EPA) is the government's central environmental authority. The Agency's role is to instigate and coordinate work towards strong and broadened environmental responsibility in society. The Swedish EPA is intended in particular to support the environmental activities of other players by developing and passing on knowledge, formulating requirements and levels of aspiration and following up and assessing.

Facts and figures and information on climate change, climate-related activities and research in this area can be found on the Agency's website at www.naturvardsverket.se/klimat. The electronic bookshop contains publications on the problem of climate change, such as:

- a study pack for upper secondary schools entitled "Tänk dig vädret om 25 år" (Imagine the weather in 25 years), with an associated video. Focus on climate change. Booklet, 2001.
- Klara fakta om klimatförändringen (Clear facts about climate change), 2002.
- Om klimatförändringen – OH-paket (About climate change – OH transparencies pack) (OH transparencies, booklet, speaker's manuscript), 2002.
- En varmare värld (A warmer world). Monitor 18, 2003.
- När löftena ska infrias – klimatpolitik i hetluften (When promises have to be met – climate policy in hot air). Debate book, 2003.

The Swedish EPA also houses Sweden's special library for information on the external environment, including climate. It runs a web portal on emission allowances www.utslappshandel.se together with the Swedish Energy Agency.

Swedish Energy Agency

The Swedish Energy Agency is the country's central authority for energy issues. In the latest energy bill, "Working together for a secure, efficient and environmentally energy supply" (2002), increased emphasis is put on information and training. The Swedish Energy Agency is therefore putting effort into providing information which contributes to knowledge about the impact of the energy system on climate and to reducing energy use.

The authority has a number of regular communication channels. The most important of these is the website www.stem.se. The website Energifakta (Energy Facts), which is partly aimed at teachers and schoolchildren, has been in existence since 2002. Other channels are the journal Energivärlden (The World of Energy), an annual conference known as Energitinget, attended by more than a thousand people, and a number of publications concerned with energy and its environmental impact. Brochures on various aspects of climate-related work are published, for instance about Swedish climate research "Swedish Climate Policy Research Programmes", which is backed up by a website with links to all the research programmes (www.sweclipp.se). Information on energy use and renewable energy sources for energy consumers is mainly provided in printed form and published on the website. Some major information projects have also been carried out.

To increase knowledge about and stimulate interest in economically and environmentally motivated

[13] www.stem.se/värme i villan

energy efficiency improvements among the public and certain other groups, a structure of cooperation between actors at national, regional and local level has been established. The Swedish State has earmarked a sum of SEK 540 million over the period 2003-2007 to fund municipal energy advice. A further SEK 135 million is being spent on information, testing and training at local and regional level. In 2003, a municipal energy advisory service was for the first time available in all 290 Swedish municipalities. Around half the municipalities have topped up the government grant to market the municipal energy advisory service. Grants for energy advisory services have been issued continuously since 1998.

Swedish Consumer Agency

The Swedish Consumer Agency is Sweden's central administrative authority for consumer issues, with principal responsibility for implementing government consumer policy. An overarching aim is to assist in the development of patterns of consumption which reduce the strains on the environment and contribute to long-term sustainable development. The Agency ensures that consumers have access to good information. In most municipalities there are special consumer advisors who are trained by the Agency. These consumer advisors were trained in energy saving and energy labelling in 2003 and 2004.

On behalf of the government, the Agency has developed a website containing consumer and environmental information, for example concerning the availability of environmentally sound consumer products, and guidance on how environmental impact can be reduced by one's own actions and use of products. Information on the website with the greatest climate focus over the period 2001-2004 is:

- information on heating for houses and an energy costing which calculates costs of investments that reduce energy requirements in houses and at the same time provides information on how the investment affects the environment with respect to greenhouse gas emissions (http://www.energi.konsumentverket.se),
- a shopping guide with information on the environment and energy use for ten product groups, including electricity, lawnmowers and white goods (http://www.kopguiden.konsumentverket.se),
- an 'envirometer' which shows in a readily understandable way a person's environmental impact, where it is possible to estimate what a change in behaviour signifies for energy use (http://www.miljomataren.konsumentverket.se),
- information on cars with low fuel consumption and therefore low carbon dioxide emissions as well as tips on how fuel consumption and other environmental impact of the vehicle can be reduced (http://www.bilar.konsumentverket.se),
- information on what food has a lower impact on the climate and simple ways of saving electricity in the kitchen (http://www.mat.konsumentverket.se).

Among other climate information initiatives aimed at the public in 2001-2004, mention can be made of the Swedish Consumer Agency's annual brochure "Bilar, bränsleförbrukning och vår miljö" (Cars, fuel consumption and our environment), containing tips for those who are intending to buy a new car and want to save money and avoid harming the environment. Around 20 articles, several notices and web items on the issue of climate change and the impact of products on climate have been published in the magazine Råd & Rön and at http://www.radron.se.

Swedish Museum of Natural History

The museum is a knowledge centre and a living meeting-place for the public and experts interested in nature and the environment. A large exhibition, "Mission: Climate Earth" opened in September 2004 and is due to continue for three to five years. The aim is to provide fundamental knowledge on climate issues and foster active interest among the public so that they can take part in the social debate. Keywords are participation, creativity and trust in the future. The exhibition interweaves facts with experiences and alternative solutions to what visitors can do for themselves to contribute towards reducing impact on climate. During the period from October to December 2004, the exhibition attracted around 75 000 visitors[14].

Swedish Institute for Ecological Sustainability

The Swedish Institute for Ecological Sustainability (IEH) started in 1999 as a separate agency under the Ministry of the Environment. Since the beginning of 2005, the organisation has been known as the Swedish Council for Sustainable Development. The purpose of IEH was to support local work aimed at ecological sustainability. This assignment has been linked to the local investment programmes (LIPs), with the Institute providing information on experience gained from LIPs, good practice and support for municipalities which have applied for funding for climate investment programmes (Klimp). Support for the municipalities has been provided through web information, networks, publications

[14] www.nrm.se

and meetings with applicants. The Institute has arranged several regional conferences in cooperation with the Swedish EPA and the county administrative boards. The Institute has also produced an information brochure[15] on ecologically sustainable transport together with the National Road Administration.

Swedish Meteorological and Hydrological Institute

The Rossby Centre (RC), a research unit at the Swedish Meteorological and Hydrological Institute (SMHI) which develops climate models and calculates and describes future climate trends also has extensive information activities in relation to climate, climate change and the consequences of climate change. The information is governed by the needs of those affected in society, which includes most bodies (universities, authorities, companies and organisations). Communication is undertaken through publications (both scientific and more popular), websites, newsletters, lectures, media contacts and direct contact by e-mail and telephone. Over the period 2002 – 2004 someone from the Centre lectured three times a week. Material (maps) on climate scenarios can be downloaded from the website, and a CD containing data is available.

Other information centres

There are a number of other information centres at which the issue of climate change is communicated. Many Swedish municipalities, but also other actors, have information on their websites and convey this information in other forms.

9.7 Engagement of the public and non-governmental organisations

Swedish Society for Nature Conservation

The work of the Swedish Society for Nature Conservation on the issue of climate change is principally geared towards political lobbying, opinion-making and urging greater consumer power. School materials on climate and traffic (Klimatresan – the Climate Journey) have been produced and were used on three teacher courses arranged by the Society in Stockholm, Gothenburg and Sundsvall in 2003. A total of 80 teachers took part. The Society issued several reports and held seminars on the issue of climate change in 2004. The seminars were aimed at upper secondary school teachers and the general public. Exhibitions, lectures and a national challenge known as "Klimattrampet" have been arranged in 2005. "Klimattrampet" involved a bicycle ride from Haparanda to Ystad linked to climate exhibitions in 15 locations. The Swedish Society for Nature Conservation's website on energy and the climate is among the society's most heavily visited pages (www.snf.se). The Society's magazine for members, Sveriges Natur, which has a circulation of around 120 000 copies, had a large themed issue concerned with climate in 2001, 2004 and 2005.

Ekocentrum

The Ekocentrum Foundation is a knowledge forum which shows ways of attaining ecologically sustainable social development. The Foundation houses the largest permanent environmental exhibition in Sweden, focusing on new technology and ideas for a sustainable lifestyle, including ways in which climate impact can be minimised. The aim is to cause visitors to adopt the new technology needed to change over to sustainable society, appreciate the need for change and consequently create scope for political change as well as changing their own behaviour. The Centre holds hundreds of environmental training courses annually, a number of which are concerned with climate. Around 50 lectures are open to the public, while the remainder are held in conjunction with the exhibitions and are targeted at companies, administrative bodies, organisations, students and the public. The Foundation had 18 000 visitors in 2004 (www.ekocentrum.se).

The Non-Formal Adult Education Association

The Non-Formal Adult Education Association, in cooperation with BioFuel Region, began a three-year information project in 2004 aimed at a change-over from the use of liquid fuel to fuel based on forest raw materials. BioFuel Region is an arena for regional collaboration focusing on biomass fuel from cellulose. The target group is the public, authorities and companies in parts of northern Sweden. The Association also has study circles in eco-driving and study materials on this topic on its website, www.sv.se.

Other activities

To offer participation and an insight into what is presented in this, Sweden's fourth national communication under the Framework Convention Climate Change, a hearing (consultation exercise) has also been arranged. Representatives of organisations, government agencies, industry and commerce and NGOs have been invited to take part.

[15] National Road Administration 2003.

9.8 International activities

The Swedish Environmental Protection Agency represents Sweden in work related to Article 6 of the Convention on Climate Change (Education, Training and Public Awareness) intended to disseminate information internationally on the efforts Sweden has made to increase awareness of climate change and its causes.

- In 2002, the attitudes of the Swedish public to the issue of climate change were presented at a workshop in Valsain (Spain).
- During the Belgian presidency of the EU, on 6-7 May 2003 in Mons (Belgium) information was provided on Swedish climate information activity and the government's commitment to climate investment programmes as well as on the national climate campaign and experience from it.
- The Swedish climate campaign was also presented at the 2003 Nordic information officers' meeting in Iceland, at a side-event with an associated exhibition at the climate negotiations in Milan in 2003 (Conference of the Parties, COP9) and at Bridging the Gap in Dublin in April 2004.
- Sweden took part in COP 10 in Buenos Aires in 2004 with an exhibition on Swedish climate initiatives (Swedish climate strategy, the climate campaign and local climate investment programmes). Two side-events were also organised on the successful climate-change policy which has led to Sweden having lowered its carbon dioxide emissions at the same time as significant economic growth has taken place.

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Annex 1: Acronyms and abbreviations

AES	General Energy System Studies
AIT	Asian Institute of Technology
ARRPEEC	Asian Regional Research Programme in Energy, Environment and Climate
BACC	Baltic Assessment of Climate Change
BALTEX	Baltic Sea Experiment
GDP	Gross Domestic Product
BOOS	Baltic Operational Oceanographic System
CE	Climate and Energy
CEON	Circumarctic Environmental Observatories Network
CFC	chlorofluorocarbons
CGIAR	Consultative Group for International Agricultural Research
CIFOR	Center for International Research
CLIME	Climate and Lake Impacts in Europe
CLIPORE	Climate Policy Research Programme
CO_2 eq.	carbon dioxide equivalent
COPE	Communication, Organisation, Policy instruments, Efficiency
CSPR	Climate Sciences and Policy Research
DAC	Development Assistance Committee in the OECD
EKN	Swedish Export Credits Guarantee Board
ENCAP	Enhanced Capture of CO_2
ENSEMBLES	Ensemble-based Predictions of Climate Changes and their Impacts
ENVISAT	European satellite for monitoring of the environment
ESA	European Space Agency
ESPON	European Spatial Planning Observation Network
EUMETNET	European Meteorological Network
EUMETSAT	European Organisation for the exploitation of meteorological satellites
EUROGOOS	European Global Ocean Observing System
F gases	fluorinated greenhouse gases
GAC	Göteborg Atmospheric Center
GCOS	Global Climate Observing Systems
GEF	Global Environment Facility
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GIWA	Global International Water Assessment
CAP	EU Common Agricultural Policy
GLOSS	Global Sea Level Observing System
GMES	Global Monitoring for Environment and Security
GMV	Göteborg Centre for Environment and Sustainability
GOOS	Global Ocean Observing System
GPS	Global Positioning System
GRDC	Global Runoff Data Center
GTOS	Global Terrestrial Observation System
GWh	Gigawatt-hour
HCFC	hydrochlorofluorocarbons
HFC	hydrofluorocarbons (incompletely halogenated fluorocarbons)
ICRAF	International Council for Research in Agroforestry
IGBP	International Geosphere-Biosphere Programme
INTERREG	EU programme with regional focus
IPCC	Intergovernmental Panel on Climate Change
IUCN	World Conservation Union
IVA	Royal Swedish Academy of Engineering Sciences
IVL	Swedish Environmental Research Institute
JCOMM	Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology
kW	kilowatt
kWh	kilowatt-hour
LDC	Least Developed Countries
LULUCF	Land Use, Land-Use Change and Forestry
MRC	Mekong River Commission for Sustainable Development

Mtonnes	million tonnes
NILS	National Inventory of Landscapes in Sweden
NOOS	Northwest Shelf Operational Observing System
OECD	Organisation for Economic Co-operation and Development
PCF	Prototype Carbon Fund
PFF	Programme Council for Automotive Research
PPP	Purchasing Power Parity
PRISM	Programme for Integrated earth System Modelling
PRUDENCE	Prediction of Regional scenarios and Uncertainties for Defining EuropeaN Climate change risks and Effects
RCAO	Rossby Center regional Atmosphere-Ocean model
RIS	National Forest Inventory
RIS-MI	National Forest Inventory – Forest Soil Inventory
RIS-RT	National Forest Inventory – National Forest Survey
SAF	Satellite Application Facility
SAS	Scandinavian Airlines System
SCANNET	Scandinavian North European Network of Terrestrial Field Bases
SCB	Statistics Sweden.
SEAREG	Sea level change affecting the spatial development in the Baltic Sea region
SEI	Stockholm Environment Institute
SGU	Geological Survey of Sweden
Sida	Swedish International Cooperation Development Agency
SLU	Swedish University of Agricultural Sciences
SMED	Swedish Environmental Emissions Data
SMHI	Swedish Meteorological and Hydrological Institute
SWECLIM	Swedish Climate Modelling, research programme completed in 2001
TBE	Tick-Borne Encephalitis
TWh	Terawatt-hour
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
WCRP	World Climate Research Programme
WMO	World Meteorological Organisation
WRI	World Resources Institute
WWW	World Weather Watch of WMO

Annex 2: Summary tables of emissions and removals of greenhouse gases. Extracts from the 2005 National Inventory Report

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Sweden
1990
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**35 985.69**	**6 510.16**	**8 871.29**	**3.85**	**440.05**	**107.31**	**51 918.34**
1. Energy	**51 661.32**	**564.35**	**1 521.54**				**53 747.21**
A. Fuel Combustion (Sectoral Approach)	50 613.66	564.24	1 518.41				52 696.30
1. Energy Industries	10 186.63	21.97	338.57				10 547.17
2. Manufacturing Industries and Construction	10 724.42	45.80	508.47				11 278.69
3. Transport	18 351.64	269.26	323.92				18 944.82
4. Other Sectors	10 505.86	224.92	320.01				11 050.78
5. Other	845.11	2.28	27.45				874.84
B. Fugitive Emissions from Fuels	1 047.66	0.11	3.13				1 050.90
1. Solid Fuels	947.38	0.08	2.39				949.85
2. Oil and Natural Gas	100.28	0.03	0.74				101.05
2. Industrial Processes	**4 252.15**	**4.84**	**870.70**	**3.85**	**440.05**	**107.31**	**5 678.90**
A. Mineral Products	1 917.47	NO	NO				1 917.47
B. Chemical Industry	68.80	0.00	829.25	NA	NA	NO	898.05
C. Metal Production	2 265.89	0.11	0.00		440.05	23.90	2 729.95
D. Other Production	NE						0.00
E. Production of Halocarbons and SF_6				NO	NO	NO	0.00
F. Consumption of Halocarbons and SF_6				3.85	0.00	83.41	87.26
G. Other	IE	4.73	41.45	NA	NA	NO	46.18
3. Solvent and Other Product Use	**320.32**		**90.22**				**410.55**
4. Agriculture	**0.00**	**3 387.11**	**6 193.43**				**9 580.54**
A. Enteric Fermentation		3 026.53					3 026.53
B. Manure Management		360.58	798.52				1 159.10
C. Rice Cultivation		NO					0.00
D. Agricultural Soils [2]	IE	0.00	5 394.90				5 394.90
E. Prescribed Burning of Savannas		NO	NO				0.00
F. Field Burning of Agricultural Residues		NO	NO				0.00
G. Other		NO	NO				0.00
5. Land-Use Change and Forestry [1]	**-20 291.96**	**0.00**	**0.00**				**-20 291.96**
6. Waste	**43.86**	**2 553.86**	**195.40**				2 793.11
A. Solid Waste Disposal on Land	NA	2 553.86					2 553.86
B. Wastewater Handling		0.00	195.40				195.40
C. Waste Incineration	43.86	NA	0.00				43.86
D. Other	NO	NO	NO				0.00
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
	NO	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	**3 563.08**	**0.54**	**55.87**				**3 619.49**
Aviation	1 335.16	0.23	19.31				1 354.70
Marine	2 227.92	0.31	36.56				2 264.79
Multilateral Operations	**NE**	**0.00**	**0.00**				**0.00**
CO_2 Emissions from Biomass	**11 368.20**						**11 368.20**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	0.00	-24 100.00	-24 100.00			-24 100.00
B. Forest and Grassland Conversion	0.00		0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00
D. CO_2 Emissions and Removals from Soil	3 808.04	0.00	3 808.04			3 808.04
E. Other	0.00	0.00	0.00	0.00	0.00	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	3 808.04	-24 100.00	-20 291.96	0.00	0.00	-20 291.96

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	72 210.30
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	51 918.34

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Sweden
1991
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**27 389.07**	**6 489.10**	**8 738.47**	**8.20**	**432.66**	**109.70**	**43 167.20**
1. Energy	**52 216.42**	**560.75**	**1 546.28**				**54 323.45**
A. Fuel Combustion (Sectoral Approach)	51 213.84	560.65	1 543.38				53 317.87
1. Energy Industries	11 391.60	25.61	364.66				11 781.86
2. Manufacturing Industries and Construction	10 466.67	44.36	498.46				11 009.49
3. Transport	18 056.26	262.93	339.95				18 659.14
4. Other Sectors	10 232.16	225.30	305.90				10 763.35
5. Other	1 067.16	2.45	34.42				1 104.03
B. Fugitive Emissions from Fuels	1 002.58	0.10	2.90				1 005.58
1. Solid Fuels	930.82	0.08	2.39				933.29
2. Oil and Natural Gas	71.75	0.02	0.51				72.29
2. Industrial Processes	**4 136.87**	**4.91**	**914.55**	**8.20**	**432.66**	**109.70**	**5 606.88**
A. Mineral Products	1 727.12	NO	NO				1 727.12
B. Chemical Industry	69.55	0.00	872.65	NA	NA	NO	942.20
C. Metal Production	2 340.20	0.11	0.00		431.86	23.90	2 796.07
D. Other Production	NE						0.00
E. Production of Halocarbons and SF_6				NO	NO	NO	0.00
F. Consumption of Halocarbons and SF_6				8.20	0.80	85.80	94.80
G. Other	IE	4.79	41.90	NA	NA	NO	46.69
3. Solvent and Other Product Use	**311.23**		**89.06**				**400.29**
4. Agriculture	**0.00**	**3 324.97**	**5 993.19**				**9 318.16**
A. Enteric Fermentation		2 972.42					2 972.42
B. Manure Management		352.55	776.38				1 128.93
C. Rice Cultivation		NO					0.00
D. Agricultural Soils [2]	IE	0.00	5 216.81				5 216.81
E. Prescribed Burning of Savannas		NO	NO				0.00
F. Field Burning of Agricultural Residues		NO	NO				0.00
G. Other		NO	NO				0.00
5. Land-Use Change and Forestry [1]	**-29 327.65**	**0.00**	**0.00**				**-29 327.65**
6. Waste	**52.20**	**2 598.47**	**195.40**				2 846.07
A. Solid Waste Disposal on Land	NA	2 598.47					2 598.47
B. Wastewater Handling		0.00	195.40				195.40
C. Waste Incineration	52.20	NA	0.00				52.20
D. Other	NO	NO	NO				0.00
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.00**
	NO	NO	NO	NO	NO	NO	0.00
Memo Items:							
International Bunkers	**3 727.93**	**0.56**	**59.66**				**3 788.14**
Aviation	1 088.16	0.18	16.76				1 105.10
Marine	2 639.78	0.38	42.89				2 683.05
Multilateral Operations	**NE**	0.00	0.00				**0.00**
CO_2 Emissions from Biomass	**11 774.91**						**11 774.91**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	0.00	-33 100.00	-33 100.00			-33 100.00
B. Forest and Grassland Conversion	0.00		0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00
D. CO_2 Emissions and Removals from Soil	3 772.35	0.00	3 772.35			3 772.35
E. Other	0.00	0.00	0.00	0.00	0.00	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	3 772.35	-33 100.00	-29 327.65	0.00	0.00	-29 327.65

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	72 494.85
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	43 167.20

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Sweden
1992
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**33 113.05**	**6 595.88**	**8 666.60**	**11.32**	**335.98**	**109.46**	**48 832.29**
1. Energy	**52 110.57**	**560.49**	**1 598.19**				**54 269.25**
A. Fuel Combustion (Sectoral Approach)	51 279.52	560.39	1 595.52				53 435.43
1. Energy Industries	11 932.92	22.64	373.61				12 329.17
2. Manufacturing Industries and Construction	9 648.74	52.29	497.42				10 198.45
3. Transport	18 939.31	258.05	372.89				19 570.25
4. Other Sectors	9 639.36	225.12	313.47				10 177.95
5. Other	1 119.19	2.29	38.13				1 159.60
B. Fugitive Emissions from Fuels	831.05	0.10	2.68				833.82
1. Solid Fuels	743.96	0.07	2.03				746.06
2. Oil and Natural Gas	87.09	0.03	0.64				87.76
2. Industrial Processes	**3 996.45**	**4.89**	**881.92**	**11.32**	**335.98**	**109.46**	**5 340.03**
A. Mineral Products	1 640.91	NO	NO				1 640.91
B. Chemical Industry	53.26	0.00	840.10	NA	NA	NO	893.36
C. Metal Production	2 302.28	0.11	0.00		335.18	23.90	2 661.48
D. Other Production	NE						0.00
E. Production of Halocarbons and SF_6				NO	NO	NO	0.00
F. Consumption of Halocarbons and SF_6				11.32	0.80	85.56	97.68
G. Other	IE	4.78	41.82	NA	NA	NO	46.60
3. Solvent and Other Product Use	**300.78**		**107.57**				**408.35**
4. Agriculture	**0.00**	**3 423.97**	**5 897.40**				**9 321.37**
A. Enteric Fermentation		3 060.42					3 060.42
B. Manure Management		363.55	792.50				1 156.06
C. Rice Cultivation		NO					0.00
D. Agricultural Soils [2]	IE	0.00	5 104.90				5 104.90
E. Prescribed Burning of Savannas		NO	NO				0.00
F. Field Burning of Agricultural Residues		NO	NO				0.00
G. Other		NO	NO				0.00
5. Land-Use Change and Forestry [1]	**-23 353.08**	**0.00**	**0.00**				**-23 353.08**
6. Waste	**58.33**	**2 606.53**	**181.52**				2 846.37
A. Solid Waste Disposal on Land	NA	2 606.53					2 606.53
B. Wastewater Handling		0.00	181.52				181.52
C. Waste Incineration	58.33	NA	0.00				58.33
D. Other	NO	NO	NO				0.00
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
	NO	NO	NO	NO	NO	NO	NO
Memo Items:							
International Bunkers	**3 908.91**	**0.57**	**64.69**				**3 974.17**
Aviation	899.65	0.14	15.69				915.48
Marine	3 009.26	0.43	49.00				3 058.68
Multilateral Operations	**NE**	0.00	0.00				**0.00**
CO_2 Emissions from Biomass	**12 724.55**						**12 724.55**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	0.00	-27 100.00	-27 100.00			-27 100.00
B. Forest and Grassland Conversion	0.00		0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00
D. CO_2 Emissions and Removals from Soil	3 746.92	0.00	3 746.92			3 746.92
E. Other	0.00	0.00	0.00	0.00	0.00	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	3 746.92	-27 100.00	-23 353.08	0.00	0.00	-23 353.08

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	72 185.37
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	48 832.29

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Sweden
1993
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**26 767.87**	**6 658.50**	**8 764.13**	**33.16**	**350.87**	**97.75**	**42 672.28**
1. Energy	**51 727.44**	**561.58**	**1 615.00**				**53 904.03**
A. Fuel Combustion (Sectoral Approach)	50 727.69	561.47	1 611.94				52 901.11
1. Energy Industries	11 771.07	29.25	367.67				12 168.00
2. Manufacturing Industries and Construction	10 371.41	51.18	518.60				10 941.19
3. Transport	18 102.60	252.07	382.78				18 737.44
4. Other Sectors	9 605.92	227.26	314.77				10 147.96
5. Other	876.69	1.72	28.12				906.53
B. Fugitive Emissions from Fuels	999.75	0.11	3.06				1 002.92
1. Solid Fuels	910.44	0.08	2.38				912.90
2. Oil and Natural Gas	89.31	0.03	0.69				90.02
2. Industrial Processes	**4 045.68**	**5.03**	**859.31**	**33.16**	**350.87**	**97.75**	**5 391.79**
A. Mineral Products	1 661.33	NO	NO				1 661.33
B. Chemical Industry	54.76	0.00	816.23	NA	NA	NO	870.99
C. Metal Production	2 329.59	0.11	0.00		348.17	23.90	2 701.77
D. Other Production	NE						0.00
E. Production of Halocarbons and SF_6				NO	NO	NO	0.00
F. Consumption of Halocarbons and SF_6				33.16	2.70	73.85	109.71
G. Other	IE	4.91	43.08	NA	NA	NO	47.99
3. Solvent and Other Product Use	**278.83**		**107.26**				**386.09**
4. Agriculture	**0.00**	**3 576.65**	**6 001.04**				**9 577.70**
A. Enteric Fermentation		3 165.53					3 165.53
B. Manure Management		411.12	720.53				1 131.65
C. Rice Cultivation		NO					0.00
D. Agricultural Soils [2]	IE	0.00	5 280.51				5 280.51
E. Prescribed Burning of Savannas		NO	NO				0.00
F. Field Burning of Agricultural Residues		NO	NO				0.00
G. Other		NO	NO				0.00
5. Land-Use Change and Forestry [1]	**-29 332.10**	**0.00**	**0.00**				**-29 332.10**
6. Waste	**48.02**	**2 515.24**	**181.52**				2 744.77
A. Solid Waste Disposal on Land	NA	2 515.24					2 515.24
B. Wastewater Handling		0.00	181.52				181.52
C. Waste Incineration	48.02	NA	0.00				48.02
D. Other	NO	NO	NO				0.00
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
	NO	NO	NO	NO	NO	NO	NO
Memo Items:							
International Bunkers	**4 252.67**	**0.62**	**67.88**				**4 321.18**
Aviation	1 229.95	0.19	18.76				1 248.90
Marine	3 022.72	0.44	49.12				3 072.28
Multilateral Operations	**NE**	**0.00**	**0.00**				**0.00**
CO_2 Emissions from Biomass	**13 584.56**						**13 584.56**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	0.00	-33 100.00	-33 100.00			-33 100.00
B. Forest and Grassland Conversion	0.00		0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00
D. CO_2 Emissions and Removals from Soil	3 767.90	0.00	3 767.90			3 767.90
E. Other	0.00	0.00	0.00	0.00	0.00	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	3 767.90	-33 100.00	-29 332.10	0.00	0.00	-29 332.10

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	72 004.37
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	42 672.28

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Sweden
1994
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**32 387.99**	**6 586.59**	**8 880.91**	**72.91**	**348.92**	**102.29**	**48 379.62**
1. Energy	**54 084.40**	**555.26**	**1 693.81**				**56 333.47**
A. Fuel Combustion (Sectoral Approach)	52 743.92	555.13	1 690.08				54 989.12
1. Energy Industries	12 243.10	34.36	381.91				12 659.37
2. Manufacturing Industries and Construction	11 357.24	57.96	554.49				11 969.69
3. Transport	18 689.89	247.25	413.88				19 351.02
4. Other Sectors	9 680.37	213.66	317.17				10 211.20
5. Other	773.32	1.91	22.63				797.86
B. Fugitive Emissions from Fuels	1 340.48	0.13	3.73				1 344.35
1. Solid Fuels	1 270.65	0.11	3.18				1 273.93
2. Oil and Natural Gas	69.84	0.02	0.56				70.42
2. Industrial Processes	**4 285.12**	**4.68**	**831.26**	**72.91**	**348.92**	**102.29**	**5 645.18**
A. Mineral Products	1 742.96	NO	NO				1 742.96
B. Chemical Industry	57.14	0.00	789.26	NA	NA	NO	846.40
C. Metal Production	2 485.02	0.12	0.00		345.08	26.29	2 856.50
D. Other Production	NE						0.00
E. Production of Halocarbons and SF_6				NO	NO	NO	0.00
F. Consumption of Halocarbons and SF_6				72.91	3.85	76.00	152.76
G. Other	IE	4.56	42.00	NA	NA	NO	46.56
3. Solvent and Other Product Use	**274.73**		**95.80**				**370.54**
4. Agriculture	**0.00**	**3 621.12**	**6 080.61**				**9 701.73**
A. Enteric Fermentation		3 199.03					3 199.03
B. Manure Management		422.09	724.33				1 146.42
C. Rice Cultivation		NO					0.00
D. Agricultural Soils [2]	IE	0.00	5 356.29				5 356.29
E. Prescribed Burning of Savannas		NO	NO				0.00
F. Field Burning of Agricultural Residues		NO	NO				0.00
G. Other		NO	NO				0.00
5. Land-Use Change and Forestry [1]	**-26 305.35**	**0.00**	**0.00**				**-26 305.35**
6. Waste	**49.08**	**2 405.54**	**179.42**				2 634.04
A. Solid Waste Disposal on Land	NA	2 405.54					2 405.54
B. Wastewater Handling		0.00	179.42				179.42
C. Waste Incineration	49.08	NA	0.00				49.08
D. Other	NO	NO	NO				0.00
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	0.00
	NO	NO	NO	NO	NO	NO	0.00
Memo Items:							
International Bunkers	**4 910.83**	**0.71**	**77.77**				**4 989.31**
Aviation	1 350.69	0.20	20.06				1 370.95
Marine	3 560.13	0.51	57.72				3 618.36
Multilateral Operations	**NE**	**0.00**	**0.00**				**0.00**
CO_2 Emissions from Biomass	**15 127.32**						**15 127.32**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	0.00	-30 100.00	-30 100.00			-30 100.00
B. Forest and Grassland Conversion	0.00		0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00
D. CO_2 Emissions and Removals from Soil	3 794.65	0.00	3 794.65			3 794.65
E. Other	0.00	0.00	0.00	0.00	0.00	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	3 794.65	-30 100.00	-26 305.35	0.00	0.00	-26 305.35

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	74 684.97
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	48 379.62

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Sweden
1995
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**36 293.64**	**6 500.44**	**8 688.00**	**129.40**	**391.40**	**129.30**	**52 132.18**
1. Energy	**52 901.58**	**566.24**	**1 679.86**				**55 147.69**
A. Fuel Combustion (Sectoral Approach)	51 667.08	566.12	1 676.26				53 909.45
1. Energy Industries	11 347.08	37.85	358.64				11 743.56
2. Manufacturing Industries and Construction	11 591.14	55.48	546.33				12 192.96
3. Transport	18 811.32	242.59	446.98				19 500.89
4. Other Sectors	9 215.49	228.40	304.76				9 748.65
5. Other	702.05	1.79	19.55				723.39
B. Fugitive Emissions from Fuels	1 234.51	0.13	3.60				1 238.24
1. Solid Fuels	1 152.24	0.10	2.93				1 155.27
2. Oil and Natural Gas	82.26	0.03	0.67				82.96
2. Industrial Processes	**4 378.45**	**4.94**	**767.66**	**129.40**	**391.40**	**129.30**	**5 801.15**
A. Mineral Products	1 951.39	NO	NO				1 951.39
B. Chemical Industry	57.77	0.00	723.85	NA	NA	NO	781.62
C. Metal Production	2 369.30	0.11	0.00		380.47	26.29	2 776.17
D. Other Production	NE						0.00
E. Production of Halocarbons and SF_6				NO	NO	0.00	0.00
F. Consumption of Halocarbons and SF_6				129.40	10.93	103.01	243.34
G. Other	IE	4.83	43.81	NA	NA	0.00	48.64
3. Solvent and Other Product Use	**263.57**		**123.69**				**387.26**
4. Agriculture	**0.00**	**3 530.17**	**5 930.85**				**9 461.02**
A. Enteric Fermentation		3 106.07					3 106.07
B. Manure Management		424.10	667.91				1 092.02
C. Rice Cultivation		NO					0.00
D. Agricultural Soils [2]	IE	0.00	5 262.93				5 262.93
E. Prescribed Burning of Savannas		NO	NO				0.00
F. Field Burning of Agricultural Residues		NO	NO				0.00
G. Other		NO	NO				0.00
5. Land-Use Change and Forestry [1]	**-21 292.70**	**0.00**	**0.00**				**-21 292.70**
6. Waste	**42.74**	**2 399.09**	**185.94**				2 627.77
A. Solid Waste Disposal on Land	NA	2 399.09					2 399.09
B. Wastewater Handling		0.00	185.94				185.94
C. Waste Incineration	42.74	NA	0.00				42.74
D. Other	NO	NO	NO				0.00
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.00**
	NO	NO	NO	NO	NO	NO	0.00
Memo Items:							
International Bunkers	**4 937.85**	**0.81**	**77.52**				**5 016.18**
Aviation	1 437.04	0.31	20.93				1 458.28
Marine	3 500.80	0.51	56.59				3 557.90
Multilateral Operations	**NE**	**0.00**	**0.00**				**0.00**
CO_2 Emissions from Biomass	**15 919.98**						**15 919.98**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	0.00	-25 100.00	-25 100.00			-25 100.00
B. Forest and Grassland Conversion	0.00		0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00
D. CO_2 Emissions and Removals from Soil	3 807.30	0.00	3 807.30			3 807.30
E. Other	0.00	0.00	0.00	0.00	0.00	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	3 807.30	-25 100.00	-21 292.70	0.00	0.00	-21 292.70

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	73 424.88
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	52 132.18

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Sweden
1996
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**38 899.50**	**6 464.11**	**8 875.06**	**181.31**	**351.04**	**110.66**	**54 881.66**
1. Energy	**56 551.33**	**572.11**	**1 875.61**				**58 999.06**
A. Fuel Combustion (Sectoral Approach)	55 432.87	572.00	1 872.55				57 877.41
1. Energy Industries	15 335.97	53.21	541.99				15 931.17
2. Manufacturing Industries and Construction	11 596.52	53.90	534.82				12 185.24
3. Transport	18 603.13	229.72	474.52				19 307.37
4. Other Sectors	9 252.82	233.60	301.84				9 788.27
5. Other	644.42	1.57	19.38				665.37
B. Fugitive Emissions from Fuels	1 118.47	0.11	3.06				1 121.64
1. Solid Fuels	1 056.93	0.09	2.72				1 059.75
2. Oil and Natural Gas	61.54	0.02	0.34				61.90
2. Industrial Processes	**4 319.78**	**4.96**	**739.49**	**181.31**	**351.04**	**110.66**	**5 707.23**
A. Mineral Products	1 863.66	NO	NO				1 863.66
B. Chemical Industry	58.90	0.00	695.33	NA	NA	NO	754.23
C. Metal Production	2 397.23	0.11	0.00		330.38	31.07	2 758.78
D. Other Production	NE						0.00
E. Production of Halocarbons and SF_6				NO	NO	NO	0.00
F. Consumption of Halocarbons and SF_6				181.31	20.66	79.59	281.55
G. Other	IE	4.85	44.16	NA	NA	NO	49.01
3. Solvent and Other Product Use	**248.31**		**137.33**				**385.64**
4. Agriculture	**0.00**	**3 518.34**	**5 936.69**				**9 455.03**
A. Enteric Fermentation		3 088.79					3 088.79
B. Manure Management		429.55	667.50				1 097.05
C. Rice Cultivation		NO					0.00
D. Agricultural Soils [2]	IE	0.00	5 269.20				5 269.20
E. Prescribed Burning of Savannas		NO	NO				0.00
F. Field Burning of Agricultural Residues		NO	NO				0.00
G. Other		NO	NO				0.00
5. Land-Use Change and Forestry [1]	**-22 269.05**	**0.00**	**0.00**				**-22 269.05**
6. Waste	**49.12**	**2 368.69**	**185.94**				2 603.75
A. Solid Waste Disposal on Land	NA	2 368.69					2 368.69
B. Wastewater Handling		0.00	185.94				185.94
C. Waste Incineration	49.12	NA	0.00				49.12
D. Other	NO	NO	NO				0.00
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.00**
	NO	NO	NO	NO	NO	NO	0.00
Memo Items:							
International Bunkers	**5 183.98**	**0.77**	**82.12**				**5 266.87**
Aviation	1 475.52	0.24	21.89				1 497.65
Marine	3 708.47	0.53	60.23				3 769.23
Multilateral Operations	**NE**	**0.00**	**0.00**				**0.00**
CO_2 Emissions from Biomass	**17 735.22**						**17 735.22**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	0.00	-26 100.00	-26 100.00			-26 100.00
B. Forest and Grassland Conversion	0.00		0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00
D. CO_2 Emissions and Removals from Soil	3 830.95	0.00	3 830.95			3 830.95
E. Other	0.00	0.00	0.00	0.00	0.00	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	3 830.95	-26 100.00	-22 269.05	0.00	0.00	-22 269.05

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	77 150.71
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	54 881.66

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
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Sweden
1997
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**29 495.92**	**6 392.52**	**8 811.08**	**275.64**	**324.10**	**155.83**	**45 455.09**
1. Energy	**52 400.27**	**535.83**	**1 738.64**				**54 674.73**
A. Fuel Combustion (Sectoral Approach)	51 397.66	535.72	1 735.68				53 669.06
1. Energy Industries	11 353.40	43.75	373.48				11 770.63
2. Manufacturing Industries and Construction	12 157.57	52.09	548.24				12 757.89
3. Transport	18 822.27	216.56	502.08				19 540.91
4. Other Sectors	8 480.32	221.93	294.29				8 996.54
5. Other	584.11	1.39	17.59				603.09
B. Fugitive Emissions from Fuels	1 002.60	0.11	2.96				1 005.67
1. Solid Fuels	920.75	0.08	2.43				923.27
2. Oil and Natural Gas	81.85	0.03	0.53				82.41
2. Industrial Processes	**4 100.96**	**5.31**	**734.69**	**275.64**	**324.10**	**155.83**	**5 596.52**
A. Mineral Products	1 735.11	NO	NO				1 735.11
B. Chemical Industry	58.40	0.00	686.96	NA	NA	NO	745.36
C. Metal Production	2 307.45	0.11	0.00		301.94	40.63	2 650.13
D. Other Production	NE						0.00
E. Production of Halocarbons and SF_6				NO	NO	NO	0.00
F. Consumption of Halocarbons and SF_6				275.64	22.16	115.20	413.00
G. Other	IE	5.20	47.73	NA	NA	NO	52.93
3. Solvent and Other Product Use	**231.70**		**141.67**				**373.37**
4. Agriculture	**0.00**	**3 516.00**	**6 010.69**				**9 526.69**
A. Enteric Fermentation		3 096.50					3 096.50
B. Manure Management		419.50	691.14				1 110.64
C. Rice Cultivation		NO					0.00
D. Agricultural Soils [2]	IE	0.00	5 319.55				5 319.55
E. Prescribed Burning of Savannas		NO	NO				0.00
F. Field Burning of Agricultural Residues		NO	NO				0.00
G. Other		NO	NO				0.00
5. Land-Use Change and Forestry [1]	**-27 287.61**	**0.00**	**0.00**				**-27 287.61**
6. Waste	**50.60**	**2 335.38**	**185.39**				2 571.38
A. Solid Waste Disposal on Land	NA	2 335.38					2 335.38
B. Wastewater Handling		0.00	185.39				185.39
C. Waste Incineration	50.60	NA	0.00				50.60
D. Other	NO	NO	NO				0.00
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	0.00
	NO	NO	NO	NO	NO	NO	0.00
Memo Items:							
International Bunkers	**5 908.98**	**0.85**	**94.20**				**6 004.03**
Aviation	1 560.26	0.23	23.55				1 584.04
Marine	4 348.72	0.62	70.65				4 419.99
Multilateral Operations	**NE**	**0.00**	**0.00**				**0.00**
CO_2 Emissions from Biomass	**16 265.28**						**16 265.28**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	0.00	-31 100.00	-31 100.00			-31 100.00
B. Forest and Grassland Conversion	0.00		0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00
D. CO_2 Emissions and Removals from Soil	3 812.39	0.00	3 812.39			3 812.39
E. Other	0.00	0.00	0.00	0.00	0.00	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	3 812.39	-31 100.00	-27 287.61	0.00	0.00	-27 287.61

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	72 742.70
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	45 455.09

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Sweden
1998
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**33 127.47**	**6 237.39**	**8 834.50**	**311.47**	**308.76**	**99.42**	**48 919.02**
1. Energy	**53 062.41**	**524.22**	**1 774.91**				**55 361.55**
A. Fuel Combustion (Sectoral Approach)	51 913.64	524.11	1 771.69				54 209.43
1. Energy Industries	12 363.27	46.34	388.95				12 798.55
2. Manufacturing Industries and Construction	11 571.47	52.36	533.95				12 157.78
3. Transport	19 103.13	205.74	542.02				19 850.89
4. Other Sectors	8 404.77	218.52	292.79				8 916.08
5. Other	471.01	1.14	13.98				486.13
B. Fugitive Emissions from Fuels	1 148.78	0.12	3.22				1 152.11
1. Solid Fuels	1 076.99	0.09	2.72				1 079.81
2. Oil and Natural Gas	71.78	0.02	0.50				72.31
2. Industrial Processes	**4 134.09**	**7.12**	**817.66**	**311.47**	**308.76**	**99.42**	**5 678.52**
A. Mineral Products	1 788.97	NO	NO				1 788.97
B. Chemical Industry	54.01	0.00	771.59	NA	NA	NO	825.60
C. Metal Production	2 291.11	0.09	0.00		292.46	38.24	2 621.90
D. Other Production	NE						0.00
E. Production of Halocarbons and SF_6				NO	NO	NO	0.00
F. Consumption of Halocarbons and SF_6				311.47	16.30	61.18	388.96
G. Other	IE	7.03	46.07	NA	NA	NO	53.10
3. Solvent and Other Product Use	**212.70**		**144.15**				**356.85**
4. Agriculture	**0.00**	**3 422.24**	**5 937.96**				**9 360.20**
A. Enteric Fermentation		3 007.38					3 007.38
B. Manure Management		414.86	690.21				1 105.07
C. Rice Cultivation		NO					0.00
D. Agricultural Soils [2]	IE	0.00	5 247.75				5 247.75
E. Prescribed Burning of Savannas		NO	NO				0.00
F. Field Burning of Agricultural Residues		NO	NO				0.00
G. Other		NO	NO				0.00
5. Land-Use Change and Forestry [1]	**-24 330.90**	**0.00**	**0.00**				**-24 330.90**
6. Waste	**49.16**	**2 283.81**	**159.82**				2 492.80
A. Solid Waste Disposal on Land	NA	2 283.81					2 283.81
B. Wastewater Handling		0.00	159.82				159.82
C. Waste Incineration	49.16	NA	0.00				49.16
D. Other	NO	NO	NO				0.00
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.00**
	NO	NO	NO	NO	NO	NO	0.00
Memo Items:							
International Bunkers	**6 690.61**	**0.99**	**106.64**				**6 798.24**
Aviation	1 673.00	0.27	25.14				1 698.41
Marine	5 017.61	0.72	81.50				5 099.82
Multilateral Operations	**NE**	0.00	0.00				**0.00**
CO_2 Emissions from Biomass	**16 645.25**						**16 645.25**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	0.00	-28 100.00	-28 100.00			-28 100.00
B. Forest and Grassland Conversion	0.00		0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00
D. CO_2 Emissions and Removals from Soil	3 769.10	0.00	3 769.10			3 769.10
E. Other	0.00	0.00	0.00	0.00	0.00	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	3 769.10	-28 100.00	-24 330.90	0.00	0.00	-24 330.90

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	73 249.92
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	48 919.02

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Sweden
1999
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**27 408.80**	**6 037.02**	**8 377.12**	**372.22**	**329.16**	**100.62**	**42 624.95**
1. Energy	**50 561.72**	**498.40**	**1 734.00**				**52 794.11**
A. Fuel Combustion (Sectoral Approach)	49 404.04	498.29	1 730.74				51 633.07
1. Energy Industries	10 952.02	47.54	355.74				11 355.31
2. Manufacturing Industries and Construction	10 660.62	48.95	495.80				11 205.37
3. Transport	19 433.67	193.90	586.45				20 214.02
4. Other Sectors	7 948.81	206.92	280.46				8 436.18
5. Other	408.92	0.98	12.28				422.18
B. Fugitive Emissions from Fuels	1 157.68	0.11	3.26				1 161.05
1. Solid Fuels	1 105.11	0.09	2.76				1 107.97
2. Oil and Natural Gas	52.57	0.02	0.50				53.08
2. Industrial Processes	**3 911.00**	**5.49**	**730.45**	**372.22**	**329.16**	**100.62**	**5 448.95**
A. Mineral Products	1 736.79	NO	NO				1 736.79
B. Chemical Industry	53.63	0.00	684.17	NA	NA	NO	737.80
C. Metal Production	2 120.58	0.09	0.00		321.58	38.24	2 480.49
D. Other Production	NE						0.00
E. Production of Halocarbons and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and SF_6				372.22	7.59	62.38	442.19
G. Other	IE	5.40	46.28	NA	NA	NO	51.68
3. Solvent and Other Product Use	**193.19**		**134.54**				**327.73**
4. Agriculture	**0.00**	**3 385.70**	**5 619.60**				**9 005.30**
A. Enteric Fermentation		2 972.85					2 972.85
B. Manure Management		412.85	642.00				1 054.86
C. Rice Cultivation		NO					0.00
D. Agricultural Soils [2]	IE	0.00	4 977.59				4 977.59
E. Prescribed Burning of Savannas		NO	NO				0.00
F. Field Burning of Agricultural Residues		NO	NO				0.00
G. Other		NO	NO				0.00
5. Land-Use Change and Forestry [1]	**-27 305.31**	**0.00**	**0.00**				**-27 305.31**
6. Waste	**48.20**	**2 147.43**	**158.53**				2 354.17
A. Solid Waste Disposal on Land	NA	2 147.43					2 147.43
B. Wastewater Handling		0.00	158.53				158.53
C. Waste Incineration	48.20	NA	0.00				48.20
D. Other	NO	NO	NO				0.00
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0.00**
	NO	NO	NO	NO	NO	NO	0.00
Memo Items:							
International Bunkers	**6 788.51**	**0.99**	**106.96**				**6 896.45**
Aviation	1 879.29	0.27	28.12				1 907.68
Marine	4 909.22	0.71	78.84				4 988.77
Multilateral Operations	**NE**	**0.00**	**0.00**				**0.00**
CO_2 Emissions from Biomass	**16 509.40**						**16 509.40**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	0.00	-31 100.00	-31 100.00			-31 100.00
B. Forest and Grassland Conversion	0.00		0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00
D. CO_2 Emissions and Removals from Soil	3 794.69	0.00	3 794.69			3 794.69
E. Other	0.00	0.00	0.00	0.00	0.00	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	3 794.69	-31 100.00	-27 305.31	0.00	0.00	-27 305.31

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	69 930.26
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	42 624.95

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Sweden
2000
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**25 121.21**	**5 819.35**	**8 254.90**	**419.28**	**270.50**	**92.25**	**39 977.49**
1. Energy	**48 083.78**	**475.65**	**1 708.26**				**50 267.69**
A. Fuel Combustion (Sectoral Approach)	46 942.19	475.53	1 704.91				49 122.63
1. Energy Industries	9 550.90	46.02	319.88				9 916.80
2. Manufacturing Industries and Construction	10 150.88	39.33	469.33				10 659.54
3. Transport	19 252.52	177.60	629.75				20 059.88
4. Other Sectors	7 594.36	211.88	274.03				8 080.27
5. Other	393.53	0.70	11.91				406.15
B. Fugitive Emissions from Fuels	1 141.59	0.11	3.35				1 145.05
1. Solid Fuels	1 064.07	0.09	2.63				1 066.79
2. Oil and Natural Gas	77.52	0.03	0.72				78.26
2. Industrial Processes	**4 112.12**	**5.34**	**699.98**	**419.28**	**270.50**	**92.25**	**5 599.46**
A. Mineral Products	1 971.12	NO	NO				1 971.12
B. Chemical Industry	47.74	0.00	650.38	NA	NA	NO	698.12
C. Metal Production	2 093.25	0.09	0.00		264.03	52.58	2 409.95
D. Other Production	NE						0.00
E. Production of Halocarbons and SF_6				NO	NO	NO	0.00
F. Consumption of Halocarbons and SF_6				419.28	6.47	39.67	465.42
G. Other	IE	5.25	49.60	NA	NA	NO	54.85
3. Solvent and Other Product Use	**186.38**		**122.14**				**308.52**
4. Agriculture	**0.00**	**3 297.44**	**5 578.40**				**8 875.84**
A. Enteric Fermentation		2 901.61					2 901.61
B. Manure Management		395.83	627.98				1 023.81
C. Rice Cultivation		NO					NO
D. Agricultural Soils [2]	IE	0.00	4 950.43				4 950.43
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		NO	NO				NO
G. Other		NO	NO				NO
5. Land-Use Change and Forestry [1]	**-27 305.51**	**0.00**	**0.00**				**-27 305.51**
6. Waste	**44.44**	**2 040.93**	**146.11**				2 231.48
A. Solid Waste Disposal on Land	NO	2 040.93					2 040.93
B. Wastewater Handling		0.00	146.11				146.11
C. Waste Incineration	44.44	NA	0.00				44.44
D. Other	NO	NO	NO				0.00
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	0.00
	NO	**NO**	**NO**	**NO**	**NO**	**NO**	**0.00**
Memo Items:							
International Bunkers	**6 697.19**	**0.94**	**105.08**				**6 803.21**
Aviation	1 926.37	0.23	28.97				1 955.57
Marine	4 770.83	0.70	76.10				4 847.63
Multilateral Operations	**NE**	0.00	0.00				**0.00**
CO_2 Emissions from Biomass	**15 111.77**						**15 111.77**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	0.00	-31 100.00	-31 100.00			-31 100.00
B. Forest and Grassland Conversion	0.00		0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00
D. CO_2 Emissions and Removals from Soil	3 794.49	0.00	3 794.49			3 794.49
E. Other	0.00	0.00	0.00	0.00	0.00	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	3 794.49	-31 100.00	-27 305.51	0.00	0.00	-27 305.51

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	67 282.99
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	39 977.49

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Sweden
2001
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**28 640.39**	**5 802.28**	**8 206.37**	**441.07**	**267.24**	**115.50**	**43 472.85**
1. Energy	**48 851.32**	**485.76**	**1 796.48**				**51 133.56**
A. Fuel Combustion (Sectoral Approach)	47 703.21	485.65	1 793.22				49 982.07
1. Energy Industries	10 845.08	56.27	362.78				11 264.13
2. Manufacturing Industries and Construction	10 215.16	49.57	486.53				10 751.26
3. Transport	19 407.18	161.38	664.45				20 233.00
4. Other Sectors	6 965.46	218.00	271.62				7 455.08
5. Other	270.33	0.43	7.84				278.59
B. Fugitive Emissions from Fuels	1 148.12	0.12	3.26				1 151.49
1. Solid Fuels	1 066.56	0.09	2.64				1 069.29
2. Oil and Natural Gas	81.55	0.03	0.62				82.20
2. Industrial Processes	**4 366.26**	**6.83**	**575.62**	**441.07**	**267.24**	**115.50**	**5 772.51**
A. Mineral Products	2 013.68	NO	NO				2 013.68
B. Chemical Industry	46.74	0.76	494.89	NA	NA	NO	542.39
C. Metal Production	2 305.84	0.11	0.00		259.29	60.23	2 625.46
D. Other Production	NE						0.00
E. Production of Halocarbons and SF_6				NO	NO	NO	0.00
F. Consumption of Halocarbons and SF_6				441.07	7.95	55.27	504.29
G. Other	IE	5.96	80.72	NA	NA	NO	86.69
3. Solvent and Other Product Use	**186.18**		**118.42**				**304.60**
4. Agriculture	**0.00**	**3 319.73**	**5 570.85**				**8 890.58**
A. Enteric Fermentation		2 874.94					2 874.94
B. Manure Management		444.79	590.70				1 035.49
C. Rice Cultivation		NO					0.00
D. Agricultural Soils [2]	IE	0.00	4 980.15				4 980.15
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		NO	NO				NO
G. Other		NO	NO				NO
5. Land-Use Change and Forestry [1]	**-24 810.84**	**0.00**	**0.00**				**-24 810.84**
6. Waste	**47.47**	**1 989.96**	**145.01**				2 182.44
A. Solid Waste Disposal on Land	NA	1 989.96					1 989.96
B. Wastewater Handling		0.00	145.01				145.01
C. Waste Incineration	47.47	NA	NO				47.47
D. Other	NO	NO	NO				0.00
7. Other *(please specify)*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	NO	NO	NO	NO	NO	NO	NO
Memo Items:							
International Bunkers	**6 526.31**	**0.91**	**102.06**				**6 629.28**
Aviation	1 870.86	0.22	28.14				1 899.22
Marine	4 655.45	0.69	73.92				4 730.06
Multilateral Operations	**NE**	**0.00**	**0.00**				**0.00**
CO_2 Emissions from Biomass	**18 179.06**						**18 179.06**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	106 961.79	-135 547.83	-28 586.04			-28 586.04
B. Forest and Grassland Conversion	0.00		0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00
D. CO_2 Emissions and Removals from Soil	3 775.21	0.00	3 775.21			3 775.21
E. Other	0.00	0.00	0.00	0.00	0.00	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	110 736.99	-135 547.83	-24 810.84	0.00	0.00	-24 810.84

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	68 283.69
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	43 472.85

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO_2 emissions from LUCF.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Sweden
2002
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**28 290.35**	**5 628.97**	**8 157.66**	**462.19**	**300.69**	**103.22**	**42 943.08**
1. Energy	**50 352.18**	**476.21**	**1 863.88**				**52 692.27**
A. Fuel Combustion (Sectoral Approach)	49 228.18	476.09	1 860.48				51 564.76
1. Energy Industries	12 112.04	59.27	391.77				12 563.08
2. Manufacturing Industries and Construction	10 514.73	42.33	487.97				11 045.03
3. Transport	19 801.66	151.03	693.69				20 646.38
4. Other Sectors	6 480.92	222.97	277.52				6 981.42
5. Other	318.83	0.49	9.52				328.84
B. Fugitive Emissions from Fuels	1 123.99	0.12	3.40				1 127.51
1. Solid Fuels	1 040.86	0.09	2.65				1 043.59
2. Oil and Natural Gas	83.14	0.03	0.75				83.92
2. Industrial Processes	**4 243.14**	**6.94**	**539.09**	**462.19**	**300.69**	**103.22**	**5 655.28**
A. Mineral Products	1 983.44	NO	NO				1 983.44
B. Chemical Industry	50.00	0.76	455.39	NA	NA	NO	506.15
C. Metal Production	2 209.70	0.10	0.00		282.99	68.12	2 560.90
D. Other Production	NE						0.00
E. Production of Halocarbons and SF_6				NO	NO	NO	0.00
F. Consumption of Halocarbons and SF_6				462.19	17.71	35.11	515.00
G. Other	IE	6.09	83.70	NA	NA	NO	89.79
3. Solvent and Other Product Use	**175.63**		**127.14**				**302.76**
4. Agriculture	**0.00**	**3 300.58**	**5 487.85**				**8 788.43**
A. Enteric Fermentation		2 858.40					2 858.40
B. Manure Management		442.18	591.37				1 033.54
C. Rice Cultivation		NO					0.00
D. Agricultural Soils[2]	IE	0.00	4 896.49				4 896.49
E. Prescribed Burning of Savannas		NO	NO				0.00
F. Field Burning of Agricultural Residues		NO	NO				0.00
G. Other		NO	NO				0.00
5. Land-Use Change and Forestry[1]	**-26 541.32**	**0.00**	**0.00**				**-26 541.32**
6. Waste	**60.73**	**1 845.24**	**139.69**				2 045.66
A. Solid Waste Disposal on Land	NA	1 845.24					1 845.24
B. Wastewater Handling		0.00	139.69				139.69
C. Waste Incineration	60.73	NA	0.00				60.73
D. Other	NO	NO	NO				0.00
7. Other *(please specify)*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	NO	NO	NO	NO	NO	NO	0.00
Memo Items:							
International Bunkers	**5 716.15**	**0.82**	**90.12**				**5 807.09**
Aviation	1 611.37	0.21	24.70				1 636.27
Marine	4 104.78	0.61	65.42				4 170.81
Multilateral Operations	**NE**	**0.00**	**0.00**				**0.00**
CO_2 Emissions from Biomass	**17 447.62**						**17 447.62**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	108 832.57	-139 138.69	-30 306.12			-30 306.12
B. Forest and Grassland Conversion	0.00		0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00
D. CO_2 Emissions and Removals from Soil	3 764.80	0.00	3 764.80			3 764.80
E. Other	0.00	0.00	0.00	0.00	0.00	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	112 597.37	-139 138.69	-26 541.32	0.00	0.00	-26 541.32

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	69 484.40
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	42 943.08

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO_2 emissions from LUCF.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Sweden
2003
Submission 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**34 496.17**	**5 512.97**	**8 210.32**	**470.92**	**298.54**	**66.44**	**49 055.37**
1. Energy	**51 199.86**	**489.42**	**1 952.16**				**53 641.43**
A. Fuel Combustion (Sectoral Approach)	50 419.55	489.33	1 949.53				52 858.40
1. Energy Industries	12 768.83	63.70	442.83				13 275.37
2. Manufacturing Industries and Construction	11 128.77	42.64	498.81				11 670.22
3. Transport	20 056.50	139.06	715.47				20 911.03
4. Other Sectors	6 165.96	243.49	283.35				6 692.81
5. Other	299.48	0.43	9.07				308.99
B. Fugitive Emissions from Fuels	780.32	0.09	2.63				783.03
1. Solid Fuels	700.05	0.06	1.89				702.00
2. Oil and Natural Gas	80.27	0.03	0.73				81.03
2. Industrial Processes	**4 505.35**	**7.43**	**533.26**	**470.92**	**298.54**	**66.44**	**5 881.95**
A. Mineral Products	1 924.30	0.00	0.00				1 924.30
B. Chemical Industry	47.74	0.83	445.87	NA	NA	0.00	494.44
C. Metal Production	2 533.31	0.13	0.00		282.33	35.06	2 850.82
D. Other Production	NE						0.00
E. Production of Halocarbons and SF_6				NO	NO	0.00	0.00
F. Consumption of Halocarbons and SF_6				470.92	16.21	31.38	518.52
G. Other	IE	6.48	87.40	NA	NA	0.00	93.87
3. Solvent and Other Product Use	**168.96**		**136.38**				**305.33**
4. Agriculture	**0.00**	**3 276.06**	**5 448.87**				**8 724.93**
A. Enteric Fermentation		2 816.66					2 816.66
B. Manure Management		459.40	560.27				1 019.66
C. Rice Cultivation		0.00					0.00
D. Agricultural Soils[2]	IE	0.00	4 888.61				4 888.61
E. Prescribed Burning of Savannas		0.00	0.00				0.00
F. Field Burning of Agricultural Residues		0.00	0.00				0.00
G. Other		0.00	0.00				0.00
5. Land-Use Change and Forestry[1]	**-21 498.94**	**0.00**	**0.00**				**-21 498.94**
6. Waste	**120.94**	**1 740.07**	**139.65**				2 000.66
A. Solid Waste Disposal on Land	NA	1 740.07					1 740.07
B. Wastewater Handling		0.00	139.65				139.65
C. Waste Incineration	120.94	0.00	0.00				120.94
D. Other	NO	0.00	0.00				0.00
7. Other *(please specify)*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	NO	NO	NO	NO	NO	NO	0.00
Memo Items:							
International Bunkers	**7 087.67**	**0.97**	**111.55**				**7 200.19**
Aviation	1 566.51	0.15	24.00				1 590.66
Marine	5 521.16	0.82	87.55				5 609.53
Multilateral Operations	**NE**	**0.00**	**0.00**				**0.00**
CO_2 Emissions from Biomass	**18 371.30**						**18 371.30**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	113 873.39	-139 138.69	-25 265.30			-25 265.30
B. Forest and Grassland Conversion	0.00		0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	0.00	0.00	0.00			0.00
D. CO_2 Emissions and Removals from Soil	3 766.36	0.00	3 766.36			3 766.36
E. Other	0.00	0.00	0.00	0.00	0.00	0.00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	117 639.75	-139 138.69	-21 498.94	0.00	0.00	-21 498.94

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	70 554.31
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	49 055.37

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table 10s5 if Parties report non-CO_2 emissions from LUCF.

TABLE 10 EMISSIONS TRENDS (CO_2)

Sweden

(Sheet 1 of 5)

2003

Submission

2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
							(Gg)								
1. Energy	**0.00**	**51 661.32**	**52 216.42**	**52 110.57**	**51 727.44**	**54 084.40**	**52 901.58**	**56 551.33**	**52 400.27**	**53 062.41**	**50 561.72**	**48 083.78**	**48 851.32**	**50 352.18**	**51 199.86**
A. Fuel Combustion (Sectoral Approach)	0.00	50 613.66	51 213.84	51 279.52	50 727.69	52 743.92	51 667.08	55 432.87	51 397.66	51 913.64	49 404.04	46 942.19	47 703.21	49 228.18	50 419.55
1. Energy Industries		10 186.63	11 391.60	11 932.92	11 771.07	12 243.10	11 347.08	15 335.97	11 353.40	12 363.27	10 952.02	9 550.90	10 845.08	12 112.04	12 768.83
2. Manufacturing Industries and Construction		10 724.42	10 466.67	9 648.74	10 371.41	11 357.24	11 591.14	11 596.52	12 157.57	11 571.47	10 660.62	10 150.88	10 215.16	10 514.73	11 128.77
3. Transport		18 351.64	18 056.26	18 939.31	18 102.60	18 689.89	18 811.32	18 603.13	18 822.27	19 103.13	19 433.67	19 252.52	19 407.18	19 801.66	20 056.50
4. Other Sectors		10 505.86	10 232.16	9 639.36	9 605.92	9 680.37	9 215.49	9 252.82	8 480.32	8 404.77	7 948.81	7 594.36	6 965.46	6 480.92	6 165.96
5. Other		845.11	1 067.16	1 119.19	876.69	773.32	702.05	644.42	584.11	471.01	408.92	393.53	270.33	318.83	299.48
B. Fugitive Emissions from Fuels	0.00	1 047.66	1 002.58	831.05	999.75	1 340.48	1 234.51	1 118.47	1 002.60	1 148.78	1 157.68	1 141.59	1 148.12	1 123.99	780.32
1. Solid Fuels		947.38	930.82	743.96	910.44	1 270.65	1 152.24	1 056.93	920.75	1 076.99	1 105.11	1 064.07	1 066.56	1 040.86	700.05
2. Oil and Natural Gas		100.28	71.75	87.09	89.31	69.84	82.26	61.54	81.85	71.78	52.57	77.52	81.55	83.14	80.27
2. Industrial Processes	**0.00**	**4 252.15**	**4 136.87**	**3 996.45**	**4 045.68**	**4 285.12**	**4 378.45**	**4 319.78**	**4 100.96**	**4 134.09**	**3 911.00**	**4 112.12**	**4 366.26**	**4 243.14**	**4 505.35**
A. Mineral Products		1 917.47	1 727.12	1 640.91	1 661.33	1 742.96	1 951.39	1 863.66	1 735.11	1 788.97	1 736.79	1 971.12	2 013.68	1 983.44	1 924.30
B. Chemical Industry		68.80	69.55	53.26	54.76	57.14	57.77	58.90	58.40	54.01	53.63	47.74	46.74	50.00	47.74
C. Metal Production		2 265.89	2 340.20	2 302.28	2 329.59	2 485.02	2 369.30	2 397.23	2 307.45	2 291.11	2 120.58	2 093.25	2 305.84	2 209.70	2 533.31
D. Other Production		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Production of Halocarbons and SF_6															
F. Consumption of Halocarbons and SF_6															
G. Other		IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
3. Solvent and Other Product Use		**320.32**	**311.23**	**300.78**	**278.83**	**274.73**	**263.57**	**248.31**	**231.70**	**212.70**	**193.19**	**186.38**	**186.18**	**175.63**	**168.96**
4. Agriculture	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
A. Enteric Fermentation															
B. Manure Management															
C. Rice Cultivation															
D. Agricultural Soils [2]	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
E. Prescribed Burning of Savannas															
F. Field Burning of Agricultural Residues															
G. Other															
5. Land-Use Change and Forestry [3]	**0.00**	**-20 291.96**	**-29 327.65**	**-23 353.08**	**-29 332.10**	**-26 305.35**	**-21 292.70**	**-22 269.05**	**-27 287.61**	**-24 330.90**	**-27 305.31**	**-27 305.51**	**-24 810.84**	**-26 541.32**	**-21 498.94**
A. Changes in Forest and Other Woody Biomass Stocks		-24 100.00	-33 100.00	-27 100.00	-33 100.00	-30 100.00	-25 100.00	-26 100.00	-31 100.00	-28 100.00	-31 100.00	-31 100.00	-28 586.04	-30 306.12	-25 265.30
B. Forest and Grassland Conversion		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. CO_2 Emissions and Removals from Soil		3 808.04	3 772.35	3 746.92	3 767.90	3 794.65	3 807.30	3 830.95	3 812.39	3 769.10	3 794.69	3 794.49	3 775.21	3 764.80	3 766.36
E. Other		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6. Waste	**0.00**	**43.86**	**52.20**	**58.33**	**48.02**	**49.08**	**42.74**	**49.12**	**50.60**	**49.16**	**48.20**	**44.44**	**47.47**	**60.73**	**120.94**
A. Solid Waste Disposal on Land		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
B. Waste-water Handling															
C. Waste Incineration		43.86	52.20	58.33	48.02	49.08	42.74	49.12	50.60	49.16	48.20	44.44	47.47	60.73	120.94
D. Other		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
7. Other *(please specify)*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total Emissions/Removals with LUCF [4]	**0.00**	**35 985.69**	**27 389.07**	**33 113.05**	**26 767.87**	**32 387.99**	**36 293.64**	**38 899.50**	**29 495.92**	**33 127.47**	**27 408.80**	**25 121.21**	**28 640.39**	**28 290.35**	**34 496.17**
Total Emissions without LUCF[4]	**0.00**	**56 277.65**	**56 716.72**	**56 466.13**	**56 099.96**	**58 693.34**	**57 586.35**	**61 168.55**	**56 783.52**	**57 458.37**	**54 714.11**	**52 426.72**	**53 451.23**	**54 831.67**	**55 995.11**
Memo Items:															
International Bunkers	**0.00**	**3 563.08**	**3 727.93**	**3 908.91**	**4 252.67**	**4 910.83**	**4 937.85**	**5 183.98**	**5 908.98**	**6 690.61**	**6 788.51**	**6 697.19**	**6 526.31**	**5 716.15**	**7 087.67**
Aviation		1 335.16	1 088.16	899.65	1 229.95	1 350.69	1 437.04	1 475.52	1 560.26	1 673.00	1 879.29	1 926.37	1 870.86	1 611.37	1 566.51
Marine		2 227.92	2 639.78	3 009.26	3 022.72	3 560.13	3 500.80	3 708.47	4 348.72	5 017.61	4 909.22	4 770.83	4 655.45	4 104.78	5 521.16
Multilateral Operations		**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**
CO_2 Emissions from Biomass		**11 368.20**	**11 774.91**	**12 724.55**	**13 584.56**	**15 127.32**	**15 919.98**	**17 735.22**	**16 265.28**	**16 645.25**	**16 509.40**	**15 111.77**	**18 179.06**	**17 447.62**	**18 371.30**

[1] Fill in the base year adopted by the Party under the Convention, if different from 1990.

[2] See footnote 4 to Summary 1.A of this common reporting format.

[3] Take the net emissions as reported in Summary 1.A of this common reporting format. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

[4] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report CO_2 emissions and removals from Land-Use Change and Forestry.

TABLE 10 EMISSIONS TRENDS (CH_4)

Sweden

(Sheet 2 of 5)

2003

Submission

2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
						(Gg)									
Total Emissions	**0.00**	**310.01**	**309.00**	**314.09**	**317.07**	**313.65**	**309.54**	**307.81**	**304.41**	**297.02**	**287.48**	**277.11**	**276.30**	**268.05**	**262.52**
1. Energy	**0.00**	**26.87**	**26.70**	**26.69**	**26.74**	**26.44**	**26.96**	**27.24**	**25.52**	**24.96**	**23.73**	**22.65**	**23.13**	**22.68**	**23.31**
A. Fuel Combustion (Sectoral Approach)	0.00	26.87	26.70	26.69	26.74	26.43	26.96	27.24	25.51	24.96	23.73	22.64	23.13	22.67	23.30
1. Energy Industries		1.05	1.22	1.08	1.39	1.64	1.80	2.53	2.08	2.21	2.26	2.19	2.68	2.82	3.03
2. Manufacturing Industries and Construction		2.18	2.11	2.49	2.44	2.76	2.64	2.57	2.48	2.49	2.33	1.87	2.36	2.02	2.03
3. Transport		12.82	12.52	12.29	12.00	11.77	11.55	10.94	10.31	9.80	9.23	8.46	7.68	7.19	6.62
4. Other Sectors		10.71	10.73	10.72	10.82	10.17	10.88	11.12	10.57	10.41	9.85	10.09	10.38	10.62	11.59
5. Other		0.11	0.12	0.11	0.08	0.09	0.09	0.07	0.07	0.05	0.05	0.03	0.02	0.02	0.02
B. Fugitive Emissions from Fuels	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
1. Solid Fuels		0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Oil and Natural Gas		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Industrial Processes	**0.00**	**0.23**	**0.23**	**0.23**	**0.24**	**0.22**	**0.24**	**0.24**	**0.25**	**0.34**	**0.26**	**0.25**	**0.33**	**0.33**	**0.35**
A. Mineral Products		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.04
C. Metal Production		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.01
D. Other Production															
E. Production of Halocarbons and SF_6															
F. Consumption of Halocarbons and SF_6															
G. Other		0.23	0.23	0.23	0.23	0.22	0.23	0.23	0.25	0.33	0.26	0.25	0.28	0.29	0.31
3. Solvent and Other Product Use															
4. Agriculture	**0.00**	**161.29**	**158.33**	**163.05**	**170.32**	**172.43**	**168.10**	**167.54**	**167.43**	**162.96**	**161.22**	**157.02**	**158.08**	**157.17**	**156.00**
A. Enteric Fermentation		144.12	141.54	145.73	150.74	152.33	147.91	147.09	147.45	143.21	141.56	138.17	136.90	136.11	134.13
B. Manure Management		17.17	16.79	17.31	19.58	20.10	20.20	20.45	19.98	19.76	19.66	18.85	21.18	21.06	21.88
C. Rice Cultivation		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils		IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
E. Prescribed Burning of Savannas		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other		NO	NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
A. Changes in Forest and Other Woody Biomass Stocks															
B. Forest and Grassland Conversion		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands															
D. CO_2 Emissions and Removals from Soil															
E. Other		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6. Waste	**0.00**	**121.61**	**123.74**	**124.12**	**119.77**	**114.55**	**114.24**	**112.79**	**111.21**	**108.75**	**102.26**	**97.19**	**94.76**	**87.87**	**82.86**
A. Solid Waste Disposal on Land		121.61	123.74	124.12	119.77	114.55	114.24	112.79	111.21	108.75	102.26	97.19	94.76	87.87	82.86
B. Waste-water Handling		IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
C. Waste Incineration		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
7. Other *(please specify)*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo Items:															
International Bunkers	**0.00**	**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.04**	**0.04**	**0.04**	**0.05**	**0.05**	**0.04**	**0.04**	**0.04**	**0.05**
Aviation		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Marine		0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
Multilateral Operations		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
CO_2 Emissions from Biomass															

TABLE 10 EMISSIONS TRENDS (N_2O)

Sweden

(Sheet 3 of 5)

2003

Submission

2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
						(Gg)									
Total Emissions	**0.00**	**28.62**	**28.19**	**27.96**	**28.27**	**28.65**	**28.03**	**28.63**	**28.42**	**28.50**	**27.02**	**26.63**	**26.47**	**26.32**	**26.48**
1. Energy	**0.00**	**4.91**	**4.99**	**5.16**	**5.21**	**5.46**	**5.42**	**6.05**	**5.61**	**5.73**	**5.59**	**5.51**	**5.80**	**6.01**	**6.30**
A. Fuel Combustion (Sectoral Approach)	0.00	4.90	4.98	5.15	5.20	5.45	5.41	6.04	5.60	5.72	5.58	5.50	5.78	6.00	6.29
1. Energy Industries		1.09	1.18	1.21	1.19	1.23	1.16	1.75	1.20	1.25	1.15	1.03	1.17	1.26	1.43
2. Manufacturing Industries and Construction		1.64	1.61	1.60	1.67	1.79	1.76	1.73	1.77	1.72	1.60	1.51	1.57	1.57	1.61
3. Transport		1.04	1.10	1.20	1.23	1.34	1.44	1.53	1.62	1.75	1.89	2.03	2.14	2.24	2.31
4. Other Sectors		1.03	0.99	1.01	1.02	1.02	0.98	0.97	0.95	0.94	0.90	0.88	0.88	0.90	0.91
5. Other		0.09	0.11	0.12	0.09	0.07	0.06	0.06	0.06	0.05	0.04	0.04	0.03	0.03	0.03
B. Fugitive Emissions from Fuels	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
1. Solid Fuels		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
2. Oil and Natural Gas		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Industrial Processes	**0.00**	**2.81**	**2.95**	**2.84**	**2.77**	**2.68**	**2.48**	**2.39**	**2.37**	**2.64**	**2.36**	**2.26**	**1.86**	**1.74**	**1.72**
A. Mineral Products		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry		2.68	2.82	2.71	2.63	2.55	2.34	2.24	2.22	2.49	2.21	2.10	1.60	1.47	1.44
C. Metal Production		NE	NE	NE	NE	NE	NE	NE	NE	NA	NE	NE	NE	NE	NE
D. Other Production															
E. Production of Halocarbons and SF_6															
F. Consumption of Halocarbons and SF_6															
G. Other		0.13	0.14	0.13	0.14	0.14	0.14	0.14	0.15	0.15	0.15	0.16	0.26	0.27	0.28
3. Solvent and Other Product Use		**0.29**	**0.29**	**0.35**	**0.35**	**0.31**	**0.40**	**0.44**	**0.46**	**0.47**	**0.43**	**0.39**	**0.38**	**0.41**	**0.44**
4. Agriculture	**0.00**	**19.98**	**19.33**	**19.02**	**19.36**	**19.61**	**19.13**	**19.15**	**19.39**	**19.15**	**18.13**	**17.99**	**17.97**	**17.70**	**17.58**
A. Enteric Fermentation															
B. Manure Management		2.58	2.50	2.56	2.32	2.34	2.15	2.15	2.23	2.23	2.07	2.03	1.91	1.91	1.81
C. Rice Cultivation															
D. Agricultural Soils		17.40	16.83	16.47	17.03	17.28	16.98	17.00	17.16	16.93	16.06	15.97	16.06	15.80	15.77
E. Prescribed Burning of Savannas		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land-Use Change and Forestry	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
A. Changes in Forest and Other Woody Biomass Stocks															
B. Forest and Grassland Conversion		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands															
D. CO_2 Emissions and Removals from Soil															
E. Other		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6. Waste	**0.00**	**0.63**	**0.63**	**0.59**	**0.59**	**0.58**	**0.60**	**0.60**	**0.60**	**0.52**	**0.51**	**0.47**	**0.47**	**0.45**	**0.45**
A. Solid Waste Disposal on Land															
B. Waste-water Handling		0.63	0.63	0.59	0.59	0.58	0.60	0.60	0.60	0.52	0.51	0.47	0.47	0.45	0.45
C. Waste Incineration		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Other		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
7. Other *(please specify)*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
		NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo Items:															
International Bunkers	**0.00**	**0.18**	**0.19**	**0.21**	**0.22**	**0.25**	**0.25**	**0.26**	**0.30**	**0.34**	**0.35**	**0.34**	**0.33**	**0.29**	**0.36**
Aviation		0.06	0.05	0.05	0.06	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.09	0.08	0.08
Marine		0.12	0.14	0.16	0.16	0.19	0.18	0.19	0.23	0.26	0.25	0.25	0.24	0.21	0.28
Multilateral Operations		**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**
CO_2 Emissions from Biomass															

TABLE 10 EMISSION TRENDS (HFCs, PFCs and SF_6)

Sweden

(Sheet 4 of 5)

2003

Submission

2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
							(Gg)								
Emissions of HFCs[5] – CO_2 equivalent (Gg)	**0.00**	**3.85**	**8.20**	**11.32**	**33.16**	**72.91**	**129.40**	**181.31**	**275.64**	**311.47**	**372.22**	**419.28**	**441.07**	**462.19**	**470.92**
HFC-23		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-32		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-41															
HFC-43-10mee															
HFC-125		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-134															
HFC-134a		0.00	0.01	0.01	0.03	0.05	0.09	0.12	0.18	0.21	0.26	0.29	0.30	0.32	0.32
HFC-152a		0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.14	0.14	0.13	0.15	0.17	0.14	0.21
HFC-143															
HFC-143a		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-227ea		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-236fa															
HFC-245ca															
Emissions of PFCs[5] – CO_2 equivalent (Gg)	**0.00**	**440.05**	**432.66**	**335.98**	**350.87**	**348.92**	**391.40**	**351.04**	**324.10**	**308.76**	**329.16**	**270.50**	**267.24**	**300.69**	**298.54**
CF_4		0.06	0.06	0.04	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.04
C_2F_6		0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.00
C_3F_8		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_4F_{10}															
c-C_4F_8															
C_5F_{12}															
C_6F_{14}															
Emissions of SF_6[5] – CO_2 equivalent (Gg)	**0.00**	**107.31**	**109.70**	**109.46**	**97.75**	**102.29**	**129.30**	**110.66**	**155.83**	**99.42**	**100.62**	**92.25**	**115.50**	**103.22**	**66.44**
SF_6		0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00

[5] Enter information on the actual emissions. Where estimates are only available for the potential emissions, specify this in a comment to the corresponding cell. Only in this row the emissions are expressed as CO_2 equivalent emissions in order to facilitate data flow among spreadsheets.

TABLE 10 EMISSION TRENDS (SUMMARY)

Sweden

(Sheet 5 of 5)

2003

Submission

2005

GREENHOUSE GAS EMISSIONS	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)														
Net CO_2 emissions/removals	0.00	35 985.69	27 389.07	33 113.05	26 767.87	32 387.99	36 293.64	38 899.50	29 495.92	33 127.47	27 408.80	25 121.21	28 640.39	28 290.35	34 496.17
CO_2 emissions (without LUCF) [6]	0.00	56 277.65	56 716.72	56 466.13	56 099.96	58 693.34	57 586.35	61 168.55	56 783.52	57 458.37	54 714.11	52 426.72	53 451.23	54 831.67	55 995.11
CH_4	0.00	6 510.16	6 489.10	6 595.88	6 658.50	6 586.59	6 500.44	6 464.11	6 392.52	6 237.39	6 037.02	5 819.35	5 802.28	5 628.97	5 512.97
N_2O	0.00	8 871.29	8 738.47	8 666.60	8 764.13	8 880.91	8 688.00	8 875.06	8 811.08	8 834.50	8 377.12	8 254.90	8 206.37	8 157.66	8 210.32
HFCs	0.00	3.85	8.20	11.32	33.16	72.91	129.40	181.31	275.64	311.47	372.22	419.28	441.07	462.19	470.92
PFCs	0.00	440.05	432.66	335.98	350.87	348.92	391.40	351.04	324.10	308.76	329.16	270.50	267.24	300.69	298.54
SF_6	0.00	107.31	109.70	109.46	97.75	102.29	129.30	110.66	155.83	99.42	100.62	92.25	115.50	103.22	66.44
Total (with net CO_2 emissions/removals)	**0.00**	**51 918.34**	**43 167.20**	**48 832.29**	**42 672.28**	**48 379.62**	**52 132.19**	**54 881.67**	**45 455.09**	**48 919.01**	**42 624.94**	**39 977.49**	**43 472.86**	**42 943.08**	**49 055.37**
Total (without CO_2 from LUCF) [6] [8]	**0.00**	**72 210.30**	**72 494.85**	**72 185.36**	**72 004.38**	**74 684.96**	**73 424.89**	**77 150.71**	**72 742.69**	**73 249.91**	**69 930.25**	**67 283.00**	**68 283.69**	**69 484.40**	**70 554.31**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)														
1. Energy	0.00	53 747.21	54 323.45	54 269.25	53 904.03	56 333.47	55 147.69	58 999.06	54 674.73	55 361.55	52 794.11	50 267.69	51 133.56	52 692.27	53 641.43
2. Industrial Processes	0.00	5 678.90	5 606.88	5 340.02	5 391.80	5 645.18	5 801.16	5 707.23	5 596.52	5 678.51	5 448.94	5 599.47	5 772.52	5 655.28	5 881.95
3. Solvent and Other Product Use	0.00	410.55	400.29	408.35	386.09	370.54	387.26	385.64	373.37	356.85	327.73	308.52	304.60	302.76	305.33
4. Agriculture	0.00	9 580.54	9 318.16	9 321.37	9 577.70	9 701.73	9 461.02	9 455.03	9 526.69	9 360.20	9 005.30	8 875.84	8 890.58	8 788.43	8 724.93
5. Land-Use Change and Forestry [7]	0.00	-20 291.96	-29 327.65	-23 353.08	-29 332.10	-26 305.35	-21 292.70	-22 269.05	-27 287.61	-24 330.90	-27 305.31	-27 305.51	-24 810.84	-26 541.32	-21 498.94
6. Waste	0.00	2 793.11	2 846.07	2 846.37	2 744.77	2 634.04	2 627.77	2 603.75	2 571.38	2 492.80	2 354.17	2 231.48	2 182.44	2 045.66	2 000.66
7. Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

[6] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report CO_2 emissions and removals from Land-Use Change and Forestry.

[7] Net emissions.

[8] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry. Note that these totals will differ from the totals reported in Table Summary2 if Parties report non-CO_2 emissions from LUCF.

Annex 3: Bilateral and regional financial support related to implementation of the Framework Convention on Climate Change, 2000-2003

Table 5 **Bilateral and regional financial support related to implementation of the Convention, 2000 (SEK million)**

Recipient country/ region	Mitigation						Adaptation			Other	Total
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity building /research	Management of coastal areas	Other vulnerability reduction		
1. Mozambique	25.59						19.56	100.50			**145.65**
2. Tanzania	75.86		2.08	2.95		0.97	26.75	1.78		31.74	**142.13**
3. Vietnam	102.49			2.75		3.65	29.63	1.06			**139.58**
4. Nicaragua							0.53			104.65	**105.18**
5. Bangladesh										57.96	**57.96**
6. Zambia	6.87					2.17	37.06			0.13	**46.23**
7. Sri Lanka	31.00								0.42	1.33	**32.75**
8. Ethiopia				0.28			31.45				**31.73**
9. Laos			14.97	14.97		0.03	0.44				**30.41**
10. Russia	7.81	1.84	3.68	1.03	3.02	3.03				9.86	**30.27**
11. Poland	0.59		0.09		13.39			0.05		11.46	**25.58**
12. Zimbabwe		6.91		0.19			15.45			2.09	**24.64**
13. Palestine					22.16						**22.16**
14. Kosovo	18.71	1.42								1.42	**21.55**
15. Cambodia										20.02	**20.02**
16. Ghana	9.75									9.75	**19.50**
17. China	0.32			0.53	11.44	0.41	1.26			3.06	**17.02**
18. India			2.80		2.75		4.75			2.00	**12.30**
19. Thailand	0.67	1.31	1.03		0.67	1.98		3.94			**9.60**
20. Africa regional	0.18	6.92	1.01	5.07			41.84	4.39		8.48	**67.89**
21. Asia regional	1.70		1.50				26.58		4.48	5.01	**39.27**
22. Latin America reg	2.50		2.91	3.15			14.86	2.58	8.36	9.16	**43.52**
23. Europe regional	1.79	1.45		0.64				0.42		1.09	**5.39**
24. Global programmes	17.83	3.14	10.59	97.76	0.71	10.34	44.11	14.78	9.80	85.12	**294.18**
25. All others	8.80	12.66	10.50	4.82	9.48	9.92	23.34	-	0.24	20.16	**99.92**
TOTAL:	**312.46**	**35.65**	**51.16**	**134.14**	**63.62**	**32.50**	**317.61**	**129.50**	**23.30**	**384.49**	**1 484.43**
of which loans:	**40.75**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**19.75**	**60.50**

Table 5 **Bilateral and regional financial support related to implementation of the Convention, 2001 (SEK million)**

Recipient country/region	Mitigation						Adaptation			Other	Total
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity building /research	Management of coastal areas	Other vulnerability reduction		
1. Nepal	135.00										**135.00**
2. Bangladesh									1.16	124.62	**125.78**
3. Tanzania	43.86		1.54	1.68		1.01	36.25	1.59		35.51	**121.44**
4. Sri Lanka	102.00								1.82	8.09	**111.91**
5. Mozambique	40.95						15.76	42.45		7.53	**106.69**
6. Uganda	68.59			2.41	2.31		2.31			29.17	**104.79**
7. Vietnam	52.31		1.15	3.20		4.15	39.61	0.75			**101.17**
8. Nicaragua			2.59	2.59			1.65		1.65	54.00	**62.48**
9. Ethiopia	0.12			14.84			37.46			0.15	**52.57**
10. Zambia	8.15	0.20				0.11	33.94			0.04	**42.44**
11. India		0.60	4.53		11.12		17.61			4.63	**38.49**
12. Serbia	17.54	2.60								16.52	**36.66**
13. Russia	9.59	0.20	5.05	0.32	2.25	0.70		0.13		13.04	**31.28**
14. Laos			9.04	9.04	2.06	2.06	2.06				**24.26**
15. Kosovo	15.20	5.97	0.25				0.21			1.84	**23.47**
16. China	0.23	0.23	0.23	0.91	18.40	1.02	0.72			0.90	**22.64**
17. Palestine	6.90				10.04						**16.94**
18. Ghana	13.25									3.45	**16.70**
19. Ukraine			0.89	12.00						0.89	**13.78**
20. Africa regional	3.26	4.28	5.68	8.11	0.23	0.23	67.27	7.15	0.03	13.96	**110.20**
21. Asia regional	4.64		1.65	6.64			32.77			2.70	**48.40**
22. Latin America reg.			10.75	11.04			14.64	0.03	7.18	9.44	**53.08**
23. Europe regional	2.15			0.27						78.79	**81.21**
24. Global programmes	16.76	2.94	16.00	13.06		6.03	79.68	12.00	19.04	99.73	**265.24**
25. All others	16.72	9.74	5.90	15.49	11.44	9.05	15.79	8.91	0.13	26.96	**120.14**
TOTAL:	**557.2**	**26.8**	**65.2**	**101.6**	**57.9**	**24.4**	**397.7**	**73.0**	**31.0**	**531.96**	**1 866.76**
of which loans:	**340.7**	-	-	-	**18.4**	-	-	-	-	**62.3**	**421.39**

Table 5 **Bilateral and regional financial support related to implementation of the Convention, 2002 (SEK million)**

Recipient country/region	Mitigation						Adaptation			Other	Total
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity building /research	Management of coastal areas	Other vulnerability reduction		
1. Tanzania	51.05		0.29	2.90	1.03	0.53	10.89	3.15		56.65	**126.49**
2. Nicaragua			9.52	9.52			0.64		0.64	106.12	**126.44**
3. Mozambique	18.95						59.71	20.07		13.76	**112.49**
4. Vietnam	36.72		14.67	2.52		3.50	17.42	0.75			**75.58**
5. Russia	44.72		3.10	0.24	5.00			1.05		16.12	**70.23**
6. Uganda	10.77			10.31	10.31		14.07			24.44	**69.90**
7. Ethiopia	0.39			18.85			37.59	0.23		7.63	**64.69**
8. Zambia	5.71					0.14	43.85		3.09		**52.79**
9. Sri Lanka	2.75						45.00	0.89	1.02	0.18	**49.84**
10. Laos			3.22	3.22	3.76	3.76	6.73		2.43	18.00	**41.12**
11. Jordan	28.50	2.60					7.75				**38.85**
12. India		0.81	0.61		13.31		12.53			3.58	**30.84**
13. Serbia	16.81	6.91								6.65	**30.37**
14. Nepal	23.76										**23.76**
15. Bangladesh									1.60	18.07	**19.67**
16. China	0.18		5.00		11.30	1.20	1.91				**19.59**
17. Lithuania	17.16		0.01								**17.17**
18. Honduras		8.00		7.00	1.76				0.04	0.06	**16.86**
19. Kosovo	3.97	12.57								0.14	**16.68**
20. Africa regional	9.06	1.27	21.97	7.55	1.74	0.06	92.21	7.33	3.35	20.43	**164.97**
21. Asia regional	2.30		6.01	6.07			26.56			28.86	**69.80**
22. Latin America reg.			9.89	10.12			17.52	2.34	9.51	0.10	**49.48**
23. Europe regional	8.98		0.15		7.50	0.14		0.20		3.69	**20.66**
24. Global programmes	33.63	2.95	22.80	16.55		6.66	94.45	8.78	20.36	67.33	**273.51**
25. All others	34.26	11.77	3.14	25.55	24.02	3.75	23.09	1.99	4.40	43.51	**175.46**
TOTAL:	**349.7**	**46.9**	**100.4**	**120.4**	**79.7**	**19.7**	**511.9**	**46.8**	**46.4**	**435.3**	**1 757.24**
of which loans:	**59.7**	**-**	**5.0**	**-**	**11.0**	**-**	**45.0**	**-**	**-**	**18.0**	**138.66**

Table 5 **Bilateral and regional financial support for implementation of the Convention, 2003 (SEK million)**

Recipient country/region	Mitigation						Adaptation			Other	Total
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity building /research	Management of coastal areas	Other vulnerability reduction		
1. Mozambique	60.19						99.90	10.47		8.09	**178.65**
2. Tanzania	42.41			0.36		0.16	13.62	2.46		35.35	**94.36**
3. Ethiopia	0.39			8.33			66.09			3.97	**78.78**
4. India			0.63		59.23		11.38			2.41	**73.65**
5. Mongoliet	68.00										**68.00**
6. Laos			3.77	3.77	3.19	3.19	6.96		3.08	37.00	**60.96**
7. Bangladesh	40.00						2.85		0.81	4.42	**48.08**
8. Zambia	6.18						40.89			0.38	**47.45**
9. Uganda	7.69			7.11	6.49		19.57				**40.86**
10. Malawi	17.84									17.84	**35.68**
11. Nicaragua			15.25	15.25			2.30		2.28		**35.08**
12. Vietnam	15.40		0.25	3.13		2.10	12.45	0.37			**33.70**
13. Russia	11.95	1.56	1.84	0.05	4.36			0.44		12.84	**33.04**
14. Kosovo	12.72	9.98								1.70	**24.40**
15. Serbia	9.61	0.69								3.87	**14.17**
16. China	4.25			0.27		1.26	5.56			2.49	**13.83**
17. Ukraine	2.09		2.84	7.99						0.40	**13.32**
18. Latvia	3.00				8.82					0.96	**12.78**
19. Honduras		7.00		2.50	2.25						**11.75**
20. Africa regional		124.13	24.33	8.19	1.14		80.78	11.24	13.43	26.83	**290.07**
21. Asia regional	2.75	3.20	2.89	7.00			20.70	1.26	0.54	21.43	**59.77**
22. Latin America reg.			5.50	5.50			10.63	1.24	6.80	0.66	**30.33**
23. Europe regional	6.15		0.21	2.01	6.00		0.21			0.85	**15.43**
24. Global programmes	25.15	0.98	30.44	24.57		5.56	50.49	7.32	15.00	35.25	**194.76**
25. All others	18.06	13.58	4.11	11.94	14.43	5.89	28.30	1.38	7.78	32.03	**137.50**
TOTAL:	**353.8**	**161.1**	**92.1**	**108.0**	**105.9**	**18.2**	**472.7**	**36.2**	**49.7**	**248.8**	**1 646.40**
of which loans:	**108.2**	-	-	-	-	-	-	-	-	**181.0**	**289.22**

Annex 4: Description of the national registry for emission allowances

Name and contact details of the registry administrator	
Registry administrator	
Name	Mattias Eriksson
Address	Box 310
Post code	631 04
Postal town	Eskilstuna
Country	Sweden
Telephone number	+46 (0)16 544 2173, +46(0)70 2089910
Fax number	+46 (0)16 544 2099
E-mail	mattias.eriksson@stem.se

The Swedish national registry has been set up as a Swedish registry and not as part of a consolidated transnational registry together with other countries. Sweden is purchasing the registry software, together with Denmark, Estonia, Finland, Ireland, Lithuania, the Netherlands and Hungary, from the United Kingdom's Department of the Environment, Food and Rural Affairs (DEFRA).

The system is made up of a standardised relational database. All calls are made through what are known as *stored procedures*. MS SQL Server 2000 is used as the database manager. The system is run in a virtual server environment, which makes it possible to dynamically expand the capacity of the server when required. The capacity of the servers is oversized so that there is no risk of insufficient capacity.

The national registry is adapted to the data exchange standard (DES) between registry systems with the aim of ensuring correct, transparent and efficient exchange of data between national registries, the registry for the clean development mechanism and the independent (ITL) transaction log (decision 19/CP.7, paragraph 1). The European Commission approved the Swedish national registry for operation according to DES#7 in mid-April.

The Swedish registry meets all the requirements for procedures to minimise discrepancies in issuing, transactions, acquisition, cancellation and retirement of ERUs, CERS, AAUs or RMUs. The registry also fulfils the requirements for the termination of a transaction where a discrepancy has been discovered and the possibility of corrections in the event of failed termination of a transaction. The processes are only carried out by the authorised officers at the Swedish Energy Agency. The registry administrator is responsible for the work being carried out correctly and approves activities in the registry. To minimise the risk of inconsistent data in the registries and ITL, a transaction always takes place according to the requirements contained in DES. A transaction is not ended until both registries have received acknowledgement that the transaction has been registered on the server concerned. If a transaction which is initiated in the Swedish registry contains a non-conformity, this will be identified by ITL sending a message with an error code. If ITL sends an error code, the transaction is concluded in the registry. An error message is presented to the person who initiated the transaction. If the registry fails to conclude the transaction, the registry administrator notifies the central administrator, with the aim of obtaining instructions for any action to be taken. The registry administrator can carry out manual corrections on behalf of the central administrator.

The Commission Regulation (EC) No 2216/2004 of 21 December 2004 for a standardised and secured system of registries pursuant to Directive 2003/87/EC of the European Parliament and of the Council and Decision No 280/2004/EC of the European Parliament and of the Council accept only user name and password being required to log in (Annex XV). The Swedish Energy Agency requires log-in with electronic identification to the national registry (Bank ID, VeriSign PTA or SmartTrust), which

signifies a higher level of security than is prescribed by the Registries Ordinance. Security is also kept at a high level by TietoEnator being responsible for validation. Validation takes place through an OSIF interface[1]. This is a standard which has been drawn up by a cooperative organisation headed by Stockholm County Council. The Swedish Energy Agency has taken part in the preparation of the standard.

The Swedish registry will publish the information specified in Annex XVI of the Registries Ordinance at www.utslappshandel.se, which is the Internet address of the Swedish registry is www.utslappshandel.se.

To ensure, maintain and recover data with the aim of guaranteeing integrity of storage, the Swedish Energy Agency uses IBM's Tivoli Storage Manager (TSM) for backing up, restoring and archiving. The TSM server and its tape robot are located around 10 km from the Agency building and are connected by a fibre-optic cable. The TSM server makes routine backups every night. *Snapshots* are also taken every week for virtual servers to make it possible for data to be re-created quickly in the event of a critical situation. Virtual servers are arranged in a farm of multiple physical servers. In the event of maintenance of the physical hardware, virtual servers can be moved to another physical server in real time. It is thus possible to balance the utilisation of physical servers by moving virtual servers around on different physical servers. In the event of major disasters such as fires, the *snapshot* of a virtual server can be re-created on another physical server.

The registry software has been tested in four different tests by the European Commission (COM). General tests on the software have been carried out between COM and the software developer DEFRA (specified in Annex XIII to 2216/2004/EC). COM has also tested the registry on two occasions in accordance with DES#5.5 and DES#7 in relation to the Swedish Energy Agency.

[1] For further details. see www.sveid.se.

Annex 5: The national system for inventory and reporting of greenhouse gas emissions and removals

In accordance with the Kyoto Protocol and its associated decision 20/CP7, and the EU decision (280/2004/EC) concerning a mechanism for monitoring greenhouse gas emissions, Sweden has constructed a national system for inventory and reporting of greenhouse gas emissions and removals.[1] The national system is due to come into effect on 1 January 2006.

Name and contact information of responsible organisation

Ministry of Sustainable Development
Contact person: Per Rosenqvist
Address: 103 33 Stockholm, SWEDEN
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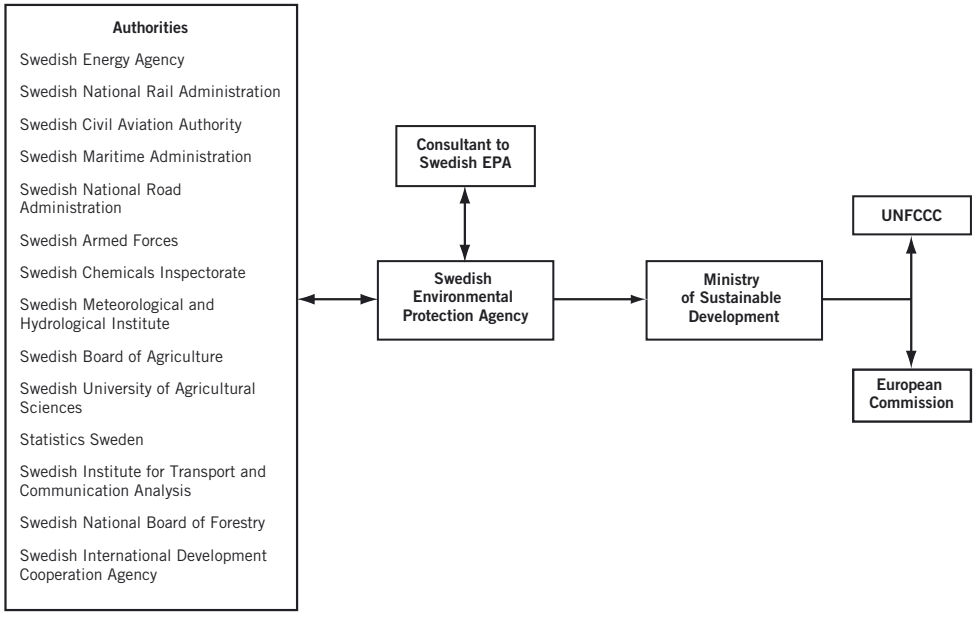
Organisational structure and roles and responsibilities of various government agencies

In order to set up the annual inventory report and other reporting, there is cooperation between the Ministry of Sustainable Development, the Swedish Environmental Protection Agency, government agencies and consultants.

The Ministry of Sustainable Development is responsible for the national system and for Sweden reporting in accordance with stated international requirements in the area of climate change. The ***Swedish Environmental Protection Agency*** is responsible, on behalf of the Ministry of Sustainable Development, for producing material for the required reporting. The Swedish EPA is thus respon-

Institutional Arrangements—Workflow



[1] Swedish Environmental Protection Agency 2005. Sweden's national system for inventory and reporting in accordance with the Kyoto Protocol and decisions within the EU

sible for coordinating the national system for Swedish climate reporting and for maintaining the reporting system required for reporting.

On behalf of the Swedish Environmental Protection Agency, ***consultants (SMED[2])*** process material arriving from the various government agencies and data they have produced themselves and carry out calculations of Swedish greenhouse gas emissions and removals.

Fourteen government agencies take part in the national system and are responsible for different parts of the inventory process:

The ***Swedish Energy Agency*** takes part by providing material for the calculation of emissions from the energy sector, material on projections for the energy sector, figures on the use of flexible mechanisms and figures from the national registry and by conducting a peer review in the energy sector excluding transport.

The ***Swedish National Rail Administration*** takes part by providing material for the calculation of emissions and calculations of emissions from the state-owned railways. The ***Swedish Civil Aviation Authority,*** the ***Swedish Maritime Administration,*** the ***Swedish National Road Administration*** and the ***Swedish Armed Forces*** take part by providing material for the calculation of emissions from aviation, shipping, road traffic and military transport respectively.

The ***Swedish Institute for Transport and Communications Analysis*** takes part by conducting a peer review in the transport sector.

The ***Swedish Chemicals Inspectorate*** takes part by supplying material for the calculation of emissions from the industrial processes and solvent and other product use sectors.

The ***Swedish Board of Agriculture*** takes part by providing material for the calculation of emissions from the agricultural sector as well as conducting a peer review in the agricultural sector and parts of the land use, land-use change and forestry sector (LULUCF).

Statistics Sweden takes part by providing material for the calculation of emissions from the agricultural sector and the land use, land-use change and forestry sector.

The ***Swedish University of Agricultural Sciences*** and the ***Swedish Meteorological and Hydrological Institute*** take part by providing material for calculations of emissions and removals of greenhouse gases from land use, land-use change and forestry.

The ***National Board of Forestry*** takes part by providing material for calculations of emissions and removals of greenhouse gases from land use, land-use change and forestry and conducting peer review in the land use, land-use change and forestry sector.

The ***Swedish International Development Cooperation Agency (Sida)*** takes part by providing material for the reporting of initiatives that relate to the agency's cooperation with developing countries.

Legal structure

The legal basis for the national system is provided by an "Ordinance (2005:626) Concerning Climate Reporting". In this ordinance, the Swedish Environmental Protection Agency has identified responsibilities for coordinating national work for Swedish climate reporting and maintaining the national system. The responsibilities of various government agencies who are to take part in the national system are also specified in the ordinance. The quality system, including national and international peer review, and times of delivery of material, are also set forth in the ordinance.

The legal responsibility of SMED (the consultants) is described in a framework contract between the Swedish Environmental Protection Agency and SMED. The contract governs the extent of the assignment, choice of methodology, requirements for quality systems, reporting times, assistance in development projects and international meetings.

There is also legislation in Sweden that indirectly supports climate-reporting work by providing a basis for the calculation of greenhouse gas emissions and removals. Environmental reports are submitted under the Environmental Code (1998:808), and the Official Statistics Act (SFS 2001:99) imposes an obligation to submit annual figures. In addition, the government agencies are obliged to comply with the Secrecy Act (1980:100) and to archive documents in accordance with the Archives Act (1990:782).

Procedural arrangements

The Swedish inventory and reporting are carried out annually by following a particular procedure. There is a plan of activity for the annual process which describes all activities that must be performed during the inventory and reporting to maintain a high level of quality.

Data are supplied from the government agencies to SMED, and on behalf of the Swedish Environmental Protection Agency SMED also gathers information from various businesses and organisations. Data are collected during the period from April to August, depending on when the figures become available. **Calculations** are then per-

[2] SMED is a consortium whose full name is Svenska MiljöEmissionsData ('Swedish Environmental Emissions Data) and comprises Statistics Sweden (SCB), the Swedish Meteorological and Hydrological Institute (SMHI), the Swedish Environmental Research Institute (IVL) and the Swedish University of Agricultural Sciences (SLU).

formed by SMED over the period from August to September and then undergo quality assurance and review. SMED supplies data, including the inventory report, to the Swedish Environmental Protection Agency in mid-October, after which a **national peer review** is conducted before the report is sent to the Ministry of Sustainable Development for preparation and forwarding to UNFCCC.

The process of collecting activity data, choosing emission factors and method and developing methods of calculation

Activity data are supplied from government agencies to SMED, which also collects activity data from various businesses and industry organisations, as well as environmental reports. Emission factors may be installation-specific, established at national level or standard factors from the IPCC. The methods for calculating emissions are in agreement with current requirements and guidelines. The Swedish Environmental Protection Agency has devised a quality system in consultation with concerned government agencies. It comprises routines for the checking and follow-up of inventory work. The result of checking and follow-up provides a basis for improving the inventory and reporting of the next year and establishing the need for development projects.

Analysis of priority emission sources

In accordance with IPCC Good Practice Guidance, Chapter 7, the Swedish Environmental Protection Agency, supported by SMED, carries out an annual analysis to identify the emission sources to which priority should be accorded in the inventory work. The analysis is reported annually and is used, together with other material, to provide guidance on what areas need to be improved. The analysis is communicated to the concerned government agencies, so that they can judge what methods and routines need to be adopted for quality control and quality assurance.

Conversion of previously reported data

After the peer review, opinions are collated and decisions are taken on what conversions are to be made for the next inventory. If new and better information on data or a better method becomes available, conversions are carried out by using consistent data or the new methodology for the whole time series. If this is not possible, an alternative technique is used in accordance with current guidelines [3]

The quality system

The Swedish Environmental Protection Agency established an overall **quality plan** in conjunction with the introduction of the quality system. Since the quality system was **implemented,** the quality plan forms part of the internal quality systems of the consultants and government agencies. The quality plan is updated continuously and revised after the annual inventory and reporting have been carried out.

The government agencies which take part in climate-reporting activity have to develop and maintain a **quality system** for the annual inventory and reporting in accordance with specified requirements. The quality system describes the overall structure for systematic inventory and reporting so that a high level of quality is maintained. The quality system covers all the parties involved in the inventory. These parties have introduced routines in accordance with the quality system to plan, carry out, check and follow up the activities required to complete the inventory. The Swedish quality system is based on the structure described in UNFCCC Decision 20/CP7.

The national system has to safeguard the level of quality in the inventory, that is to say ensure transparency, consistency, comparability, completeness and accuracy in the inventory. The Swedish Environmental Protection Agency establishes **quality targets** in order to steadily develop and improve the inventory and to provide a basis for the work of affected consultants and government agencies on the inventory.

The Swedish Environmental Protection Agency is responsible for conducting a **peer review at national level** in cooperation with concerned government agencies, according to the routines established for this purpose. This review takes place annually when the inventory is carried out, and covers the calculations performed and assumptions on which the calculations are based.

There are documented routines for the **expert peer review at international level.** Concerned government agencies and consultants are available to answer any questions.

The Swedish Environmental Protection Agency conducts **quality audits** of its own internal work on quality control and quality assurance, assisted by independent personnel. The Swedish Environmental Protection Agency is also responsible for consultants conducting internal quality audits during the inventory and assisting with the Swedish Environmental Protection Agency's quality audits of their work.

[3] IPCC. IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.

Approval of the inventory

The Swedish Environmental Protection Agency sends the climate reporting to the Ministry of Sustainable Development for preparation, 20 working days before the applicable reporting date. The climate report is sent to affected ministries in the Swedish Government Offices to canvas their views, which are collated, and when the climate report has been approved by the Ministry of Sustainable Development it is sent to UNFCCC and the European Commission.

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Kronologisk förteckning

1. Finansiella konglomerat. Fi.
2. Kungörande i PoIT. Redovisning av uppdrag om elektroniskt kungörande. Ju.
3. Svensk rätt i integrationspolitisk belysning. Ju.
4. Avräkning av utländsk skatt. Fi.
5. Angrepp mot informationssystem. Ju.
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11. Den europeiska exekutionstiteln för obestridda fordningar. Ju.
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13. Försäkringsbolags tillgång till patientjournaler. Ju.
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15. Förstärkning och förenkling – ändringar i anställningsskyddslagen och föräldraledighetslagen. N.
16. Att fånga kunnandet om lärande och undervisning. Om villkoren för skolledare och lärare att ta del av systematiskt framtagen kunskap om utbildningsverksamhet. U.
17. Vakant
18. Säkerhet i vägtunnlar. N.
19. De projektbaserade mekanismerna enligt Kyotoprotokollet och länkdirektivet. M.
20. Svenskt värdskap för ESS. U.
21. Tvångsmedel för att förebygga eller förhindra allvarlig brottslighet. Ju.
22. Småskalig livsmedelsförädling. Jo.
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24. Tidsbegränsat uppehållstillstånd för offer för människohandel m.fl. UD.
25. Förhandsavgörande från EG-domstolen. Ju.
26. Utökat informationsutbyte mellan arbetslöshetskassorna och inom Arbetsmarknadsverkets verksamhet. N.
27. Arbetsgivares informationsskyldighet – ändringar i anställningsskyddslagen. N.
28. Skattefusk, effektivitet och rättvisa – utökad skattekontroll i vissa branscher och diskussioner rörande schabloniserade inslag i beskattningen. Fi.
29. Förslag om ett utvecklat elcertifikatsystem. M.
30. En anpassad försvarsunderrättelseverksamhet. Fö.
31. Anpassningar till nya EG-bestämmelser om livsmedel, djurhälsa, foder, djurskydd och växtskydd m.m. + Bilagor. Jo.
32. Minknäringen i Sverige. Jo.
33. Vuxenutbildningslag. Förslag utarbetat inom Utbildnings- och kulturdepartementet. U.
34. Några bodelningsfrågor. Ju.
35. Rätten att sätta och utfärda betyg. U.
36. Genomförande av EG-direktivet om uppehållstillstånd för studier. UD.
37. Bulgariens och Rumäniens anslutning till Europeiska unionen. + Bilagor. UD.
38. Tillträde till Förenta nationernas konvention mot korruption. Ju.
39. Bostadsfinansiering. M.
40. Genomförande av EG-direktivet om mänskliga vävnader och celler. S.
41. Högsta och lägsta belopp för penningböter. Ju.
42. Kontraheringsplikt vid företagsförsäkring m.m. – en diskussionspromemoria. Ju.
43. Genomförande av direktivet och rambeslutet om åtgärder mot förorening från fartyg. N.
44. Sweden's second national report under the Joint Convention on the safety of spent fuel management and on the safety of radioactive waste management. Swedish implementation of the obligations of the Joint Convention. M.
45. Europakooperativ. Ju.
46. Lag om förbud mot vissa kampsportsmatcher. Ju.
47. Kompletterande bestämmelser till EG-förordningen om konsumentskyddssamarbete m.m. Jo.
48. Överlämnande av passageraruppgifter. UD.
49. Hamnskydd. N.
50. Personuppgiftsbehandling hos Försvarsmakten och Försvarets radioanstalt. Fö.
51. Energieffektivisering och energismart byggande. M.
52. Löneskrifter för enmansföretag. Fi.
53. Hemliga tvångsmedel m.m. under en stärkt parlamentarisk kontroll. Ju.
54. Upphovsrätt och handlingsoffentlighet. Redovisning av uppdrag rörande 8 kap. 27 § sekretesslagen. Ju.
55. Sweden's fourth national communication on climate change. Under the United Nations Framework Convention on Climate Change. M.

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